

**CITY OF CHICAGO
DEPARTMENT OF AVIATION
CHICAGO-O'HARE INTERNATIONAL AIRPORT
TAXIWAY Z/J AND TANK FARM ROAD – PACKAGE B**

**PART THREE OF THREE
TECHNICAL SPECIFICATIONS**

**SPECIFICATION NUMBER: 564489
PROJECT NUMBER: OH.6143.710.372.50**



**CITY OF CHICAGO
Rahm Emanuel
Mayor**



**O'HARE INTERNATIONAL AIRPORT
Ginger S. Evans
Commissioner
Chicago Department of Aviation**

Issued by:

**DEPARTMENT OF PROCUREMENT SERVICES
Jamie L. Rhee
Chief Procurement Officer**

**ISSUED FOR BID
MARCH 21, 2018**

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PROJECT REQUIREMENTS

SECTION 01010

PART 1 DESCRIPTION

1.01 SCOPE OF WORK

A. Work under this Contract consists of furnishing all labor, materials, tools, equipment, transportation and service for the **Taxiway Z/J and Tank Farm Road Package B** project as shown on the Plans and for the Work shown under all Sections of the Technical Specifications subject to the requirements of the Contract Documents, including all appurtenant Work and accessories, to the complete satisfaction, approval and acceptance by the Commissioner. The Work is to be performed under a unit price basis Contract. The Contractor will, among others:

1. Construct Taxiway J pavement
2. Construct Taxiway U pavement
3. Construct Tank Farm Road pavement
4. Construct drainage network to connect to existing drainage northeast of Runway 15-33
5. Install CECO, CED, Power, Sanitary, and Water utilities
6. Install Airfield Lighting infrastructure
7. Stripe taxiway and roadway pavement markings
8. Install temporary and final erosion control

1.02 COMMISSIONER'S REPRESENTATIVE

A. The Commissioner's representative on this Project is **WSP USA** – Construction Manager (CM). A Resident Engineer will be assigned to the Project. All contacts, inquiries, correspondence, and all submittals of any type, including but not limited to schedules, shop Drawings, Project data and samples, must be sent exclusively to the Resident Engineer unless otherwise directed by the Resident Engineer. The only exceptions are for notices that are required in the General Conditions - Part Two of the Contract, which are to be sent to the Chief Procurement Officer with copies of such notices sent to the Resident Engineer.

1.03 ARCHITECT/ENGINEER

- A. The Architect/Engineer on this Project is **Chicago Aviation Runway Designers (CARD) and Patrick Engineering**. The Contractor must not have any direct contact with the Architect/ Engineer, regarding this Project before or after Contract award. All inquiries regarding the Contract Documents must be made to the Resident Engineer only.

1.04 DIRECTOR/COMMISSIONER

- A. Where the Contract Documents refer to Commissioner or Director, it will be understood to be interchangeable and mean the Commissioner of the Chicago Department of Aviation (CDA) or the Director of the O'Hare Modernization Program (OMP), or their designated representative.

1.05 USE AND ADOPTION OF IDOT SSRBC

- A. Where the Illinois Department of Transportation "Standard Specifications for Road and Bridge Construction" (IDOT SSRBC) is adopted or referenced in the CDA/OMP technical specifications and standards, the following interpretations and translations will apply:
 - 1. Where the SSRBC refer to "Engineer", it will be understood to mean "Commissioner".
 - 2. Where the SSRBC refer to "Engineer" for required tests and inspection, it will be understood to mean "Contractor".
 - 3. The Contractor will perform the Quality Control (QC) tests and inspections, the Commissioner will perform the Quality Assurance (QA) as specified in the SSRBC.
 - 4. Unless otherwise indicated in the CDA/OMP specification, the SSRBC method of measurement and basis of payment will not apply.
 - 5. The SSRBC must be the current (or latest revision).
- B. Reference use of the SSRBC will include the current IDOT *Supplemental Specifications* and *Recurring Special Provisions* and *Policy Memorandums*.
- C. The above interpretations and provisions will apply and govern all specifications and standards where IDOT SSRBC is adopted or referenced, regardless of whether the individual specification fully defined them or not.

1.06 TYPICAL SUBGRADE PREPARATION FOR MISCELLANEOUS STRUCTURES

- A. In addition to the requirements shown on the Drawings, the Contractor must verify the required minimum allowable bearing on the subgrade beneath miscellaneous structures including storm and sanitary sewer manholes, catch basins, junction chambers, valve basins, and electrical manholes and handholes and other structures as directed by the Commissioner.
- B. Contractor QC to verify bearing to 3 feet minimum or to depth as directed by the Commissioner.
- C. The cost of verifying the required bearing will be considered included and incidental to the price of the structure.

1.07 SCHEDULED WORK HOURS

- A. The Contractor should anticipate that all Work performed within 250 feet of a runway centerline, except as noted otherwise in the Contract Documents, will be Night Time Work to be performed during the hours of 10:30 p.m. to 6:00 a.m. central time. Night Time Work may also be required for portions of work within the TOFA if closure can not be acquired for the active taxiway.

All other Work may be performed during normal day time hours, subject to height restrictions noted in 1.07.B. These hours will constitute the regularly scheduled working hours, for this portion of the Work.

- B. Work schedule may be restricted due to operational impacts including impacts to instrument flight rules (IFR) due to construction equipment heights or proximity to runway surfaces and NAVAID equipment. Night Work may be required where working height penetrates above the PART 77 contours, unless otherwise specifically allowed by the Commissioner. Closure of any movement area must be coordinated and scheduled during the weekly ORD Short-Term Operational Phasing (STOP) meeting.
- C. For other restrictions that may affect scheduling, refer to the "Standard Notes on General Requirements".

1.08 PERMIT REQUIREMENTS

- A. In addition to the General Conditions (Part 2), Article III – Property, Item E – Permits and Licenses, the following permits are required to

be obtained by the Contractor:

1. City of Chicago Department of Building (DOB) permits.
2. City of Chicago Department of Water Management (CDWM) sanitary and storm sewer installation permits.
3. City of Chicago Department of Environment (CDOE) permits for installation/removal of above ground storage tank (AST) and underground storage tank (UST), Crushing equipment installation permits and crushing authorization letter, demolition.
4. Illinois Environmental Protection Agency (IEPA) permits for the installation of crushing equipment, operation of the crushing equipment, demolition notification.
5. Compliance with the National Pollutant Discharge Elimination System (NPDES) ILR10 permitting program by providing Contractor/Subcontractor signature of the IEPA ILR10 Certification statement in each project's Storm Water Pollution Prevention Plan (SWPPP) (Coordination of the Notice of Intent and Notice of Termination will be handled by the Commissioner).
6. FAA 7460-1 Notice of Proposed Construction or Alteration.
7. Illinois Department of Transportation (IDOT) Highway permits.

B. The Contractor must include in the Baseline Schedule:

1. All permits required for the Work.
2. Tasks for the submittal of each permit application to the Commissioner thirty days in advance of the milestone submittal to the appropriate agency for permit. This thirty day duration is for the review of the application by the Commissioner. The content and accuracy of each permit application is solely the Contractor's responsibility.

C. Submittals:

1. Schedule of permits for the Work to be submitted during mobilization.
2. Copy of each permit application and all correspondence associated with the permit application and permit approval.

1.09 WORKFORCE DEVELOPMENT PROVISIONS FOR CDA FEDERALLY FUNDED PROJECTS

A. Employment Outreach Requirements:

1. The City is committed to improving access to employment for low income individuals and residents of socio-economically disadvantaged areas. To this end, the City supports and encourages the promotion of work opportunities to Chicago residents living in socio-economically disadvantaged areas. Contractor is strongly encouraged to employ residents of socio-economically disadvantaged areas and other low-income individuals.
2. The City is also committed to connecting veterans to employers, and employers to veterans. Therefore, the Contractor is reminded of its obligations under 49 USC 47112(c)(Veteran's Preference) and is encouraged to employ Chicago veterans and partner with the City's Office of Veterans Affairs to advertise job openings, obtain resumes, and promote general hiring outreach.
3. No later than the Notice to Proceed Date, the City may identify Socio-Economically Disadvantaged Areas. Contractor must conduct a minimum of one job fair in each of up to three Socio-Economically Disadvantaged Areas (to be identified by the City) to foster hiring employees from such areas. The job fairs are to be held no later than 30 days following the Notice to Proceed unless otherwise agreed by the City. Job fairs must include contractor's subcontractors to the extent practicable. Contractor must also participate in any City-sponsored job fairs or similar outreach events as reasonably requested by the City, including but not limited to job fairs for veterans. Nothing in this section prohibits Contractor from conducting additional job fairs in other locations or at other times. Pay Item 01010-02, "Allowance for Workforce Development" will cover the actual cost of renting a City approved hall or venue for Community Outreach Activities. This allowance will be measured for payment in accordance with Article X, "Changes in the Work," of Part 2 – General Conditions. Contractor must provide the cost estimate with name of hall or venue for the City's approval. All other work for conducting community outreach is considered incidental to the Contract.
4. For any new hires of Contractor or its Subcontractors, Contractor or Subcontractors must provide job postings or employment listings to area workforce development groups or agencies as identified by the City, assist agencies, and the City's Office of Veterans Affairs.
5. In order to help promote the efficiency of the Work, Contractor

must designate and identify a member of its team as an Employment Services Coordinator who will be assigned to assist employees, particularly new hires who are low income or are from Socio-Economically Disadvantaged Areas, or employees who are veterans, regarding access to information and social services that may help them be successful employees.

6. The Employment Services Coordinator will also serve as a liaison between the Contractor and social services organizations, assist agencies, workforce development groups or agencies, and labor organizations to help Contractor advertise job openings, obtain resumes, and plan and execute job fairs in Socio-Economically Disadvantaged Areas in order to promote hiring outreach throughout Chicago and especially in Socio-Economically Disadvantaged Areas. Likewise, the Employment Services Coordinator will also serve as a liaison between the Contractor and the City's Office of Veterans' Affairs and other veterans' affairs organizations to promote the employment of veterans.
7. Contractor must report to the City in a form acceptable to the Commissioner regarding its efforts under this section, and also the number of employees ultimately hired who are veterans or are from Socio-Economically Disadvantaged Areas.

B. Employment Plan:

No later than twenty business days after contract award Contractor must provide a written plan outlining the steps it intends to take to ensure compliance with its Equal Employment Opportunity obligations as well as its plans for outreach to veterans and to workers in Socio-Economically Disadvantaged Areas.

C. Sustainable Airport Commuting:

In accordance with CDA's commitment to sustainability and reducing carbon emissions associated with the airport, as well as reducing construction related traffic impacts on the traveling public, Contractor and its Subcontractors must encourage employees to access their jobs at the Airport by using public transportation. To this end, an allowance amount has been established for Contractor to provide a shuttle bus free to workers on the project between, at minimum, the worksite and the CTA Blue Line Rosemont station under Pay item 01010-02, "Allowance for Workforce Development". This allowance will be limited to the Contractor's actual costs of operating the shuttle bus. This

allowance will be measured for payment in accordance with Article X, "Changes in the Work," of Part 2 – General Conditions. Contractor must provide a shuttle bus plan, including cost estimates, for the City's approval within twenty days of contract award.

1.10 MATERIAL STOCKPILE (FOR CONTRACTOR'S USE) AND EQUIPMENT STORAGE

- A. Material stockpiled for the Contractor's use must only be in locations designated as the construction staging areas shown on the Plans or directed by the Commissioner.
- B. The storage of equipment, when not in use, must be located in areas and in such a manner which must not interfere with normal operations of the Airport. Locations selected for collection of debris and/or storage of equipment and material must be approved by the Commissioner.

1.11 SOIL BORINGS

- A. Where applicable, subsurface soil investigations were performed as part of this Project and are included in the Plans. Additional subsurface soil investigations are available at the Commissioner's office. Data is for general information for the Contractor only. The Commissioner will not assume responsibility for variations of subsoil conditions. Additional site investigations may be made by a testing laboratory employed by the Contractor subject to approval of the Commissioner.

1.12 BENCH MARKS

- A. The Contractor must use established bench marks and other reference points. The Contractor must replace same if they are destroyed or disturbed in any manner, due to Contractor operations.

1.13 CLEANING

- A. Maintain all paved areas free from all dirt, dust, and debris.

1.14 UNDERGROUND CONSTRUCTION NOTIFICATION

- A. The O'Hare International Airport Underground Construction Notification form must be completely executed a minimum of twenty-one (21) calendar days prior to the commencement of any excavation and/or utility work. The Contractor cannot perform any excavation or utility work without receiving a fully executed O'Hare International

Airport Underground Construction Notification form. This is referred to in the plans as the dig book.

- B. Contractor must include in the Baseline, Monthly Update and Two-Week Look Ahead Schedules a predecessor milestone and task to represent the submittal and execution of the Underground Construction Notification form for each activity associated with excavation and utility work. The milestone denotes the submittal of the form to the weekly Short Term Operational Phasing Meeting (STOP) meeting which is held every Monday. The task denotes the twenty-one (21) calendar day form approval period.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Allowance for Owner Requested Testing and Investigation will cover costs work to perform material testing and inspection as directed by the Commissioner and not otherwise shown. The work includes but is not limited to, the collection of samples, transportation to an approved testing facility, testing and reporting, inspections, field surveys and investigations. Expenses from the Allowance will be subject to prior review and approval by the Commissioner only, and will be measured for payment as described in Article X, "Changes in Work", of the Part 2 General Conditions document.
- B. Allowance for Workforce Development is as measured under Section 1.09A.3 and 1.09C of this specification.
- C. Allowance for Runway and Taxiway Commissioning and Decommissioning: An allowance amount has been established for the Work to facilitate the decommissioning of various taxiways, and for the commissioning of taxiways and its related work, at locations as directed by the Commissioner. This Work, as directed and approved by the Commissioner, includes but is not limited to, modifications to existing airfield signage, purchasing of airfield signage placards and film, and correction of any Part 139 violations associated with this Work., as well as any additional labor and/or material to support CDA's decommissioning and re-designation efforts. This Work will be measured for payment in accordance with Article X, "Changes in the Work," of Part 2 – General Conditions.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Item 01010-01 – Allowance for Owner Requested Testing and Investigation: The Contractor must receive written notice from the Commissioner and Chief Procurement Officer to proceed with the work. The work will be paid for as shown in Article X, “Changes in the Work,” of the Part 2, General Conditions. Any remaining balance from the Allowance will be retained by the city.
- B. Item 01010-02 – Allowance for Workforce Development: Contractor will be paid for actual costs associated with renting a hall or venue approved by the City for community outreach activities and providing contractor shuttle bus service from the CTA to the work site. All other work for community outreach activities is considered incidental to the Contract. The Work will be paid for as shown in Article X, “Changes in the Work,” of Part 2 – General Conditions. Upon completion of the Project, any remaining balance in this Allowance will be returned to the City in the form of an appropriate credit.
- C. Item 01010-03 – Allowance for Runway and Taxiway Commissioning and Decommissioning: The Contractor must receive written notice from the Commissioner and Chief Procurement Officer to proceed with the Work. The Work will be paid for as shown in Article X, “Changes in the Work,” of Part 2 – General Conditions. Upon completion of the Project, any remaining balance in this Allowance will be returned to the City in the form of an appropriate credit.

ITEM #	DESCRIPTION	UOM
01010-01	ALLOWANCE FOR OWNER REQUESTED TESTING AND INVESTIGATION	AL
01010-02	ALLOWANCE FOR WORKFORCE DEVELOPMENT	AL
01010-03	ALLOWANCE FOR RUNWAY AND TAXIWAY COMMISSIONING AND DECOMMISSIONING	AL

END OF SECTION 01010

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AIR QUALITY – EQUIPMENT EMISSIONS

SECTION 01111

PART 1 GENERAL

1.01 SUMMARY

- A. The diesel emissions of vehicles and equipment used for work pertaining to this Contract shall be in accordance with Section 2-92-595 of the Chicago Municipal Code (“Code”) with exceptions as noted in this Specification Section.
- B. This Section includes use and tracking requirements and procedures for compliance with certain sustainable design guidelines based on the Chicago Department of Aviation Sustainable Airport Manual (SAM), current version. References can be found at www.airportsgoinggreen.org.
- C. This Section includes tracking requirements and forms necessary for compliance with this Specification and in accordance with the requirements of Credit 7.1 of the Design & Construction Chapter of the SAM.

1.02 RELATED DOCUMENTS

- A. Section 2-92-595 “Clean Diesel Contracting” of the Chicago Municipal Code (attached at the end of this specification section)
- B. Additional information can also be found on the City’s website at <http://www.cityofchicago.org/city/en/progs/env/clean-diesel.html> including federal and state grant and rebate programs to help defray costs to repower or retrofit diesel equipment.
- C. Section 9-80-095 “Idling Reduction” of the Chicago Municipal Code

1.03 PERFORMANCE REQUIREMENTS

- A. The Contractor will adhere to Section 2-92-595 of the City of Chicago Municipal Code with exceptions as noted in this Specification Section.

1.04 SUBMITTALS

- A. In addition to submittal requirement pursuant to the Section 2-92-595 of the City of Chicago Municipal Code, the Contractor must transmit the submittals described below to the Commissioner/Construction

Manager and to the following email address:
samdocs@cityofchicago.org.

- B. The Contractor shall submit documentation pursuant to 2-92-595 of the Code with the following additions:
1. The Contractor shall submit a Diesel Emissions Compliance Plan (see 1.04C) prior to the Contractor's initial Application for Payment for Mobilization.
 2. The Chicago Department of Aviation Diesel Emissions Compliance Form (attached at the end of this Specification and available electronically at www.airportsgoinggreen.org) shall be submitted monthly with the Contractor's Application for Payment.
 3. The Contractor shall submit a final Chicago Department of Aviation Diesel Emissions Compliance Form with the Contractor's Closeout Documentation.
- C. Diesel Emissions Compliance Plan: The Plan shall be developed by the Contractor and shall be submitted to the Commissioner for review with the Contractor's Application for Payment for Mobilization: The Plan shall include the following sections, at a minimum:
1. General: Provide an overall strategy for complying with the requirements of this specification with the Project.
 2. Contractor Identification: List names, addresses, and telephone numbers of the Contractor and all subcontractors operating equipment listed in the report. Identify any contractors or subcontractors that have a clean fleet score annual waiver as defined in Section 2-92-595 (a)(4).
 3. Equipment Identification: Indicate anticipated types and quantities of equipment, applicable to this specification, using the Diesel Emission Compliance Form to calculate the pre-construction estimate of the clean fleet score for the Project.
- D. Diesel Emissions Compliance Submittal Transmittal: When submitting the documentation to the Commissioner as required in Paragraphs 1.04B and 1.04C, the Contractor must complete the Submittal Transmittal Cover Sheet attached at the end of this Specification section and attach this with the appropriate submittal.

1.05 QUALITY ASSURANCE

- A. Contractor Qualifications: Diesel emissions reporting as it pertains to this specification must be performed only by a qualified Contractor. The term qualified means experienced in performing the Work required by this Section. The qualified Contractor must have experience on Projects similar in size and scope to this Project. The Contractor will submit evidence of such qualifications (e.g. Project list, timeframe, diesel equipment emission compliance reports) upon request by the Commissioner.
- B. Regulatory Requirements: In addition to City Ordinances regarding diesel emission requirements described herein, Contractor will comply with emission requirements of authorities (e.g. state, local, or federal) having jurisdiction.

1.06 SPECIAL REQUIREMENTS

- A. (Not Used)

PART 2 PRODUCTS

2.01 FUEL USE REQUIREMENTS

- A. The fuel use requirements apply to all off-road vehicles and equipment utilized by Contractors, Subcontractors and Suppliers.
- B. The fuel use requirements apply to all on-road vehicles and equipment utilized by Contractors, Subcontractors and Suppliers.
- C. The Contractor must utilize Ultra Low Sulfur Diesel (ULSD) for all diesel-powered vehicles and equipment (both mobile and stationary) with engine horsepower ratings of 50 hp or more that are utilized on the Project site. The ULSD must conform to the American Society of Testing and Materials (ASTM) D975 with the following additional specifications:
 - 1. ASTM D5453 15 ppm Sulfur maximum
 - 2. ASTM D6078 Lubricity (Scuffing Load Ball-on-Cylinder Lubricity Evaluator - SBOCLE) 3100g minimum
 - 3. ASTM D613 Cetane 45 minimum

2.02 EQUIPMENT TECHNOLOGY REQUIREMENTS

- A. The equipment technology requirements apply to all off-road vehicles and equipment utilized by Contractors, Subcontractors and Suppliers.
- B. These requirements do not apply to on-road vehicles and equipment; however, Contractors, Subcontractors and Suppliers that transport materials regularly to and from the Project site are encouraged to follow these requirements to the best of their ability.
- C. Requirements:
 - 1. All off-road diesel-powered vehicles and equipment (both mobile and stationary), as applicable, with engine horsepower ratings of 50 hp or more, must install and/or retrofit with emissions control devices that will reduce emissions prior to utilization of said equipment on the Project. The retrofit emission control devices must consist of diesel oxidation catalysts, diesel particulate filters or similar retrofit equipment control technology that:
 - a. is included on the EPA Verified Retrofit Technology List (<http://www.epa.gov/otaq/retrofit/retroverifiedlist.htm>) or verified by the California Air Resources Board (CARB) (<http://www.arb.ca.gov/diesel/verdev/verdev.htm>) or
 - b. meets one of the following diesel emission control devices as defined in Section 2-92-595 of the Chicago Municipal Code:
 - (1) “Level 1 Control” is defined as an emission control device that achieves a particulate matter (PM) emission reduction of 25% or more.
 - (2) “Level 2 Control” is defined as an emission control device that achieves a PM emission reduction of 50% or more.
 - (3) “Level 3 Control” is defined as an emission control device that achieves a PM emission reduction of 85% or more.
 - 2. Per Section 2-92-595 of the Chicago Municipal Code, diesel equipment emissions for all applicable equipment used in the performance of the contract shall be calculated using the clean fleet score (CFS) calculation described in 2-92-595 (c)(3) and included on the Diesel Emissions Compliance Form.
 - 3. Per Section 2-92-595 of the Chicago Municipal Code, compliance with diesel equipment emissions shall be measured as described in 2-92-595 (b) using the average CFS for all

diesel equipment used in the performance of the contract.

- a. After January 1, 2014, the average CFS shall be a minimum of 2.1.
 - b. After January 1, 2017, the average CFS shall be a minimum of 3.0.
 - c. After January 1, 2020, the average CFS shall be a minimum of 4.0.
- D. Biodiesel must meet the requirements of ASTM D 6751. Any heavy-duty diesel vehicle, non-road diesel vehicle, or non-road equipment meeting the requirements of 2-92-595 (c)(3)(i) to (c)(3)(vii) that uses only a biodiesel blend of B20 (20% by volume of biodiesel in petroleum-based diesel) or greater during the reporting period can increase its clean fleet score by 0.5 points.

2.03 INTERPRETATION OF REQUIREMENTS

- A. The interpretation of these requirements and any determination of lack of compliance with these requirements may be made the subject of a claim to the Commissioner. However, the Commissioner's decision will be final. The Contractor may not file a dispute under Article XVII of Part 2 General Conditions.

PART 3 EXECUTION

3.01 PLAN IMPLEMENTATION

- A. General: Implement the Diesel Emission Compliance Plan as approved by Commissioner. All vehicles and equipment to which this requirement is applicable will be subject to random inspections to ensure full compliance with these requirements. If any equipment is found to be non-compliant, the Contractor, Subcontractor or Supplier must remove or retrofit this equipment or vehicle within 24 hours or be subject to possible impoundment by the Chicago Department of Aviation until that piece of equipment or vehicle is removed from the Project.
- B. Diesel Equipment Coordinator: Assign a Diesel Equipment Coordinator to be a single point of contact responsible for implementation, monitoring, and reporting of the diesel emission compliance requirements. Coordinator must be present for the duration of the Contract.
- C. Training: Contractor is responsible for training workers, subcontractors, and suppliers on diesel emission compliance requirements as applicable to this Contract. Distribute the Diesel

Emissions Compliance Plan to all subcontractors and suppliers when Contract work begins.

D. Idling Restrictions

1. Idling of diesel powered vehicles and equipment must not be permitted during periods of non-active vehicle use. Diesel powered engines shall not be allowed to idle for more than three consecutive minutes in a 60-minute period when the equipment is not in use, occupied by an operator, or otherwise in motion, except only as follows:
 - a. When equipment is forced to remain motionless because of traffic conditions or mechanical difficulties over which the operator has no control
 - b. When it is necessary to operate auxiliary systems installed on the equipment, only when such system operation is necessary to accomplish the intended use of the equipment
 - c. To bring the equipment to the manufacturers recommended operating temperature
 - d. When the ambient temperature is below forty (40) degrees F or above eighty (80) degrees F, or
 - e. When equipment is being repaired.
2. The use of idling reduction devices is encouraged. Idle reduction technology allows engine operators to refrain from long-duration idling of the main propulsion engine by using an alternative such as automatic engine shutoff, direct-fired/fueled heaters, auxiliary power units or electrified heat/air conditioning units. An idle reduction technology is generally defined as the installation of a technology or device that:
 - a. Reduces unnecessary main engine idling of the vehicle or equipment and /or
 - b. Is designed to provide services (e.g., heat, air conditioning and/or electricity) to the vehicle or equipment that would otherwise require the operation of the main drive equipment while the vehicle or equipment is temporarily parked or remains stationary.

E. Clean Buses/Light Duty Vehicles

1. Contractors are to incorporate, to the greatest extent possible, any other measures that may assist in reducing air quality

emissions during the performance of the contract. For example, many cleaner vehicle options now exist for employee shuttle buses and Light Duty Vehicles (LDVs) including compressed natural gas (CNG), hybrid (fuel/electric), flex fuel, biodiesel (B20 or greater), and demand on displacement. The availability of cleaner vehicle options is anticipated to expand over time and over the course of the Project. Contractors working on the Project are strongly encouraged to consider these options when making purchase decisions.

2. Each Shuttle Bus used in the performance of this contract must be outfitted with a functioning idle-shutdown timer to automatically shut down the vehicle's engine after three minutes of idling. Idle-reduction devices must allow for the elimination of unnecessary idling while providing for the comfort and safety of the driver and passengers. Such equipment may include, but is not limited to, additional battery storage, auxiliary fuel-fired heaters; auxiliary battery powered air conditioners and packaged auxiliary-power-unit solutions. The Contractor must strictly enforce a no-idling policy on all drivers involved in performance of this contract while ensuring that vehicle scheduling and on-board idle-reduction equipment function to reduce any need for idling.
3. See also SAM Credit 7.8 – Alternative Transportation During Construction.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Air Quality - Equipment Emission Compliance will not be measured separately for payment, but will be considered included in the overall Contract.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. All costs associated with meeting these requirements are included in the overall Contract. No additional time or monies will be granted to the Contractor for compliance with these requirements and any associated regulations.

END OF SECTION 01111

CHICAGO DEPARTMENT OF AVIATION

01111 AIR QUALITY - EQUIPMENT EMISSIONS

SUBMITTAL TRANSMITTAL COVER SHEET

Date: _____

Project: _____

WBS No. _____

Attention: Construction Manager

To: O'Hare Modernization Program
10510 W. Zemke Blvd.
Chicago, Illinois 60666

and via email to:
samdocs@cityofchicago.org

The following form(s) are submitted to comply with the requirements of the Specification Section 01111 Air Quality – Equipment Emissions (Check one):

☐ Diesel Emission Compliance Plan and
Pre-Construction Diesel Emission
Compliance Form

☐ Monthly Diesel Emission Compliance Form

☐ Final Diesel Emission Compliance Form

From:	
Company:	
Printed Name:	
Title:	
Signature:	
Date:	

Reviewed by:	
	Resident Engineer

Note: These submittal requirements are in addition to the requirements put forth by the City of Chicago as outlined in Section 2-92-595 of the Chicago Municipal Code.

AIR QUALITY – EQUIPMENT EMISSIONS



Office of Chicago City Clerk



O2011-1418

Office of the City Clerk

Tracking Sheet

Meeting Date:	3/9/2011
Sponsor(s):	Mayor Daley
Type:	Ordinance
Title:	Amendment of Chapter 2-92 of Municipal Code by adding new Section 595 regarding requirements associated with diesel equipment use
Committee(s) Assignment:	Committee on Energy, Environmental Protection and Public Utilities



OFFICE OF THE MAYOR
CITY OF CHICAGO

RICHARD M. DALEY
MAYOR

March 9, 2011

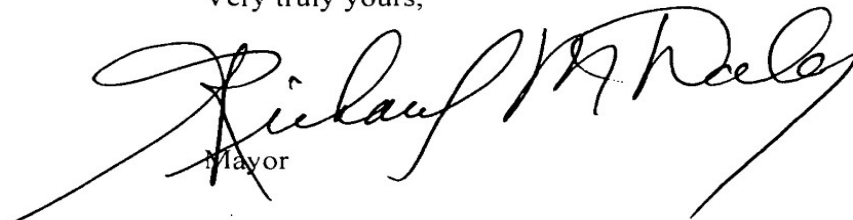
TO THE HONORABLE, THE CITY COUNCIL
OF THE CITY OF CHICAGO

Ladies and Gentlemen:

At the request of the Commissioner of the Environment, I transmit herewith an ordinance amending the Municipal Code regarding requirements associated with diesel equipment use.

Your favorable consideration of this ordinance will be appreciated.

Very truly yours,



Mayor

ORDINANCE

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF CHICAGO:

SECTION I. Chapter 2-92 of the Municipal Code of Chicago is hereby amended by inserting a new section 2-92-595, as follows:

2-92-595 Clean diesel contracting.

(a) **Definitions.** For purposes of this section, the following definitions shall apply:

- (1) "Biodiesel" means a fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated B100, and meeting the requirements of the American Society for Testing Materials ("ASTM") D 6751.
- (2) "Biodiesel blend" means a blend of biodiesel meeting ASTM D 6751 with petroleum-based diesel fuel, designated BXX, where XX represents the volume percentage of biodiesel fuel in the blend.
- (3) "CARS" means the California Air Resources Board.
- (4) "Clean fleet score ("CPS") waiver grantee" means any construction firm to which the commissioner of environment has granted a clean fleet score annual waiver certificate pursuant to subsection (f) of this section.
- (5) "Compression-ignition engine" means a reciprocating, internal-combustion engine that is not a spark-ignition engine.
- (6) "Contract" means any contract, the amount of which is \$2,000,000 or more, awarded by the city and whose cost is to be paid from funds belonging to or administered by the city, for construction projects including, but not limited to, the construction, demolition, restoration, repair, renovation, environmental remediation or environmental abatement of any building, structure, tunnel, excavation, roadway, bridge, transit station or parcel of land. The term "contract" does not include a fixed-price, fixed term, and indefinite quantity contract, such as contracts commonly referred to as "job order contracts," unless the estimated value of an individual order under the contract is \$2,000,000 or more.
- (7) "Contractor" means any person that enters into a contract with the city.
- (8) "Department" means any city department or city agency that manages or supervises a contract awarded to a contractor.
- (9) "Engine model year" means the year designating the annual new model production period during which the engine was produced, determined in accordance with 42 U.S.C. § 7521(b)(3), 40 C.F.R. § 86.082-2, 40 C.F.R. § 89.2, or 13 C.C.R. § 2421(a)(37) for purposes of compliance with US EPA or CARB emissions certification requirements and may differ from the model year of the vehicle or equipment powered by the engine.

- (10) "Heavy-duty diesel vehicle" means a motor vehicle with a gross vehicle weight rating of at least 8,500 pounds that is powered by a compression-ignition engine and which is not a "heavy-duty alternative-fuel vehicle."
- (11) "Heavy-duty alternative-fuel vehicle" means a motor vehicle with a gross vehicle weight rating of at least 8,500 pounds that is powered by an engine fueled at a minimum 80 percent, as measured by energy content, by natural gas, liquefied petroleum gas (commonly known as "propane"), hydrogen, or another fuel designated as an alternative fuel by the United States Department of Energy.
- (12) "Level 1 Control" means a verified diesel emission control retrofit device that achieves a particulate matter (PM) emission reduction of 25 percent or more from uncontrolled compression-ignition engine emission levels.
- (13) "Level 2 Control" means a verified diesel emission control retrofit device that achieves a particulate matter (PM) emission reduction of 50 percent or more from uncontrolled compression-ignition engine emission levels.
- (14) "Level 3 Control" means a verified diesel emission control retrofit device that achieves a particulate matter (PM) emission reduction of 85 percent or more from uncontrolled compression-ignition engine emission levels.
- (15) "Motor vehicle" means any self-propelled vehicle designed for transporting persons or property on a street or highway.
- (16) "Non-road engine" means a fifty horsepower or greater compression-ignition engine: (i) in or on a piece of equipment that is self-propelled (such as a cart or truck that is not a motor vehicle) or serves a dual purpose by both propelling itself and performing another function (such as garden tractors, off-highway mobile cranes and bulldozers); or (ii) in or on a piece of equipment that is intended to be propelled while performing its function (such as pushed or towed equipment); or (iii) that, by itself or in or on a piece of equipment, is portable or transportable, meaning designed to be and capable of being carried or moved from one location to another. Indicia of transportability include, but are not limited to, wheels, skids, carrying handles, dolly, trailer, or platform. The term "non-road engine" does not include an engine that is used in a motor vehicle or vehicle used solely for competition, or in a stationary source, except that this term shall include compression-ignition engines used to power portable generators, portable compressors or similar equipment used in any construction program or project.
- (17) "Non-road equipment" means equipment that is powered by a non-road engine.
- (18) "Non-road vehicle" means a vehicle that is powered by a non-road engine and that is not a motor vehicle or a vehicle used solely for competition.
- (19) "Reporting day" means the fifth day on which city business is transacted following the last working day of every reporting period.
- (20) "Reporting period" means (i) every 60 working day period from the beginning of work on the contract; or (ii) the period between the first working day and the last working day, if the contract is completed in less than a 60 working

day period; or (iii) any period following the last day of the last 60 working day period up to and including the last working day, if such period consists of not more than 75 working days and, if such period consists of more than 60 working days, the contractor provides a written notice to the department before the 60th working day that such period will consist of more than 60 working days.

- (21) "Solicitation" means the process used to communicate procurement requirements and to request responses from interested vendors.
- (22) "Spark-ignition engine" means a gasoline-fueled engine or other engine with a spark plug (or other sparking device) and with operating characteristics significantly similar to the theoretical Otto combustion cycle and uses a throttle to regulate intake air flow to control power during normal operation.
- (23) "Subcontractor" means any person that enters into a contract with a contractor to perform work on a contract.
- (24) "Tier 1 Non-road Diesel Standards," "Tier 2 Non-road Diesel Standards," "Tier 3 Non-road Diesel Standards," or "Tier 4 Non-road Diesel Standards" means US EPA's Tier 1, Tier 2, Tier 3, or Tier 4 Non-road engine emission standards, respectively, as specified in 40 C.F.R. § 89.112(a), 40 C.F.R. § 1039.101, and 40 C.F.R. § 1039.102.
- (25) "Ultra low sulfur diesel fuel" means diesel fuel that has a sulfur content of no more than fifteen parts per million.
- (26) "US EPA" means the United States Environmental Protection Agency.
- (27) "Verified diesel emission control retrofit device" means an emission control device or strategy that has been verified to achieve a specified diesel PM reduction by US EPA or CARB. "Verified diesel emission control retrofit device" does not mean the use of ultra low sulfur diesel fuel alone or a device installed by the engine manufacturer for purposes of compliance with US EPA or CARB emissions certification requirements.
- (28) "VIN" means vehicle identification number.
- (29) "Working day" means a day on which work is performed on a construction project site pursuant to a contract.

(b) *Emission reduction.* (1) Any solicitation for a contract advertised or otherwise communicated on or after June 1, 2011, and any contract entered into as a result of such solicitation shall include a specification that the contractor and any subcontractor, including a CFS waiver grantee, shall use ultra low sulfur diesel fuel for any heavy-duty diesel vehicle, non-road vehicle or non-road equipment used in the performance of the contract.

- (2) Any solicitation for a contract advertised or otherwise communicated on or after June 1, 2011, and any contract entered into as a result of such solicitation shall include a specification that the contractor or any subcontractor, including a CFS waiver grantee, shall minimize idling of motor vehicles and non-road vehicles used in the performance of the contract during periods of inactivity and shall comply with the anti-idling requirements imposed by any applicable federal, state or local law.

- (3) Any solicitation for a contract advertised or otherwise communicated on or after January 1, 2014, and any contract entered into as a result of such solicitation shall include a specification that any contractor or any subcontractor, including a CFS waiver grantee, shall not use any of the following vehicles and equipment in the performance of the contract:
- (i) any heavy-duty diesel vehicle not meeting or exceeding the US EPA's emission standards for heavy-duty diesel vehicles for the 1998 engine model year, unless such vehicle is fitted with a verified diesel emission control retrofit device; or
 - (ii) any non-road vehicle or non-road equipment not meeting or exceeding the US EPA's Tier 1 Non-road Diesel Standards, unless such vehicle or equipment is fitted with a verified diesel emission control retrofit device.
- (4) Any solicitation for a contract advertised or otherwise communicated on or after January 1, 2014, and any contract entered into as a result of such solicitation shall include a specification that the heavy-duty diesel vehicles, non-road vehicles and non-road equipment used in the performance of such contract must incorporate such engine or retrofit technology so that the contractor, through such engine or retrofit technology used directly by the contractor and all subcontractors, shall have a minimum of 2.1 clean fleet score per a reporting period, as calculated by using the methodology described in subsection (c)(5) of this section. Such solicitation and contract shall also include a specification that the contractor may exclude from the calculation of the clean fleet score all of the heavy-duty diesel vehicles, non-road vehicles and non-road equipment used in the performance of the contract during a reporting period that are owned or leased by any CFS waiver grantee.
- (5) Any solicitation for a contract advertised or otherwise communicated on or after January 1, 2017, and any contract entered into as a result of such solicitation shall include a specification that the heavy-duty diesel vehicles, non-road vehicles and non-road equipment used in the performance of such contract must incorporate such engine or retrofit technology so that the contractor, through such engine or retrofit technology used directly by the contractor and all subcontractors, shall have a minimum of 3.0 clean fleet score per a reporting period, as calculated by using the methodology described in subsection (c)(5) of this section. Such solicitation and contract shall also include a specification that the contractor may exclude from the calculation of the clean fleet score up to fifty (50) percent of all the heavy-duty diesel vehicles, non-road vehicles and non-road equipment used in the performance of the contract during a reporting period that are owned or leased by any CFS waiver grantee.
- (6) Any solicitation for a contract advertised or otherwise communicated on or after January 1, 2020, and any contract entered into as a result of such solicitation shall include a specification that the heavy-duty diesel vehicles, non-road vehicles and non-road equipment used in the performance of such

contract must incorporate such engine or retrofit technology so that the contractor, through such engine or retrofit technology used directly by the contractor and all subcontractors, shall have a minimum of 4.0 clean fleet score per a reporting period, as calculated by using the methodology described in subsection (c)(5) of this section. Such solicitation and contract shall also include a specification that the contractor may exclude from the calculation of the clean fleet score up to twenty-five (25) percent of all the heavy-duty diesel vehicles, non-road vehicles and non-road equipment used in the performance of the contract during a reporting period that are owned or leased by any CFS waiver grantee.

(c) **Compliance.** (1) Any solicitation for a contract advertised or otherwise communicated on or after January 1, 2014, and any contract entered into as a result of such solicitation shall include a specification that the contractor shall submit a written compliance plan to the department with respect to compliance with the requirements of this section within 14 days following the notice to proceed. The plan shall detail the strategy to be used by the contractor to comply with the requirements of this section. The chief procurement officer and the commissioner of environment are authorized to determine the contents of a compliance plan by rules and regulations promulgated pursuant to subsection (h) of this section.

- (2) On every reporting day, the contractor must submit to the department a detailed report of all heavy-duty diesel motor vehicles, non-road vehicles and non-road equipment used in the performance of such contract during the reporting period preceding the reporting day. The report shall, on a form provided by the city, include the following:
- (i) names, addresses, and telephone numbers of the contractor, any subcontractor, and the person responsible for the operation of the vehicles or equipment listed on the report;
 - (ii) for each heavy-duty diesel vehicle, the manufacturer, engine manufacturer, engine model year, VIN, the specific type of fuel that was used, and estimated hours of operation during the period covered by the report;
 - (iii) for each non-road vehicle and non-road equipment, the manufacturer, engine manufacturer, serial number or engine serial number, engine US EPA Tier rating, the specific type of fuel that was used, and estimated hours of operation during the period covered by the report;
 - (iv) for any heavy-duty diesel vehicle, non-road vehicle or non-road equipment fitted with a verified diesel emission control retrofit device, the retrofit device type, US EPA or CARB verification level and year of installation, in addition to the information required by subsections (c)(2)(ii) and (c)(2)(iii) of this subsection;
 - (v) a clean fleet score calculated in accordance with the provisions of this subsection; and

- (vi) a certification that the contractor has met the requirements of this section and the terms of the contract specified pursuant to the provisions of this section.
- (3) For the purpose of calculating a clean fleet score, each heavy-duty diesel vehicle, heavy-duty alternative-fuel vehicle, non-road vehicle and non-road equipment used in the performance of the contract shall be assigned a numerical value, as follows:
- (i) 0 points for any heavy-duty diesel vehicle with an engine model year of 2003 or earlier not fitted with any verified diesel emission control retrofit device;
 - (ii) 0 points for any non-road vehicle and non-road equipment meeting US EPA's Tier 1 Non-road Diesel Standards and not fitted with any verified diesel emission control retrofit device;
 - (iii) 1 point for any heavy-duty diesel vehicle with an engine model year of 2004, 2005 or 2006 and not fitted with any verified diesel emission control retrofit device;
 - (iv) 1 point for any heavy-duty diesel vehicle, non-road vehicle and non-road equipment fitted with a Level 1 Control;
 - (v) 2 points for any non-road vehicle and non-road equipment meeting US EPA's Tier 2 Non-road Diesel Standards and not fitted with any verified diesel emission control retrofit device;
 - (vi) 2.25 points for any non-road vehicle and non-road equipment meeting US EPA's Tier 3 Non-road Diesel Standards and not fitted with any verified diesel emission control retrofit device;
 - (vii) 3 points for any heavy-duty diesel vehicle, non-road vehicle and non-road equipment fitted with a Level 2 Control;
 - (viii) 3 points for any heavy-duty alternative-fuel vehicle with an engine model year of 2004, 2005 or 2006;
 - (ix) 4 points for any heavy-duty diesel vehicle with an engine model year of 2007, 2008 or 2009 and not fitted with any verified diesel emission control retrofit device;
 - (x) 4 points for any heavy-duty alternative-fuel vehicle with an engine model year of 2007, 2008 or 2009;
 - (xi) 4 points for any non-road vehicle and non-road equipment meeting US EPA's Tier 4 Non-road Diesel Standards and not fitted with any verified diesel emission control retrofit device;
 - (xii) 4 points for any heavy-duty diesel vehicle, non-road vehicle or non-road equipment fitted with a Level 3 Control;
 - (xiii) 5 points for any heavy-duty diesel vehicle with an engine model year of 2010 or later;
 - (xiv) 5 points for any heavy-duty alternative-fuel vehicle with an engine model year of 2010 or later; and
 - (xv) 5 points for any heavy-duty diesel vehicle, non-road vehicle and non-road equipment fitted with a verified diesel emission control retrofit device exceeding the efficiency levels of a Level 3 Control to the

extent that the verified diesel emission control retrofit device provides emissions reductions equivalent to the US EPA requirements for heavy-duty diesel vehicles engine model year 2010.

- (4) Each heavy-duty diesel vehicle, non-road vehicle and non-road equipment used in the performance of the contract shall be assigned only the maximum assigned point value for which it qualifies during one reporting period; provided, however, that the maximum assigned value for each heavy-duty diesel vehicle, non-road vehicle and non-road equipment listed in subsections (c)(3)(i) through (c)(3)(vii) of this section that consumed only a B20 or greater biodiesel blend during the reporting period shall be increased by one half point.
- (5) The clean fleet score for each reporting period shall be calculated by adding the numerical point values allocated, in accordance with subsections (c)(3) and (c)(4) of this section, to each heavy-duty diesel vehicle, non-road vehicle and non-road equipment used in the performance of the contract during the reporting period and dividing the total numerical point values by the total number of all heavy-duty diesel vehicles, non-road vehicles and non-road equipment used in the performance of the contract during the reporting period; provided, however, the contractor may, to the extent specified in the contract pursuant to subsections (b)(4), (b)(5) and (b)(6) of this section, exclude from the calculation of the clean fleet score heavy-duty diesel vehicles, non-road vehicles and non-road equipment used in the performance of the contract during the reporting period that are owned or leased by all CFS waiver grantees.

(d) **Costs.** All costs associated with meeting the requirements imposed pursuant to this section are incidental to the overall contract. No additional time or monies will be granted to the contractor for compliance with the requirements imposed pursuant to this section and any regulations promulgated pursuant thereto.

(e) **Enforcement.** Any solicitation for a contract subject to the provisions of this section and any contract entered into as a result of such solicitation shall include terms necessary to enforce the provisions of this section, including, but not limited to, terms

- (1) requiring the contractor and subcontractors to comply with the provisions of this section;
- (2) specifying that any city agency may conduct an audit to verify the contractor's compliance with the requirements of this section and the terms of the contract specified pursuant to the provisions of this section;
- (3) specifying that the commissioner or head of the department or the commissioner of environment or any other city agency designated by the commissioner or head of the department or the commissioner of environment is authorized to inspect or to have inspected any vehicle or equipment in order to ensure full compliance with contract requirements specified pursuant to subsections (b)(1), (b)(2), and (b)(3) of this section;

- (4) specifying that in the event of violation of any of the specifications required pursuant to subsections (b)(1), (b)(2), and (b)(3) of this section, liquidated damages shall be assessed against the contractor in the amount of \$5,000 for each violation and that each day of noncompliance shall be a separate violation; provided, however, the damages shall not exceed a total of \$50,000 for any one vehicle or piece of equipment; that such liquidated damages are not imposed as a penalty but as an estimate of the damages that the city will sustain from delay in completion of the project and inspection and other enforcement costs, as well as the resultant damages to the public health of its citizens, which damages by their nature are not capable of precise proof; and authorizing the city to withhold and deduct from monies otherwise payable to the contractor the amount of liquidated damages due to the city;
- (5) specifying that in the event the contractor has not met the minimum clean fleet score specified pursuant to subsections (b)(4), (b)(5) or (b)(6) of this section during any reporting period, liquidated damages shall be assessed against the contractor in the dollar amount that shall be calculated as follows:

$$(\text{RCFS} - \text{ACFS}) \times \$500.00 \times \text{the number of working days in the reporting period};$$
 where RCFS stands for the minimum required clean fleet score during the reporting period and ACFS stands for the actual clean fleet score obtained by the contractor in the reporting period.
 Such solicitation or contract shall also specify that noncompliance during each reporting period shall be a separate violation; that such liquidated damages are not imposed as a penalty but as an estimate of the damages that the city will sustain from delay in completion of the project and inspection and other enforcement costs, as well as the resultant damages to the public health of its citizens, which damages by their nature are not capable of precise proof; and authorizing the city to withhold and deduct from monies otherwise payable to the contractor the amount of liquidated damages due to the city; and
- (6) specifying that any person who knowingly makes a false statement of material fact to any city agency with respect to compliance with any of the contract requirements specified pursuant to any of the provisions of this section or rules and regulations promulgated thereunder shall be fined not less than \$1,000.00 nor more than \$5,000.00 for each such false statement. For purposes of this section, a person knowingly makes a false statement of material fact when such person makes a false statement of material fact as described in subsection (d) of section 1-21-010 of this Code.

(f) *Clean fleet score annual waiver.* (1) Any construction firm may apply to the commissioner of environment for a clean feet score annual waiver certificate. Applications for a clean feet score annual waiver certificate shall be on a form provided by the department of environment and shall be accompanied by a non-refundable application fee of \$100.00. The

application shall also include all of the following information and statements which shall be verified by affidavit:

- (i) list of all heavy-duty diesel vehicles, non-road vehicles and non-road equipment owned or leased by the applicant at the time of application, including the horsepower, and, to the extent applicable, the manufacturer, engine manufacturer, engine model year, VIN, serial number or engine serial number, and engine US EPA Tier rating of each of such vehicles and equipment (for purposes of this subsection, "listed vehicles and equipment");
 - (ii) a statement that the sum total horsepower of all of the listed vehicles and equipment is less than or equal to 2,500 horsepower (hp); and
 - (iii) a statement that repowering, replacing or retrofitting all or some of the listed vehicles and equipment in order to comply with contract requirements that shall be specified in accordance with the provisions of this section will cause the applicant to suffer an undue financial hardship.
- (2) If, upon review of the application, the commissioner of environment or the commissioner's designee determines that the applicant has met all of the requirements set forth in subsection (f)(1) of this section, the commissioner is authorized to grant a clean fleet score annual waiver certificate to the applicant.
 - (3) Any contractor may exclude from the calculation of the clean fleet score, to the extent allowed in subsection (b)(4), (b)(5), and (b)(6) of this section, the heavy-duty diesel vehicles, non-road vehicles and non-road equipment used in the performance of the contract during a reporting period that are owned or leased by any CFS waiver grantee.
 - (4) A clean fleet score annual waiver certificate granted pursuant to this subsection shall be valid as long as the grantee continues to qualify for such waiver; provided, however, no such waiver shall be valid for more than a one year period from the time it has been granted; and further provided that the commissioner may renew the clean fleet score annual waiver certificate for additional one year periods upon submission by the CFS waiver grantee of a statement verified by affidavit that any of the information and statements that the CFS waiver grantee submitted to the commissioner to qualify for the waiver are not changed.
 - (5) Any person who knowingly makes a false statement of material fact to the commissioner of environment with respect to a clean fleet score annual waiver certificate application specified in this subsection or rules and regulations promulgated thereunder shall be subject to the penalties provided in section 1-21-010 of this Code. For purposes of this section, a person knowingly makes a false statement of material fact when such person makes a false statement of material fact as described in subsection (d) of section 1-21-010 of this Code.
 - (6) No clean fleet score annual waiver certificate shall be granted as of January 1, 2023.
 - (g) *Recordkeeping.* The contractor shall maintain copies of plans, reports and clean fleet scores prepared or calculated and submitted in accordance with subsections (c)(1) and (c)(2)

of this section for a period of three years after the completion of the contract, and, if requested by any city agency, shall make them available for the purpose of auditing.

(h) *Regulations.* The chief procurement officer and the commissioner of environment are authorized to jointly adopt rules and regulations they may deem appropriate for the administration and enforcement of the provisions of this section.

(i) *Scope.* (1) This section shall not apply to any contract to the extent that the requirements imposed by this section are inconsistent with procedures or standards required by any law or regulation of the United States or the State of Illinois to the extent such inconsistency is not permitted under the home rule powers of the city.

(2) Any contractor, subcontractor or CFS waiver grantee, performing a contract that the commissioner of aviation is authorized to enter into in relation to the design, construction, operation and maintenance of all public airports owned or operated by the city, including, but not limited to, O'Hare Modernization Program contracts, as the term "O'Hare Modernization Program" is defined in section 2-20-025(a) of this Code, shall comply with (i) the construction air quality specifications set forth in any such contract; and (ii) all contract requirements that shall be specified in accordance with the provisions of this section; provided, however, for the purpose of this subsection (i)(2)(ii), any contractor may exclude from the calculation of the clean fleet score the vehicles and equipment used in the performance of the contract during a reporting period that are owned or leased by any CFS waiver grantee to the extent allowed in subsection (b)(4), (b)(5), and (b)(6) of this section.

(j) *Sunset.* Unless otherwise provided by ordinance, the provisions of subsections (c)(1) and (c)(2) of this section shall expire on December 31, 2030.

SECTION II. This ordinance shall take effect 10 days after its passage and approval.

LOCAL/REGIONAL MATERIALS

SECTION 01355

PART 1 GENERAL

1.01 SUMMARY

- A. This Specification includes use and tracking requirements and procedures for compliance with certain sustainable design guidelines based on the latest version of the Chicago Department of Aviation Sustainable Airport Manual (SAM). Reference can be found at www.airportsgoinggreen.org.
- B. This Section includes tracking requirements and forms necessary for compliance with this Specification and in accordance with the requirements of Credit 5.8 of the SAM.

1.02 DEFINITIONS

- A. Regional Materials: Materials and products that are manufactured, extracted, harvested, or recovered within a radius of 500 miles from the Project location. Materials and products manufactured, extracted, harvested, or recovered beyond 500 miles from the Project location but purchased within 500 miles (e.g. through a product sales representative) shall not be considered a Regional Material.
- B. Local Materials: Materials and products that are manufactured, extracted, harvested, or recovered within a radius of 250 miles from the Project location. Materials and products manufactured, extracted, harvested, or recovered beyond 250 miles from the Project location but purchased within 250 miles (e.g. through a product sales representative) shall not be considered a Local Material.
- C. Manufacturing refers to the final assembly of components into the building product that is installed at the Project site.
- D. Extracted, harvested, or recovered materials include raw building materials that are not manufactured but used in their final form at the Project site. This includes but is not limited to soil, aggregate, wood, salvaged masonry, and reclaimed concrete.

1.03 SUBMITTALS

- A. Design Estimate – With each milestone submittal during design phase, the Designer of Record shall submit a design estimate that identifies total Project material cost (less labor and equipment) and all

Local/Regional Materials that are proposed for the Project. For each material, its source and cost shall be identified.

- B. Pre-Construction Estimate - Prior to the initial Application for Mobilization Payment, the Contractor shall submit an estimate that identifies total Project material cost (less labor and equipment) and all Local/Regional Materials that are proposed for the Project. For each material, its source and cost shall be identified.
- C. Final Construction Total - With the Closeout Documentation, the Contractor shall submit the final actual total Project material cost (less labor and equipment) and all Local/Regional Materials that were used for the Project. For each material, its source and cost shall be identified.
- D. The above submittal must be transmitted to the Commissioner/Construction Manager and to the following email address: samdocs@cityofchicago.org.

1.04 CALCULATIONS

- A. Only include items in CSI Divisions 2-10 in the calculation of the percentage of materials obtained locally and/or regionally.
- B. Mechanical, electrical, plumbing components, and specialty items (CSI Divisions 11-16) must not be included in this calculation.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 DOCUMENTATION TEMPLATE

- A. Local/Regional Materials Design Estimate – Template Form 01355-1.03A attached at the end of this Specification should be used by the Designer of Record as guidance for completion of the Local/Regional Materials submittal requirements as outlined in Part 1 of this Specification Section.
- B. Local/Regional Materials Pre-Construction Estimate – Template Form 01355-1.03B attached at the end of this Specification should be used by the Contractor as guidance for completion of the Local/Regional Materials submittal requirements as outlined in Part 1 of this Specification Section.
- C. Local/Regional Materials Final Construction Total – Template Form 01355-1.03C attached at the end of this Specification should be used

by the Contractor as guidance for completion of the Local/Regional Materials submittal requirements as outlined in Part 1 of this Specification Section.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Regional Materials will not be measured separately for payment, but will be considered included in the overall Contract.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. All costs associated with meeting these requirements are included in the overall Contract. No additional time or monies will be granted to the Contractor for compliance with these requirements and any associated regulations.

END OF SECTION 01355

RECYCLED CONTENT

SECTION 01356

PART 1 GENERAL

1.01 SUMMARY

- A. This Specification includes use and tracking requirements and procedures for compliance with certain sustainable design guidelines based on the latest version of the Chicago Department of Aviation Sustainable Airport Manual (SAM). Reference can be found at www.airportsgoinggreen.org.
- B. This Section includes tracking requirements and forms necessary for compliance with this Specification and in accordance with the requirements of Credit 5.7 of the SAM.

1.02 RELATED DOCUMENTS

- A. Recycled Content of materials will be defined in accordance with 16 CFR 260.7(e) of the Federal Trade Commission's "Guide for the Use of Environmental Marketing Claims".

1.03 DEFINITIONS

- A. Recycled Materials: Materials that are manufactured, extracted, harvested, or recovered and contain some amount of post-consumer and/or pre-consumer recycled content.
- B. Recycled Content: The percentage by cost of the constituents of a product or building material that have been recovered or otherwise diverted from a solid waste stream, either during the manufacturing process (pre-consumer), or after consumer use (post-consumer).
 - 1. Post-Consumer Recycled Content is consumer waste that has become a raw material (feedstock) for another product. The post-consumer recycled content of an item will be given as a percentage by weight for the purposes of calculating the overall recycled content of the item.
 - 2. Pre-Consumer Recycled Content contains waste from industrial processes that has been traded through the marketplace. The pre-consumer recycled content of an item will be given as a percentage by weight for the purposes of calculating the overall recycled content of the item.

1.04 CALCULATIONS

- A. Only include items in CSI Divisions 2-10 in the calculation of the percentage of materials that have recycled content. This includes but is not limited to concrete and concrete products, masonry, aggregate, paving materials, steel and steel products, particle boards and other manufactured wood or fiber products, metal siding and roofing, tile paneling, carpet and pads, glazing.
- B. Mechanical, electrical, plumbing components, and specialty items (CSI Divisions 11-16) and items in FAA electrical specification sections (electrical specifications with L-prefix) must not be included in this calculation. Items that are not to be considered include but are not limited to pumps, fans, heaters, HVAC equipment, wiring, ductwork, lighting fixtures and controls.
- C. The overall Recycled Content for a product or building material shall be the percentage of total materials by cost of post-consumer recycled materials plus one half of the pre-consumer recycled materials.
- D. In the case where the recycled content of an item could not be obtained from a vendor or manufacturer, use the default recycled content percentages for the following materials in the table below (from SAM Credit 5.7). The default values are conservative and, in most cases, the actual recycled content percentages may be higher.

Material	Recycled Content (%)	
	Post-consumer	Pre-consumer
<u>Steel</u>	<u>25%</u>	—
<u>Copper</u>	<u>65%</u>	—
<u>Aluminum</u>	<u>80%</u>	—
<u>Reinforced Concrete Pipe</u>	<u>2 %</u>	—
<u>Asphaltic Paving Materials</u>	<u>45%</u>	<u>45%</u>

1.05 SUBMITTALS

- A. Design Estimate – With each milestone submittal during design phase, the Designer of Record shall submit a design estimate (see Form 01356-1.05A, “Recycled Materials Design Estimate”) that identifies total Project material cost (less labor and equipment) and the Recycled Content of the materials and products that are proposed for the Project. For each material, its post-consumer recycled content, pre-consumer recycled content, and cost shall be identified.
- B. Pre-Construction Estimate - Prior to the Contractor’s initial Applications for Mobilization Payment, the Contractor shall submit an estimate (see Form 01356-1.05B, “Recycled Materials Pre-Construction Estimate”) that identifies total Project material cost (less labor and equipment) and the Recycled Content of the materials and products that are proposed for the Project. For each material, its post-consumer recycled content, pre-consumer recycled content, and cost shall be identified.
- C. Final Construction Total - With the Closeout Documentation, the Contractor shall submit the final actual total Project material cost, less labor and equipment (see Form 01356-1.05C, “Recycled Materials Design Estimate”), and the Recycled Content of the materials and products that were used for the Project. For each material, its post-consumer recycled content, pre-consumer recycled content, and cost shall be identified.
- D. The above submittals must be transmitted to the Commissioner/Construction Manager and to the following email address: samdocs@cityofchicago.org.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 DOCUMENTATION TEMPLATE

- A. Recycled Content Design Estimate – Template Form 01356-1.05A attached at the end of this Specification Section should be used by the Designer of Record as guidance for completion of the Recycled Content submittal requirements as outlined in Part 1 of this Specification Section.
- B. Recycled Content Pre-Construction Estimate – Template Form 01356-1.05B attached at the end of this Specification Section should be used by the Contractor as guidance for completion of the Recycled Content

submittal requirements as outlined in Part 1 of this Specification Section .

- C. Recycled Content Final Construction Total – Template Form 01356-1.05C attached at the end of this Specification Section should be used by the Contractor as guidance for completion of the Recycled Content submittal requirements as outlined in Part 1 of this Specification Section .

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Recycled Materials will not be measured separately for payment, but will be considered included in the overall Contract.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. All costs associated with meeting these requirements are included in the overall Contract. No additional time or monies will be granted to the Contractor for compliance with these requirements and any associated regulations.

END OF SECTION 01356

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CHICAGO DEPARTMENT OF AVIATION/
O'HARE MODERNIZATION PROGRAM
TAXIWAY Z/JJ AND TANK FARM ROAD
OH6143.710.50.371
ISSUED FOR BID, 3/21/18

01356-8

RECYCLED CONTENT

SUSTAINABLE TEMPORARY CONSTRUCTION MATERIALS

SECTION 01360

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes use and tracking requirements and procedures for compliance with certain sustainable design guidelines based on the latest version of the Chicago Department of Aviation Sustainable Airport Manual (SAM). Reference can be found at www.airportsgoinggreen.org.
- B. This Section includes tracking requirements and forms necessary for compliance with this Specification and in accordance with the requirements of Credit 7.11 of the SAM.
- C. The requirements of this Section are applicable only for temporary construction materials defined as those materials that are used for construction that are not incorporated into the final development which may include, but are not limited to, items such as erosion control materials, temporary roadway pavements, shoring materials, formwork, temporary carpentry, and traffic control devices and signage.

1.02 RELATED DOCUMENTS

- A. Recycled Content of materials will be defined in accordance with 16 CFR 260.7(e) of the Federal Trade Commission's "Guide for the Use of Environmental Marketing Claims".

1.03 DEFINITIONS

- A. Recycled Materials: Materials that are manufactured, extracted, harvested, or recovered and contain some amount of post-consumer and/or pre-consumer recycled content.
- B. Recycled Content: The percentage by cost of the constituents of a product or building material that have been recovered or otherwise diverted from a solid waste stream, either during the manufacturing process (pre-consumer), or after consumer use (post-consumer).
 - 1. Post-Consumer Recycled Content is consumer waste that has become a raw material (feedstock) for another product. The post-consumer recycled content of an item will be given as a

percentage by weight for the purposes of calculating the overall recycled content of the item.

2. Pre-consumer Recycled Content contains waste from industrial processes that has been traded through the marketplace. The pre-consumer recycled content of an item will be given as a percentage by weight for the purposes of calculating the overall recycled content of the item.

C. Rapidly Renewable Materials: Materials and products that are made from plants that are typically harvested within a 10-year or shorter cycle.

D. Certified Wood: Wood and wood products that are certified in accordance with the Forest Stewardship Council (FSC) criteria.

1.04 CALCULATIONS

A. Recycled Content of Temporary Construction Materials:

1. Only include items in CSI Divisions 2-10 in the calculation of the percentage of temporary construction materials that have recycled content. This includes but is not limited to temporary pavements, masonry, aggregate, erosion control items such as silt fence, steel products such as construction fences, temporary carpentry including manufactured wood or fiber products, metal formwork, and temporary construction signage.
2. Mechanical, electrical, plumbing components, and specialty items (CSI Divisions 11-16) and items in FAA electrical specification sections (electrical specifications with L-prefix) must not be included in this calculation. Items that are not to be considered include but are not limited to pumps, fans, heaters, wiring, ductwork, lighting fixtures and controls.
3. Do not include rented or leased items.
4. The overall recycled content for the temporary construction materials shall be the percentage of post-consumer recycled materials plus one half of the pre-consumer recycled materials with respect to the total temporary construction materials by cost.
5. In the case where the recycled content of an item could not be obtained from a vendor or manufacturer, use the default recycled content percentages for the following materials in the table below (from SAM Credit 5.7). The default values are

conservative and, in most cases, the actual recycled content percentages may be higher.

Material	Recycled Content (%)	
	Postconsumer	Preconsumer
Steel	25%	-
Copper	65%	-
Aluminum	80%	-
Reinforced Concrete Pipe	2%	-
Asphaltic Paving Materials	45%	45%

B. Rapidly Renewable Temporary Construction Materials

1. Only include items in CSI Divisions 2-10 in the calculation of the percentage of temporary construction materials that have recycled content. This includes but is not limited to erosion control items such as silt fence, woven blankets, logs, and temporary carpentry including bamboo or fiber products.
2. Do not include rented or leased items.
3. The overall percentage of renewable materials used for the temporary construction materials shall be the percentage of renewable materials and products by cost with respect to the quantity of the total temporary construction materials by cost.

C. Certified Wood Temporary Construction Materials

1. Include only temporary carpentry or wood materials in the calculation. This includes but is not limited to scaffolding, stakes, shoring, temporary railings and walkways.
2. Do not include rented or leased items.
3. The overall percentage of certified wood used for the temporary construction materials shall be the percentage of certified wood materials and products by cost with respect to the quantity of the total temporary construction materials by cost.

1.05 SUBMITTALS

- A. Pre-Construction Estimate – Prior to the initial Application for Mobilization Payment, the Contractor shall submit an estimate (see Form 01360-1.05A, “Sustainable Temporary Construction Materials Pre-Construction Estimate”) that identifies total Project material cost (less labor and equipment) and the Recycled Content, Rapidly Renewable and Certified wood portions of the materials and products that are proposed for the Project.
- B. Final Construction Total - Concurrent with the Closeout Documentation, the Contractor shall submit the final actual total Project material cost, less labor and equipment (see Form 01360-1.05B, “Sustainable Temporary Construction Materials Final Construction Total”), and the Recycled , Rapidly Renewable, and Certified wood percentages of the materials and products that were used for the Project.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 DOCUMENTATION TEMPLATE

- A. Sustainable Temporary Construction Materials Pre-Construction Estimate – Template Form 01360-1.05A attached at the end of this Specification Section should be used by the Contractor as guidance for completion of the Sustainable Temporary Construction Materials submittal requirements as outlined in Part 1 of this Specification Section .
- B. Sustainable Temporary Construction Materials Final Construction Total – Template Form 01360-1.05B attached at the end of this Specification Section should be used by the Contractor as guidance for completion of the Sustainable Temporary Construction Materials submittal requirements as outlined in Part 1 of this Specification Section .

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. The tracking of Sustainable Temporary Construction Materials will not be measured separately for payment, but will be considered included in the overall Contract.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. All costs associated with meeting these requirements are included in the overall Contract. No additional time or monies will be granted to the Contractor for compliance with these requirements and any associated regulations.

END OF SECTION 01360

Contractor:	
Project:	
WBS No.:	

Company:	
Printed Name:	
Title:	
Signature:	
Date:	

Contractor:	
Project:	
WBS No.:	

I, [insert Contractor's name] declare that this list constitutes all of the temporary building materials and products and that, where applicable, the items as shown meet the definition of Recycled Content, Rapidly Renewable, and Certified Wood materials per the specification section(s).

Company:	
Printed Name:	
Title:	
Signature:	
Date:	
Reviewed by:	

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TRAFFIC CONTROL

SECTION 01502

PART 1 DESCRIPTION

1.01 GENERAL

- A. Furnish and install all Traffic Control as shown on the Drawings and as specified herein, including but not limited to the following:
 - 1. The governing factor in the execution and staging of construction for this Project is to provide the safest possible travel conditions.
 - 2. The Work under this Section includes the furnishing, installation, maintenance and removal of all traffic control and protection, including but not limited to signs, message boards, arrow boards, temporary concrete barriers, removal of existing pavement markings, energy attenuating systems, barricades, flagmen, warning lights, sandbags and all appurtenances used for the purpose of safely regulating, warning or guiding traffic through the construction zone as required by these Detail Specifications and as directed by the Commissioner.

1.02 RELATED WORK

- A. Traffic Control is required for all work adjacent to existing roadways used by the FAA, O'Hare Security, O'Hare Fuel Committee, and airport operations.

1.03 REFERENCES

- A. Illinois Department of Transportation - Standard Specifications for Road and Bridge Construction, latest edition.
- B. U.S. Department of Transportation, Federal Highway Administration's Manual on Uniform Traffic Control Devices, latest edition.

1.04 SUBMITTALS

- A. Submit the following
 - 1. Traffic Control Plan
 - a. The Contractor must submit for approval a traffic control plan for the areas where an existing roadway will be used by the Contractor, impacted by the work, or vehicular movements on the roadway will be impacted. The traffic

control plan is to show lane or roadway closures and durations for the duration of the Project.

- b. The Contractor must submit all requests and obtain all approvals for temporary lane or roadway closures from the Commissioner. All requests shall be submitted a minimum of 72 hours in advance of the proposed road closures. Temporary closures, where required, must be coordinated with the Commissioner. The Contractor should anticipate temporary closures to be permitted only between the hours of 10:00 p.m. to 6:00 a.m.

- (1) No lane closures will be permitted during actual or predicted snow removal conditions.

2. Construction schedule for Traffic Control Plan

1.05 QUALITY CONTROL

- A. Installation must be performed only by a qualified installer. The term qualified means experienced in performing the Work required by this Section on Projects of comparable scope, size and complexity. The Contractor must be able to demonstrate to the satisfaction of the Commissioner and Chief Procurement Officer that it and/or any subcontractors performing such Work have the qualifications, experience and, if applicable, licenses and permits to perform the Work in accordance with the terms and conditions of this Contract. The Contractor must submit evidence of such qualifications, licenses and permits upon request by the Commissioner.

- 1. The Contractor must provide a manned telephone on a continuous 24-hour-a day basis to receive notification of any deficiencies regarding traffic control and protection to correct any such deficiencies.

- B. Perform Work in accordance with the latest edition, of the appropriate divisions, of the following:

- 1. IDOT Standard Specifications for Road and Bridge Construction.
 - 2. FHWA Manual on Uniform Traffic Control Devices for Streets and Highways.
 - 3. City of Chicago, Department of Streets and Sanitation.
 - 4. IDOT Standard Specifications for Traffic Control Items.

1.06 SPECIAL REQUIREMENTS

- A. Job Conditions - General

1. The Contractor's vehicles must always move with and not across or against the flow of traffic, separated from traffic by temporary precast concrete barriers if required.
2. Vehicles must enter or leave work areas in a manner, which will not be hazardous to or interfere with normal traffic. Vehicles must not park or stop except within the designated work areas.
3. Personal vehicles will not be permitted to park within the right of way. The Contractor's personnel will be prohibited from crossing the roadway, and all pedestrian movements will be limited to within barricaded areas.

PART 2 MATERIALS AND EQUIPMENT

2.01 MATERIALS

A. Traffic Control Devices

1. All signs, signals, markings, reflectorized safety posts, portable barricades, portable flashers, arrow boards, portable message sign boards, flagmen, or other devices that are used for the purpose of regulating, warning and guiding expressway and crossroad traffic must conform to the applicable portions of the State of Illinois "Manual on Uniform Traffic Control Devices for Streets and Highways," and "Standard Specifications for Traffic Control Items."
2. Striping obliterating tape to void pavement marking will be black, non-reflective and self adhering.
3. No waiving of these requirements will be allowed without the prior written approval of the Commissioner.
4. Before beginning construction if the Contractor intends to use any signs not shown in the manual or any modification of standards shown in the manual, the Contractor must submit the details of the change and the use of the modified signs.

PART 3 CONSTRUCTION METHODS AND INSTALLATION

3.01 GENERAL

- A. All traffic control and protection must conform to the requirements of Section 701 Work Zone Traffic Control and Protection, IDOT Standard Specifications for Road and Bridge Construction, latest edition.
- B. The cones or barricades, lights, and all warning signs, as required by IDOT, which will be required whenever a lane of the traveled way is

closed to traffic, will be furnished and maintained by the Contractor. The Contractor will furnish and maintain all additional barricades, signs, warning lights, cones and flagmen, which is the opinion of the Commissioner and IDOT, are necessary to safeguard the traffic and protect the work site. The Contractor will be responsible for the traffic protection for the duration of this Contract.

- C. Placement of all signs and barricades must proceed in the direction of flow of traffic. Removal of all signs and barricades must start at the end of the construction areas and proceed toward oncoming traffic unless otherwise directed by the Commissioner. The Contractor will be required to cover all traffic control devices which may be inconsistent with traffic patterns during all changes.
- D. Contractor shall maintain access to all FAA facilities at all times. A clear, safe, and unobstructed path to all FAA facilities for use by FAA technicians shall be maintained during all Phases of the project. A muddied, highly rutted path shall not be considered "Clear, safe and unobstructed".
- E. Contractor shall maintain a lane of traffic in each direction on existing Tank Farm Road and existing Inner Western Airfield Access Road until traffic is permanently rerouted onto the new roadways.

3.02 FURNISH

- A. The Contractor's manner of prosecuting the work or minor revisions or modifications in the construction operations may require traffic control to not be installed in accordance with a standard detail and device. In such cases, the standard details and devices proposed to be used must be submitted to and approved by the Commissioner in advance of the change in traffic control.
- B. The Contractor will be required to furnish all traffic control devices unless specifically stated otherwise. Whenever the operation of the Contractor endangers or interferes with vehicular traffic, as determined by the Commissioner, the Contractor will furnish all additional traffic control devices necessary to direct traffic and protect his workmen, at no extra cost to the Commissioner. Sand bags that are used to secure barricades and sign stands are included in this item. The Commissioner reserves the right to inspect all traffic control equipment furnished by the Contractor one week before it is used on this Contract. In addition, the Contractor must furnish additional flagmen at no cost to the Commissioner, on a continuous basis whenever construction operations encroach on traveled lanes, such as pavement marking, patching operations, etc.

- C. Portable precast units which have the New Jersey configuration and which have previously been cast meeting earlier Illinois Department of Transportation standards may be used on this Project. The units must be in good condition, without cracks or spalls, and the connecting loops must not be broken. The Contractor will be allowed to mix barrier units of previous designs in the same run with new units, provided the connecting loops are compatible and the units are of the same width so that a smooth, continuous face can be obtained. Units having designs other than the New Jersey configuration may be used with the written approval of the Commissioner.

3.03 INSTALLATION

- A. Lane closure signs and flagmen signs must be erected prior to placement of drums, barricades, and/or cones and remain erected until such time as the traffic control devices have been removed from the pavement.
- B. Construction signs referring to temporary lane closures during working hours must be removed or covered during nonworking hours.
- C. The Contractor must so arrange his operations as to keep the closing of any lane of the traveled way to a minimum.
- D. The Contractor will be responsible for the proper location, installation and arrangement of all traffic control devices used for the Project. The Commissioner will inspect the traffic control device placement before work on each stage begins, and any deficiencies will be corrected by the Contractor before starting work on that stage.
- E. Whenever operations require or indicate that a relocation of a proposed or existing traffic control device is advisable including the existing signs and barricades as determined by the Commissioner, the Contractor must remove, relocate, and erect all traffic control devices in question. After the work has been completed, the Contractor, at the Commissioner's direction, must return and erect the device in its original location.
- F. All advance warning signs for lane closures, guide signs, intermediate information signs and standard signs must be installed at a minimum mounting height of seven feet to the bottom of the sign. Signs must be installed in a manner to resist damage or knockdown in severe wind conditions and also allow ease of relocation during stage changes.
- G. The Contractor will not be permitted to erect, change or remove his barricade system without prior approval of the Commissioner. The

Contractor will be required to leave and maintain all traffic control devices in place until all construction operations have been completed in each stage. The Contractor must arrange and manipulate barricade placement and schedule construction operations to permit continuous operation of all lanes designated as open to traffic unless otherwise directed by the Commissioner.

- H. The height of the barricades must be no less than three feet above the pavement or shoulder elevation. This additional protection will be considered included in the Contract, and no additional compensation will be allowed.
 - 1. At some locations it may be necessary to supplement Type II barricades with 55-gallon steel drums. The Contractor will do this upon request from the Commissioner, at no additional cost to the City.
- I. Removal of existing pavement marking and striping where required, will be by use of water blasting only.

3.04 MAINTENANCE

- A. The Contractor will be required to respond to any call from the Commissioner concerning all requests for improving or correcting traffic control devices including pavement marking tape, within one-half hour from the time of notification.
- B. In the event of severe weather conditions, the Contractor must provide additional personnel and equipment to maintain, relocate or remove all traffic control devices. In addition to general maintenance requirements throughout the day, the Contractor must realign all traffic control devices as necessary on a daily basis. The Contractor must relocate to the proper location all traffic control devices misplaced by Subcontractor operations. After notification, relocation of devices must take place in an expeditious manner.

3.05 REMOVE

- A. The Contractor must remove all traffic control devices that were furnished, installed, and maintained by him or her under this Contract, and such devices, will remain the property of the Contractor. All traffic control devices must remain in place until specific authorization to relocate the devices is received from the Commissioner for stage changes.

3.06 TEMPORARY GUIDE SIGNS

- A. The Contractor will furnish and erect temporary guide signs at the Project for maximum public guidance through the construction area and must maintain same in good condition until completion of the Project. Upon completion, the signs shall be removed. The location of the signs will be determined by the Commissioner. These temporary signs must be displayed in place prior to the commencement of construction.

3.07 GENERAL CLEAN-UP

- A. All rubbish and debris resulting from the Work of this Section must be collected and disposed of as directed by the Commissioner. The Contractor must keep all public roadways, and other public right-of-ways affected by the work, clean and free from debris and dust at all times.
- B. All work areas must be left in a broom clean condition.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Traffic Control and Protection will be measured on a lump sum basis as described herein.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Traffic Control and Protection will be paid for on a lump sum basis. The Contractor's operations may require daily changes and multiple work area installations. These will not be measured separately but will be included in the lump sum price for Traffic Control and Protection.
- B. Payment will be made under the following item:

ITEM NO. DESCRIPTION UOM		
01502-01	TRAFFIC CONTROL AND PROTECTION	LS

END OF SECTION 01502

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TEMPORARY SUPPORT OF EXISTING UTILITIES

SECTION 01510

PART 1 GENERAL

1.01 DESCRIPTION:

- A. Work under this Section is subject to the requirements of the Contract Documents.
- B. This item consists of the work required to support the existing utilities before construction begins. It does not include the support of any new utilities placed by the Contractor in this contract that may be required to do the sequencing of work.
- C. This item consists of the design, furnishing of materials, construction and removal of temporary supports for all existing utilities that are to remain in place during construction activities as shown on the construction drawings or as directed by the Commissioner.

The temporary support structures may include slabs, beams, columns, footings, foundations, grillages, piles, hangers, and any appurtenances required for the support of the utility.

The Contractor must engage the services of an Illinois licensed structural engineer (s) to provide the calculations, drawings and foundation requirements for the temporary supports systems selected.

1.02 RELATED WORK:

- A. As specified in the following sections:
 - 1. Section 02637 – Sanitary Sewers
 - 2. Section 03300 – Cast-in-Place Concrete
 - 3. Section D-701 – Pipe for Storm Drains
 - 4. Section D-705 – Pipe Underdrains for Airports
 - 5. Section D-751 – Manholes, Catch Basins, Inspection Holes and Manhole Adjustments
 - 6. Section L-110 – Installation of Airport Underground Electrical Duct
 - 7. Section M-101 – Mobilization and Closeout Documentation
 - 8. Section P-157 – Trench Backfilling
 - 9. Section P-610 – Structural Portland Cement Concrete
- B. Subsurface Investigation:

1. A geotechnical report with boring logs has been prepared for this project and is available to the Contractor. The opinions expressed in this report are those of the geotechnical engineer and represent interpretations of subsoil conditions, tests and results of analyses conducted by the geotechnical engineer. This information is to be used by the Contractor at his discretion. No responsibility is assumed by the Commissioner for subsoil quality of conditions.

1.03 REFERENCES:

- A. American Association of State Highway and Transportation Officials - Guide Design Specifications for Bridge Temporary Works 1st Edition with revisions
- B. References from utilities

1.04 SUBMITTALS:

- A. Submit the following
 1. Shop Drawings & Design Calculations
 - a. Contractor must submit complete design calculations and drawings to the Commissioner and utility owner for review and approval no later than 45 days prior to beginning construction of the temporary supports. Each drawing must be completely titled according to the contract plans, including structure name, project name, and project number. Submittals must be signed and sealed by an Illinois Licensed Structural Engineer and must include all details, dimensions, and cross sections necessary to construct the temporary supports and must include, but not be limited to, the following items:
 - (1) Plan and elevation views with a typical cross section and general notes required for constructing the temporary supports.
 - (2) Drawings showing the temporary supports and the maximum allowable deflection or settlement at each temporary support. Include a special inspection plan for monitoring the temporary supports showing compliance with the calculated deflection or settlement criteria during construction.

- (3) A set of written Rules for Excavation within 5 feet of the Utility (pipe, duct bank, etc.). Excavation using power-operated equipment is not permitted within 5 feet of the pipe unless (1) the pipe has been exposed by hand at the point of crossing or, (2) where the excavation runs parallel to the pipe, the pipe has been exposed at sufficient intervals to confirm its location.

2. Samples and/or Product Data

- a. Product Data: Catalog cuts of prefabricated elements, hangers connecting the utility to the temporary supports and other structural hardware and accessories.

1.05 QUALITY CONTROL:

- A. For fuel piping temporary support and engineering, the Contractor must be experienced in minimizing fuel system interruptions, cathodic protection, and installation of coated steel pipe. Contractors must be experienced with API 570 (Inspection, Repair, Alteration, and Rerating of in-service piping systems) and ASME B31.3 Process Piping Design.
- B. Judgment used in evaluating experience will be at the sole discretion of the Commissioner.
- C. Any damage to existing or proposed utilities during demolition and construction activities shall be coordinated with the utility owner and repaired at the Contractor's expense.

1.06 DESIGN CRITERIA:

- A. The design of the temporary supports must be according to AASHTO Guide Design Specifications for Bridge Temporary Works 1995 with revisions except as noted on the plans or as modified herein. The analyses of settlement, bearing capacity and overall slope stability shall be the responsibility of the Contractor. The Contractor must verify the net soil bearing capacity and develop his design to stay within the bearing capacity allowed.
- B. Total vertical deflection of temporarily supported utilities shall be limited to the span length divided by 600.
- C. If the temporary support is for an existing fuel pipe, the Contractor shall:

1. Provide pipe hangers, supports or anchors not to exceed the following maximum pipe support spacing:

<u>Pipe Under</u>	<u>Spacing</u>
1"	5'-0"
1-1/2	9'-0"
2	10'-0"
3	12'-0"
4	14'-0"
6	17'-0"
8	19'-0"
10	20'-0"
12	23'-0"
14	25'-0"
16	27'-0"
18	28'-0"
20	30'-0"
24	32'-0"
30" or Larger	33'-0"

2. Provide all special pipe supports required for properly supporting, guiding or anchoring all piping; submit details of special supports and exact location of all pipe hangers, supports and anchors as part of the Shop Drawings.
3. Pipe sleeves shall be provided for all pipes passing through pads, slabs and other concrete or masonry structures.
4. Pipe sleeves insulators shall be a segmented collar molded of high density polyethylene with runners. Shoe height of runners shall be as required to center the pipeline in the sleeve. Insulator shall be bolted around the fuel pipe without damaging the pipe coating.
5. Total vertical deflection of temporarily supported fuel pipes shall be limited to the span length divided by 600 or the maximum calculated to meet ASME 831.3 requirements, whichever is more stringent.

PART 2 PRODUCTS

2.01 MATERIALS:

- A. Material properties for the temporary supports shall be indicated on the shop drawings. Permanent materials and materials left in place shall conform to the requirements of the item (see article 1.02 Related Work).

PART3 EXECUTION

3.01 GENERAL INSPECTION & SURVEY

- A. Before ordering materials or commencing excavation, the Contractor must perform the following:
 - 1. Layout phasing and barricade lines.
 - 2. Layout demolition limits.
 - 3. Slope stakes for fill or excavation areas.
 - 4. Request and obtain utility locates of all existing utilities prior to excavation.
 - 5. Establish such additional lines, grades and controls as are needed for construction.
- B. Contractor must contact the Commissioner to coordinate with Airport Group International (AGI) and utilities prior to start of excavation near or at fuel line locations.
- C. Contractor to coordinate with ComEd, AT&T, the Gas Utility, and other affected utilities through the Commissioner at least two weeks prior to start of excavation near or at said utilities.

3.02 INSTALLATION & EXCAVATION:

- A. Temporary supports must be fabricated and installed according to the approved shop drawings.
- B. The Contractor must coordinate the installation of the temporary utility supports with the excavation of materials and the rules for Excavation development by the Contractor under Article 1.04.A1.a(3) herein.
- C. Where underground coated fuel pipes cross other pipes or structures with a separation of less than 6 inches, install an insulating separator. Protect the fuel pipe from contact with a 24"x36" rectangle by 1" thick bituminous-impregnated cane fiber board, "Fiexcell" as manufactured by Celotex Corporation, or approved equal
OR
Insulating separators shall be phenolic pads 1/2-inch thick.

3.03 TEMPORARY SUPPORT REMOVAL & BACKFILLING

- A. Prior to covering of exposed fuel pipe(s), provide an inspection to verify that the pipe is clear of physical contact with other pipes, pipe sleeves, casings, reinforcing steel, conduits, ductbanks, cables, or other metallic structures.

- B. The Contractor must coordinate the removal of any temporary support of existing utilities with the backfilling operations.
- C. Backfilling must be performed in accordance with the requirements of Section P-157 Trench Backfilling.

3.04 FUEL LINE REPAIR AND BACKFILLING

- A. Existing smaller fuel lines (all but the 24" fuel lines) are known to have a fairly fragile coating based on potholing to locate depths for design. Coating repair for these lines should be anticipated for any exposure. The work to repair the coating is included in the cost of the Temporary Support of Existing Utilities.
- B. For fuel lines exposed during construction, AGI must be immediately notified for direction on how to proceed with any repair and reburial. The exposed fuel line must be "jeeped" and tape coated or repaired under the direction and supervision of AGI. The exposed line must be backfilled with clean sand (no rocks) one foot below and one foot above the pipe. AGI must be present during the repair and reburial process. All costs related to the repair and reburial will be the responsibility of the Contractor. Additionally, the sand backfill is a requirement even if the line is not damaged.

3.05 GENERAL CLEAN-UP

- A. The Contractor must collect and remove from the site all rubbish and debris resulting from the work of this section.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Temporary support of known existing utilities will be considered incidental to the contract for each utility support designed, furnished, installed and removed. The temporary support includes the structural elements, supports, foundations, hangers and accessories required to securely support the utility and maintain service during construction.
- B. Measurement for temporary disconnecting and reconnecting existing subsurface drain pipes will be not paid separately. It will be incidental to the pay item of Pipe for Storm Drain, D-701 and Pipe Underdrains for Airports, D-705.

- C. Support of unforeseen utilities will be measured separately, as agreed to by the Commissioner, and paid for by allowance under pay item 01510-01, "Allowance for Unforeseen Utility Crossing, per allowance". The Contractor must receive written permission from the Commissioner to proceed with the work. The work will be paid for as shown in General Conditions, Article X, Changes in Work, 3. Time and Materials Basis. Unused portions of this allowance will not be paid to the Contractor.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment for the Temporary Support of existing utilities will be considered incidental to the contract for each temporary support placed and removed and will include all equipment, materials, tools, and labor required to design, construct, install, and remove Temporary Support of Existing Utilities as shown on drawings, encountered in the field, and as specified herein.
- B. Payment for disconnecting and reconnecting existing subsurface drain pipes will be not paid separately. It will be incidental to the pay item of Pipe for Storm Drain, D-701 and Pipe Underdrains for Airports, D-705.
- C. Item 01510-01 – Allowance for Unforeseen Utility Crossing: The Contractor must receive written notice from the Commissioner and Chief Procurement Officer to proceed with the work. The work will be paid for as shown in General Conditions, Article X, Changes in the Work, 3. Time and Materials Basis. Any remaining balance from the Allowance will be retained by the city.
- D. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
01510-01	ALLOWANCE FOR UNFORESEEN UTILITY CROSSING	AL

END OF SECTION 01510

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CONSTRUCTION WASTE MANAGEMENT

SECTION 01524

PART 1 GENERAL

1.01 SUMMARY

- A. The disposal of non-hazardous construction waste generated by work pertaining to this Contract shall be in accordance with Section 11-4-1905 of the Chicago Municipal Code ("Code") with exceptions as noted in this Specification Section.
- B. This Section includes use and tracking requirements and procedures for compliance with certain sustainable design guidelines based on the latest version of the Chicago Department of Aviation Sustainable Airport Manual (SAM). Reference can be found at www.airportsgoinggreen.org.
- C. This Section includes tracking requirements and forms necessary for compliance with this Specification and in accordance with the requirements of Credit 5.3 of the SAM.

1.02 RELATED DOCUMENTS

- A. Section 11-4-1905, "Construction or Demolition Site Waste Recycling", of the Chicago Municipal Code. (attached at end of this Specification Section)
- B. Section 13-32-125, "Construction Site Cleanliness", of the Chicago Municipal Code.
- C. Related Specification Sections include the following:
 - 1. X-100 - Site Demolition

1.03 PERFORMANCE REQUIREMENTS

- A. The Contractor will adhere to Section 11-4-1905 of the City of Chicago Municipal Code with exceptions as noted in this Specification Section.

1.04 SUBMITTALS

- A. The Contractor must transmit the submittals described below to the Commissioner/Construction Manager and to the following email address: samdocs@cityofchicago.org.
- B. The Contractor shall submit documentation pursuant to 11-4-1905 of

the Code with the following additions:

1. The City of Chicago C&D Debris Recycling Compliance Form (attached at the end of this Specification) shall be submitted monthly with the Contractor's Application for Payment. Do not complete beyond Line D (p.3) under the "Calculation of Recycling Percentage" of the C&D Debris Recycling Compliance Form and do not include the "Election Form and Contractor Affidavit" (p.4).
 2. The Contractor shall submit a Waste Management Plan and a preconstruction estimate of the C&D debris quantities prior to the Contractor's initial Application for Payment for Mobilization.
 3. The Contractor shall submit a post-construction City of Chicago C&D Debris Recycling Form with the Closeout Documentation.
- C. Waste Management Plan: The Plan shall be developed by the Contractor and shall be submitted to the Commissioner for review with the Contractors Application for Payment for Mobilization. The Plan shall include the following sections, at a minimum:
1. General: Provide an overall strategy for managing the C&D debris associated with the Project.
 2. Waste Identification: Indicate anticipated types and quantities by weight of demolition, site-clearing and construction waste generated by the Project. Include estimated quantities by weight and assumptions for estimates.
 3. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total weight of each type of waste, final disposition for each waste type, and handling and transportation procedures.
 - a. Salvaged Materials: For each type of material that is salvaged or recycled, describe the type of material, source, estimated quantity, and receiving entity. Include names, addresses, and telephone numbers for the receiving individuals and/or organizations.
 - b. Disposed Materials: Indicate how and where materials will be disposed. Include name, address, and telephone number of each landfill and incinerator facility.
 - c. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.
 - d. Stockpiles: For on-airport stockpiles, indicate location(s)

and proposed materials to be received at each stockpile location.

4. Preconstruction C&D Quantities Estimate: For every material recycled, salvaged, or disposed, estimate the quantity of each that is anticipated to be reused on-site, recycled off-site, or disposed off-site. Use the City of Chicago C&D Debris Recycling Form as a template (attached at the end of this Specification).

- D. Construction Waste Management Submittal Transmittal: When submitting the documentation to the Commissioner as required in Paragraphs 1.04B and 1.04C, the Contractor must complete the Submittal Transmittal Cover Sheet attached at the end of this Specification section and attach this with the appropriate submittal.
- E. All Chicago Department of Aviation (CDA) Projects must submit the documents outlined in Paragraph 1.04B to the Commissioner even if exempted by Section 11-4-1905 (3) of the Municipal Code.

1.05 QUALITY ASSURANCE

- A. Contractor Qualifications: Construction waste management work must be performed only by a qualified Contractor. The term qualified means experienced in performing the Work required by this Section. The qualified Contractor must have experience on Projects similar in size and scope to this Project. The Contractor will submit evidence of such qualifications (e.g. Project list, timeframe, amount of materials recycled, construction cost) upon request by the Commissioner.
- B. Regulatory Requirements: In addition to City Ordinances regarding waste recycling described herein, Contractor will comply with waste transport and disposal regulations of authorities (e.g. state, local, or federal) having jurisdiction.

1.06 SPECIAL REQUIREMENTS

- A. (Not Used)

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 PLAN IMPLEMENTATION

- A. General: Implement Waste Management Plan as approved by Commissioner. Provide means of handling, containers, storage areas, signage transportation, and other items to facilitate implementation of the Waste Management Plan for the duration of the Contract.

- B. Waste Management Coordinator: Assign a Waste Management Coordinator to be a single point of contact responsible for implementation, monitoring, and reporting of the waste management activities. Coordinator must be present for the duration of the Contract.
- C. Training: Contractor is responsible for training workers, subcontractors, and suppliers on proper waste management procedures as applicable to this Contract. Distribute Waste Management Plan to all subcontractors and suppliers when Contract work begins.
- D. Site Access and Temporary Controls: Waste management operations shall be conducted in a manner to minimally impact airport and public roadways, streets, walks, and adjacent occupied facilities. A site will be designated and identified as such for the classification of materials to be salvaged, recycled, reused, sold, donated, or disposed.

3.02 DISPOSAL OF WASTE

- A. General: Except for materials to be recovered, recycled, or reused, all other materials will be removed from the Project site. The Contractor will legally dispose of these remaining materials in a legal manner.
 - 1. Unless otherwise specified, do not allow waste materials to accumulate on-site.
 - 2. Remove and transport C&D debris in a manner that will prevent spillage and all trucks to be tarped or covered at all times during transport en route to ultimate destination.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Construction Waste Management will not be measured separately for payment, but will be considered included in the overall Contract.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. All costs associated with meeting these requirements are included in the overall Contract. No additional time or monies will be granted to the Contractor for compliance with these requirements and any associated regulations.

END OF SECTION 01524

CHICAGO DEPARTMENT OF AVIATION

01524 CONSTRUCTION WASTE MANAGEMENT

SUBMITTAL TRANSMITTAL COVER SHEET

Date: _____
Project: _____
WBS No. _____

Attention: Construction Manager

To: O'Hare Modernization Program
10510 W. Zemke Blvd.
Chicago, Illinois 60666

and via email to:
samdocs@cityofchicago.org

The following form(s) are submitted to comply with the requirements of the 01524 Construction Waste Management Specification Section (Check one):

- ☐ Waste Management Plan and
Pre-Construction C & D Debris
Estimate
☐ Final C & D Debris Recycling
Compliance Form

- ☐ Monthly C & D Debris
Recycling Compliance Form

From:	
Company:	
Printed Name:	
Title:	
Signature:	
Date:	

Reviewed by:	
	Resident Engineer

Note: These submittal requirements are in addition to the requirements put forth by the City of Chicago as outlined in Section 11-4-1905 of the Chicago Municipal Code.

responsibilities under this chapter and to coordinate the activities of the department of streets and sanitation with the department of the environment.

(Added Coun. J. 12-11-91, p. 10978)

11-4-1880 Fee-for-service contracts.

Wherever recycling services are not to be directly provided by the department of streets and sanitation to households in low-density dwellings, the department shall adopt regulations governing the issuance of fee-for-service contracts to provide for-profit and not-for-profit recycling operations. Such regulations shall, at a minimum, include criteria for providing diversion credits, tax credits and any other forms of financial assistance deemed appropriate by the department.

(Prior code § 99.1-7; Added Coun. J. 2-28-90, p. 12605; Amend 12-11-91, p. 10978)

11-4-1890 Promotion of economic development—Markets for recycled materials.

In order to promote economic development within the city and to encourage markets for recycled materials, the city department of planning and development in coordination with the department of the environment and other city departments, as appropriate, shall implement programs to build demand for recycled products among Chicago businesses, residents and local governments; to build markets for recycled materials by attracting to the city manufacturers that use recycled material as raw material; and to assist businesses in developing capacity to use recycled material in place of virgin material.

(Prior code § 99.1-8; Added Coun. J. 2-28-90, p. 12605; Amend 12-11-91, p. 10978)

11-4-1900 Promotion of recycling.

(a) On or before July 1, 1990, the department of planning and development in cooperation with the department of the environment and the department of streets and sanitation, shall develop and implement programs for issuing grants and loans to promote recycling in the City of Chicago.

(b) The department of planning and development shall submit an annual report to the mayor and the city council concerning the implementation of this section, as well as programs to build demand for recycled products among Chicago businesses, residents and local governments, programs for attracting to the city manufacturers that use recycled material as raw material, and programs to assist businesses in developing capacity to use recycled material in place of virgin material. Such report shall be available on September 1st of each year.

(Prior code § 99.1-9; Added Coun. J. 2-28-90, p. 12605; Amend 12-11-91, p. 10978)

ARTICLE XIV. REPROCESSABLE CONSTRUCTION/DEMOLITION MATERIAL

11-4-1905 Construction or demolition site waste recycling.

(1) For purposes of this section, the term[s]:

(a) "Contractor" shall have the meaning of general contractor as defined in Section 4-36-010 and shall also include any person engaged in the demolition or wrecking of a structure for which a permit is required under Section 13-32-230.

(b) "Construction and demolition debris" has the meaning ascribed to the term in Section 11-4-120 of this Code, but does not include materials that are contaminated by lead, asbestos, or other hazardous materials in such a way as to render recycling illegal or impossible.

(2) Any project subject to this section shall be required to recycle construction or demolition waste produced on site as part of construction or demolition activities by meeting the following requirements:

(a) The contractor on a project that is issued a permit on or after January 1, 2006, but before January 1, 2007, shall cause to be recycled at least 25 percent of construction and demolition debris, as measured by weight, produced on site.

- (b) The contractor on a project that is issued a permit on or after January 1, 2007, shall cause to be recycled at least 50 percent of construction and demolition debris, as measured by weight, produced on site.

(3) The following projects are subject to this section:

- (a) Residential projects with four or more units that involve the construction of a new structure or that involve buildings or structures that have been substantially rehabilitated, as determined by the commissioner of the department of buildings.
- (b) Any construction that will require a certificate of occupancy to issue from the department of buildings.
- (c) Any building demolition, other than projects for which the total cost is less than \$10,000.00.

A project is exempt from this section if only a plumbing permit, only an electrical permit or only a mechanical permit is required.

(4) The contractor shall submit documentation as described herein to the department of the environment to verify compliance with this section. Projects meeting the requirements of (2)(a) or (2)(b) of this section shall submit documentation prior to the issuance of a certificate of occupancy by the department of buildings. Projects meeting the requirements of (2)(c) of this section shall submit documentation within 60 days of completion of a project. Documentation shall be in a form prescribed by the commissioner of the department of environment and consist of notarized affidavits from the contractor and the waste-hauler for the project certifying that the project fully complies with subsection (1) or, in the case of an application for a certificate of occupancy for a portion of a partially completed project, that the project is in compliance with subsection (1) at the time the application is made. The department of environment will certify to the department of buildings and the department of construction and permits that the contractor has complied with this ordinance if: (i) the contractor has met the stated recycling goals; or (ii) the contractor has been fined for that project under subsection (6),

and the fine has been paid in full. In addition, a contractor must comply with all reasonable requests for information and documentation made by the department pursuant to an audit to monitor compliance with this section. Whenever any affiant knowingly and falsely states that a project has met the requirements of this section, or whenever any contractor knowingly submits an affidavit with such a false statement, or whenever any person knowingly fails to comply with a reasonable request made pursuant to an audit under this section, such action will be grounds to deny or revoke the issuance of a certificate of occupancy, will subject the person to a fine of \$200.00 to \$500.00, and will subject the person to additional penalties and fines pursuant to this Code or state law including, but not limited to, the revocation or suspension of an affiant's or contractor's general contractor's license pursuant to Chapter 4-36.

(5) The commissioner of the department of environment, the commissioner of the department of buildings, the commissioner of the department of streets and sanitation or the executive director of the department of construction and permits may promulgate such rules and regulations as necessary to implement the provisions of this section.

(6) Projects that fail to meet the recycling percentages identified in subsection (1) shall be subject to the following fines:

For construction projects or involving demolitions greater than 10,000 square feet of renovated, newly constructed, or demolished space	\$5,000 for each percentage point of difference between the amount by this section to be recycled and the amount actually recycled
For construction projects or demolitions involving less than 10,000 square feet of renovated, newly constructed, or demolished space	\$2,000 for each percentage point of difference between the amount required by this Section to be recycled and the amount actually recycled

(Added Coun. J. 12-15-04, p. 40435, § 3)



**CITY OF CHICAGO
CONSTRUCTION & DEMOLITION DEBRIS RECYCLING
COMPLIANCE FORM - 2006**

This is a • construction project / • demolition project. (Check one.)

(Please see the instructions on page 4.)

<u>Contractor Information</u>	<u>Construction/Demolition Site Information</u>
Contractor Name _____	Address of Project Site _____
Contractor License Number _____	Building/Demolition Permit Number _____
Street Address _____	Project Completion Date _____
City _____ State _____ Zip Code _____	Size of Project (square feet) _____
Telephone Number _____	Project Manager's Name & Telephone Number _____
Contact Name and Title _____	Property Owner's Name & Telephone Number _____

Construction and Demolition Debris Information

<u>C&D Debris Weight Information</u>	<u>Recycled C&D Debris Information</u>
1) _____ Tons of all C&D debris produced on site (This amount must match the total on page 2.) <i>minus:</i> 2) _____ Tons of contaminated C&D debris (with asbestos or other hazardous material) <i>equals:</i> 3) _____ Total amount of recyclable C&D debris (List this amount on page 3, line "B.")	4) _____ Tons of C&D debris recycled/reused off site (Completed Waste Hauler/Recycler Affidavit(s) must be attached to account for all debris taken to a recycler.) <i>plus:</i> 5) _____ Tons of reprocessed C&D debris used on site (Copy of DOE construction site reprocessing authorization must be attached.) <i>equals:</i> 6) _____ Total amount of recycled/reused C&D debris (List this amount on page 3, line "A.")

NOTE: Pursuant to Section 11-4-1905(4) of the Chicago Municipal Code, all contractors are subject to audit to verify compliance. All documentation that supports this form (such as weight tickets and receipts) must be retained for no less than three years from the date that this form is filed.

Breakdown of all C&D Debris Produced on Site

C&D Debris Type	On site Reused (tons)*	Off Site Reused/Recycled (tons)*	Off Site Disposed (tons)*
Bricks			
Concrete			
Masonry materials (cinder blocks, mortar etc.)			
Rock, stone, gravel			
Soil, dirt			
Sand			
Reclaimed asphalt pavement	-----		
Wood	-----		
Ferrous metal (iron, steel etc.)	-----		
Nonferrous metal (copper wiring etc.)	-----		
Plaster	-----		
Gypsum drywall	-----		
Paint	-----		
Plumbing fixtures and piping	-----		
Carpet and Pad	-----		
Non-asbestos insulation	-----		
Roofing shingles & other roof coverings	-----		
Cardboard, paper, packaging	-----		
Plastics	-----		
Glass	-----		
Landscape debris	-----		
Hazardous materials (please specify):	-----	-----	
Other (please specify):			

Subtotals: _____ **

Total of all C&D debris produced on site (sum of the above 3 columns): _____

***If weight measurements are not available, convert volume to weight and retain documentation to support the accuracy of the converted measurement.**

****Waste Hauler/Recycler affidavits must be attached to account for the amount of C&D debris recycled or disposed of off site. To account for C&D debris reused on or off site, the contractor must provide supporting documentation upon request by the Dept. of Environment.**

Calculation of Recycling Percentage

A) Total amount of **Recycled/Reused** C&D debris _____ tons
(from line 6, page 1)

B) Total amount of **Recyclable** C&D debris _____ tons
(from line 3, page 1)

If Line B is zero, skip to Contractor Affidavit on page 4.

C) Percent of C&D debris Recycled _____ percent
(divide A by B and multiply by 100)

Example:

A. Total amount of Recycled/Reused C&D debris.... 2,025 tons

B. Total amount of Recyclable C&D debris 5,700 tons

$$\bullet 2,025 \div 5,700 = 0.36 \text{ (rounded to the nearest hundredth)}$$

$$\bullet 0.36 \times 100 = 36$$

C. Percent of C&D debris Recycled 36 percent

D) Percent required to be recycled (for 2006) 25 percent

E) Line D minus line C _____ percent

If Line E is greater than 0%, go to Line F; if not, skip to Contractor Affidavit on page 4.

F) Multiply line E by:

\$1,000 - if project space is 10,000 square feet or more

-or-

\$500 - if project space is less than 10,000 square feet

Total penalty _____ dollars

If a penalty is owed, make payment to: *City of Chicago Department of Revenue*
(City Hall, 121 N. LaSalle, Room 107A)

****Staple original receipt here:**

(Please keep a copy for your records.)

For Department of Revenue use only:

Funds Code: **EB58 100-72-3035-2713 Ordinance 11-4-1905 Penalties**

Election Form And Contractor Affidavit

Select one option, then sign the affidavit below before a Notary Public.

- • I have complied with the recycling requirements set forth in Section 11-4-1905 of The Chicago Environmental Protection and Control Ordinance; and all the information provided herein and attached hereto is correct.

or

- • I have paid the penalty calculated on page 3; all the information provided herein and attached hereto is correct; and I will not contest this penalty.

or

- • I have completed this form in full; all the information provided herein and attached hereto is correct; and I hereby request a hearing on the applicability of Section 11-4-1905 and/or the amount of penalty due. (You will receive a notice by mail, specifying the date, time, and location of the hearing).

Signature

Name

Title

Date _____

Notary Public

INSTRUCTIONS

- 1) Complete this 4-page compliance form and sign before a Notary Public.
- 2) Attach one or more signed and notarized Waste Hauler/Recycler Affidavits.
- 3) Attach a Construction Site Reprocessing Authorization letter from the Department of Environment, if applicable.
- 4) Attach a receipt from the Department of Revenue, if a penalty was paid.
- 5) Return forms to the environment desk at DCAP, Room 906, City Hall, 121 N. LaSalle Street, within **30 days** from project completion.

If you have any questions about this form, please call 312-744-7672.

DISPOSAL OF CLEAN CONSTRUCTION OR DEMOLITION DEBRIS (CCDD) AND UNCONTAMINATED SOIL

SECTION 01525

PART 1 GENERAL

1.01 APPLICABILITY

- A. Requirements of this Section shall apply only when Clean Construction or Demolition Debris (CCDD) or Uncontaminated Soil, as these terms are defined below, is placed off airport property at a CCDD Fill Operation or Uncontaminated Soil Fill Operation that is appropriately permitted or registered in accordance with 35 Illinois Administrative Code Part 1100 and any and all other applicable laws.

1.02 SUMMARY

- A. "Clean Construction or Demolition Debris (CCDD)" has the meaning assigned to term "Clean construction and demolition debris" in 35 Illinois Administrative Code 1100.103.
- B. "Uncontaminated Soil" has the meaning assigned to the term "Uncontaminated soil" in 35 Illinois Administrative Code 1100.103.
- C. CCDD and Uncontaminated Soil as defined above, can be transported to CCDD Fill Operations or Uncontaminated Soil Fill Operations that are appropriately permitted or registered in accordance with 35 Illinois Administrative Code Part 1100 and any and all other applicable laws, so long as the Contractor complies with all requirements of 35 Illinois Administrative Code Part 1100 and any and all other applicable laws.

1.03 SUBMITTALS

- A. Form LPC-663 Uncontaminated Soil Certification by Licensed Professional Engineer (LPE) or Licensed Professional Geologist (LPG).
- B. Form LPC-662 Source Site Certification by Owner.

1.04 RELATED WORK

- A. Related Sections include the following:
 - 1. Section 01524 - Construction Waste Management

2. Section P-150 - Pavement Removal
3. Section P-152 - Excavation and Embankment
4. Section X-100 - Site Demolition

PART 2 MATERIALS [NOT USED]

PART 3 EXECUTION

3.01 DOCUMENTATION IMPLEMENTATION

- A. The LPE/LPG will make the determination of whether the site is a Potentially Impacted Property (PIP). If it is determined that the site is a non-PIP, the City will have the responsibility to complete an LPC-662. If it is determined that the site is a PIP, the LPE/LPG will have the responsibility to complete an LPC-663.
- B. Contractor will have the responsibility to submit the forms, along with any other applicable paperwork.
- C. Contractor will retain any testing firm needed to take samples or perform chemical analysis of the samples. Any laboratory performing chemical analysis must provide certification that the analysis has been performed in accordance with IEPA's rules for the accreditation of environmental laboratories.

PART 4 MEASUREMENT AND BASIS OF PAYMENT

4.01 MEASUREMENT AND PAYMENT

- A. All documentation, testing, laboratory analysis, and certification by a licensed Professional Engineer or licensed Professional Geologist, including all state and local tipping fees to meet the requirements of Public Act 96-1416 will not be measured separately for payment but will be considered included in the unit price for the associated removal or excavation items in the Contract. No additional time or monies will be granted to the Contractor for compliance with these requirements and any associated regulations.

END OF SECTION 01525

DEWATERING

SECTION 02240

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Work under this Section is subject to the requirements of the Contract Documents.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 RELATED WORK

- A. This Section includes construction dewatering.
- B. Related Sections include the following:
 - 1. Section D-701 – Pipe for Storm Drains
 - 2. Section D-705 - Pipe for Underdrains for Airports
 - 3. Section D-751 – Manholes, Catch Basins, Inspection Holes, and Manhole Adjustments
 - 4. Section P-152 – Excavation and Embankment
 - 5. Section X-100 – Site Demolition

1.03 PERFORMANCE REQUIREMENTS

- A. Design, furnish, install, operate, monitor and maintain dewatering system of sufficient scope, size and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
 - 1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood and that damage to subgrades and permanent structures is prevented.
 - 2. Prevent surface water from entering excavations by grading, dikes and other means.

3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
4. Remove dewatering system when no longer needed.

1.04 SUBMITTALS

A. Submit the following

1. Shop Drawings for Information: For dewatering system. Show arrangement, locations and details of wells and well points; locations of headers and discharge lines; and means of discharge and disposal of water.
 - a. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
 - b. Include a written report outlining control procedures to be adopted if dewatering problems arise.
 - c. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.

B. Qualification Data: For Installer and professional engineer.

C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.

D. Record Drawings at Project closeout identifying and locating capped utilities and other subsurface structural, electrical or mechanical conditions performed during dewatering.

1. Note locations and capping depth of wells and well points.

E. Field Test Reports: Before starting excavation, submit test results and computations demonstrating that dewatering system is capable of meeting performance requirements.

1.05 QUALITY CONTROL

A. Regulatory Requirements: Comply with water disposal requirements of City of Chicago and as required by the Commissioner.

B. Preinstallation Conference: Conduct conference at Project site to comply with Project requirements.

1.06 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Commissioner and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
 - 2. The geotechnical report is available from the Commissioner.
- C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During dewatering, regularly resurvey benchmarks maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 PRODUCTS [NOT USED}

PART 3 EXECUTION

3.01 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by dewatering operations.
 - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
 - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks or other adjacent occupies or used facilities without permission from Commissioner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.02 INSTALLATION:

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtunences, water disposal, and surface-water controls.
- B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.
- C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers and other excavations.
 - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
- D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers and other excavations.
 - 1. Maintain piezometric water level a minimum of 3 feet below surface of excavation.
- E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of

dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches (900 mm) below overlying construction.
- G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.03 OBSERVATION WELLS:

- A. Provide, take measurements and maintain at least the minimum number of observation wells or piezometers indicated and additional observation wells as may be required by authorities having jurisdiction.
- B. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
- C. Repair or replace, within 24 hours, observation wells that become inactive, damaged or destroyed. Suspend construction activities in areas where observation wells are not functioning properly until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
 1. Fill observation wells, remove piezometers, and fill holes with sand after dewatering is completed.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. No separate measurement will be made for items described in this Section of the Specifications.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. No separate payment will be made for items described in this Section of the Specifications. All costs for this work will be considered included in the unit prices for the pay items requiring the various work items delineated in this Specification Section.

END OF SECTION 02240

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CONTROL OF WATER

SECTION 02241

PART 1 DESCRIPTION

1.01 GENERAL

- A. The work of this Section includes control, handling, treatment, and disposal of groundwater, surface water, storm water from existing pipelines, and any other water that may be encountered during the construction.
- B. This Section includes bypass pumping of live storm and sanitary sewers.
- C. Work performed in this Section must be coordinated with Section P-156 – Temporary Air and Water Pollution, Soil Erosion, and Sediment Control, of these Specifications.

1.02 RELATED WORK

- A. Related Sections include the following:
 - 1. Section D-701 – Pipe for Storm Drains
 - 2. Section D-751 – Manholes, Catch Basins, Inspection Holes and Manhole Adjustments
 - 3. Section P-152 – Excavation and Embankment
 - 4. Section P-156 – Temporary Air and Water Pollution, Soil Erosion, and Sediment Control

1.03 PERFORMANCE REQUIREMENTS

- A. Design, provide, operate, monitor and maintain systems of sufficient scope, size and capacity to control groundwater, surface water, storm water, and all other water flow into excavations and to permit construction to proceed on dry, stable subgrades.
 - 1. Maintain water control systems to ensure erosion control, and stability of excavations and constructed slopes, such that excavation does not flood and that damage to subgrades and permanent structures is prevented.
 - 2. Prevent surface water from entering excavations by grading, dikes, ditches, and other means.
 - 3. Accomplish control of water and dewatering without damaging

existing buildings adjacent to excavation.

4. Remove water control systems when no longer needed.

1.04 SUBMITTALS

- A. Submit a Water Control Plan describing the proposed method for control, handling, treatment, and disposal of water. As a minimum, describe the following:
 1. Methods of controlling water (such as cutoff, dewatering, sumping), equipment, and power supply.
 2. Details of dewatering wells and wellpoints, including location, size, depth, spacing, length and type of screen; pumping capacity; locations of headers and discharge lines; means of discharge and disposal of water; and method of monitoring discharge.
 3. Schedule of installation and operation of water control facilities.
 4. Means of monitoring groundwater levels and piezometric pressures.
 5. Sediment and pollution control facilities as described in Section P-156 – Temporary Air and Water Pollution, Soil Erosion, and Sediment Control, of these Specifications.
 6. Discharge locations to be used.
 7. Method of bypassing existing live sewers.
 8. Resubmit, as appropriate, if the system or any part thereof is modified during installation or operation.
- B. Submit, for information only, copies of all required permits for control, handling, treatment, and disposal of water.
- C. Submit, for information only, copies of required monitoring records.
- D. Record Drawings at Project closeout identifying locations and capping depth of wells and well points.

1.05 REGULATORY REQUIREMENTS

- A. Comply with water disposal requirements of City of Chicago, North Cook County Soil and Water Conservation District (NCCSWCD), Kane Dupage Soil and Water Conservation District (KDSWCD), Corps of Engineers, Section P-156 – Temporary Air and Water Pollution, Soil Erosion, and Sediment Control, of these Specifications, and as required by the Commissioner.

1.06 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Commissioner and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
 - 2. The geotechnical report is available from the Commissioner.
- C. Survey adjacent structures and improvements, employing a qualified Illinois Licensed professional engineer or land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During dewatering, regularly resurvey benchmarks maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Commissioner if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION

3.01 GENERAL

- A. Control, handle, treat, and dispose of water continuously during the course of construction. Perform this work without interference with the operations of other Contractors, or the rights of public and private owners, and without damage to structures, adjacent property, and the environment.
- B. Protect structures, utilities, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by dewatering operations.

3.02 CONTROL OF SURFACE WATER

- A. Prevent surface water from ponding on the site and from draining into excavations, and prevent runoff from adjacent properties from entering the construction site, in quantities that might interfere with prosecution of the Work.
- B. Intercept and divert surface water by use of surface grading, dikes, curbs, ditches, sumps, and other means and in accordance with Section P-156 – Temporary Air and Water Pollution, Soil Erosion and Sediment Control, of these Specifications.

3.03 CONTROL OF WATER IN EXCAVATIONS

- A. Control water inflows to excavations to prevent loss of fines, soil erosion or piping, flowing ground, slope instability, or softening of subgrade or foundation soils.
- B. Groundwater table should be at least 3 feet below the bottom of the excavation, shaft excavation, or trench during construction activities not specifically intended to be performed in a flooded excavation and during placement of bedding and backfill, erection of formwork, placement and curing of concrete, placement of pipe, or other permanent construction.
- C. Reduce or counteract groundwater pressure in soils outside the excavation to prevent bottom heave in trenches, shafts, and other excavations.
- D. Minimize reduction of groundwater pressure outside the excavation to avoid consolidation of compressible soil strata.
- E. Provide standby pumps and standby power supply where disruption of water control systems could allow water inflows to threaten the Work or the safety of personnel. Take immediate steps to control water inflow to the excavation that could cause loss or damage to adjacent structures or property.

3.04 DEWATERING WELLS

- A. Dewatering from wells must be kept to the minimum necessary to accomplish the work. Design screens and operate wells so as to prevent removal of fine soils.
- B. Provide means to adjust water discharge from each well independently. Monitor the discharge from each well on a daily basis, and provide discharge records to the Commissioner weekly.

- C. Abandon dewatering wells and piezometers by grouting the full depth of casings and pipes by tremie method or by pressure injection from the ground surface. Grout must consist of cement and water, with the minimum amount of water necessary to allow pumping. Cut off or remove casings and pipes to at least 3 feet below final grade. Obtain any required permits for well abandonment in accordance with local regulations.

3.05 TREATMENT AND DISPOSAL OF WATER

- A. Discharge water into a sediment trap, into a ditch or temporary ditch that leads to a sediment trap, or into a sediment containment filter bag in accordance with Section P-156 – Temporary Air and Water Pollution, Soil Erosion, and Sedimentation Control, of these Specifications.
- B. Prior to discharging water, remove suspended solids, oils, cement, bentonite, and other contaminants by use of settling basins, on-site treatment plant, or other means. Reduce contaminant concentrations to levels acceptable to authorities having jurisdiction over receiving waters. Select treatment systems that can accommodate expansion if greater capacity becomes necessary during the course of the work.
- C. On completing the work, clean out and dispose of all sediments and residues in settling basins and treatment facilities. Disposal must comply with water disposal requirements of the City of Chicago, North Cook County Soil and Water Conservation District (NCCSWCD), Kane-DuPage Soil and Water Conservation District (KDSWCD), COE, Section P-156 of these Specifications, and as required by the Commissioner.

3.06 BYPASS PUMPING

- A. Maintain sewer and storm water flows around work areas in a manner that will not cause surcharging or damage to sewers, and that will protect public and private property from damage and flooding. The Contractor must not stop or impede the main flows under any circumstances.
- B. Provide, maintain, and operate temporary facilities including dams, plugs, pumping equipment, and conduits necessary to intercept flow before it reaches the point where it would interfere with the work, carry the flow past the work, and return flow to the existing sewer downstream of the work.
- C. Utilize pumps, power systems, and other equipment that will

accommodate the cyclic nature of effluent flows.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Control of Water will be measured on a lump sum basis as described herein.

BASIS OF PAYMENT

4.02 PAYMENT

- A. For each lump sum payment, 10% will be paid upon approval of the water control system design, an additional 40% of the lump sum payment will be paid upon field acceptance, by the Commissioner, of the effectiveness of the water control system, and the remaining 50% of the lump sum payment will be paid upon the basis of acceptance of the percentage of excavation completed.
- B. Payment will be made under the following item:

ITEM NO.	DESCRIPTION	UOM
02241-01	CONTROL OF WATER	LS

END OF SECTION 02241

RECYCLED CRUSHED CONCRETE AND ASPHALT

SECTION 02245

PART 1 DESCRIPTION

1.01 GENERAL

- A. Furnish all labor, materials, equipment, and processes required for the setting up, operating and removal of a portable crushing plant and associated equipment capable of producing crushed recycled concrete and crushed and/or screened recycled asphalt pavement in accordance with this specification. This work will include site restoration at the end of operations.

1.02 DESCRIPTION OF WORK

- A. The Contractor will be responsible for setting up a portable crushing plant and associated equipment as shown on the plans; crushing the concrete to Recycled Concrete Base (RCB) to gradation and crushing and/or screening the asphalt to IDOT CA-6 gradation. Only concrete from O'Hare Airport projects is to be utilized in crushing operations.
- B. Recycled Concrete Base (RCB) must meet the following gradation:

Sieve Size	Percent Passing
4"	100
3"	60 - 100
3/4"	30 - 70
1/2"	20 - 60
#4	35 maximum percent passing
#40	20 maximum percent passing
#200	0 - 5.0

- C. The RCB will be subject to acceptance testing procedures by the Commissioner/Construction Manager (CM). Crushing operation at the jobsite will be subject to monitoring by the Commissioner to ensure that the material is clean and meets the requirements. Uniformity in production of clean recycled concrete and uniformity of placement in the field free of segregation are required. Precautions shall be taken to avoid segregation of material in a temporary stockpile or during

placement. RCB must be free of reinforcing bars, PVC pipes, RAP, metals, geotextile fabric, and other objectionable materials.

- D. Upon completion of the crushing operations, the Contractor must remove the crushing plant, associated equipment and any necessary site utilities from airport property and restore the site at no additional cost to the Commissioner.

1.03 RELATED WORK

Section 01111 – Air Quality-Equipment Emissions

Section 01355 – Local/Regional Materials

Section 01356 – Recycled Content

Section 01524 – Construction Waste Management

Section 02710 – Dust Control

Section M-103 – Airport Safety and Security

Section P-156 – Temporary Air and Water Pollution, Soil Erosion, and Sediment Control

Section Q-100 – Quality Control Program

1.04 SUBMITTALS

- A. Prior to beginning the work, the Contractor must submit a Work Plan at the Pre-Construction conference to the Commissioner for approval. The Work Plan must include a description of all equipment and processes that will be utilized to crush the concrete and asphalt to the specified gradations, estimated daily production, expected duration of crushing operations, estimated total quantities of each aggregate gradation, estimated duration of mobilization and demobilization, removal of steel and deleterious materials, set up and calibration of weighing equipment, and stockpile management. No work is to commence until the Work Plan has been approved by the Commissioner.
- B. The Contractor must submit a Dust Control Plan for the methods for accomplishment for the alleviation and prevention of dust nuisance originating from construction operations within the project limits in accordance with Section 02710 – Dust Control. The Contractor must have a sufficient number of operating vacuum power sweepers and

operators on the job site at all times.

- C. The Contractor must submit a Waste Management Plan and comply with reporting requirements in accordance with Section 01524 – Construction Waste Management.
- D. RCB shall be accepted for gradation as specified herein. Sampling locations shall be determined on a random basis in accordance with statistical procedures contained in ASTM D3665. Sampling of aggregates shall be in accordance with ASTM D75.
- E. The Contractor must submit a sieve analysis per ASTM C 136 for every 2500 tons of aggregate produced, or a minimum of one test every two weeks, whichever is more frequent, for each gradation. The analysis must show that the product meets gradation of the RCB; conforming to Article 1004 of the Illinois Department of Transportation, Standard Specifications for Road and Bridge Construction (S.S.R.B.C.), latest edition. Recycled Concrete Base (RCB) must meet the gradation shown in Paragraph 1.02.B.
- F. Comply with all applicable City, State and Federal governmental regulations regarding crushing operations. This includes but is not limited to: Illinois Environmental Protection Agency (IEPA) Joint Construction and Lifetime Operating Permit for Portable Emissions Unit; City of Chicago Department of Environment (DOE) Construction Site Reprocessing Authorization Application Requirements (Crushing Authorization) and Installation Permit Application for Processing Equipment or Area (Crushing Equipment Installation Permit), as well as applicable IDOT Policy Memorandums regarding recycling Portland cement concrete into aggregate. The Contractor must obtain all required permits and submit copies to the Commissioner before starting any pre-processing or crushing operations.

PART 2 PRODUCTS

2.01 MATERIALS

- A. The Contractor must satisfy himself as to the nature of the recyclable materials stockpiles located as referenced above and provide all required labor, materials, equipment and processes in order to maximize the amount of coarse aggregate concrete product produced so that the production of RCB crushed concrete is optimized.
- B. It is the responsibility of the Contractor to determine how much, if any, of the stockpiled materials is not suitable for crushing, and remove such material prior to crushing operations. The Contractor must dispose of the unsuitable material at a location on the Airport, as

directed by the Commissioner, at no additional cost to the City.

- C. Crushed recycled concrete having a gradation of RCB, conforming to Paragraph 1.02.B.
- D. Crushed and/or screened recycled asphalt pavement (RAP) having a gradation of CA-6, conforming to Article 1004 of the Illinois Department of Transportation, Standard Specifications for Road and Bridge Construction (S.S.R.B.C.), latest edition. It should be anticipated that the contractor will encounter mostly asphalt chunk material. The asphalt stockpile has been generated over several years. What was once loose portions of broken asphalt should now be considered one large mass due to compaction from trucks driving over the pile and extended exposure to the elements. During excavation of this pile, it will be necessary to break loose portions of asphalt from the large stockpile mass. The contractor should anticipate having to process, remove and properly dispose of additional items encountered in the asphalt such as airfield lighting cans, some broken concrete, rebar steel, aggregates and asphalt grindings.
- E. The Contractor is to only use materials in the crushing and screening operations from the Commissioner's supplied recyclable materials stockpiles or other delivered and approved recyclable materials from current Airport projects. The products must be crushed from clean rubble obtained from pavement removal or foundations from O'Hare Airport projects. The Commissioner will direct the Contractor to the existing stockpiles and authorize any additional materials to be used for the crushing and recycling. The Contractor may expect to crush no more than the amount of material required for the Taxiway Z/J and Tank Farm Road project.

PART 3 EQUIPMENT

3.01 GENERAL

- A. Provide a portable tracked or wheel mounted jaw type crusher with a minimum size of 32" x 58" capable of handling larger sized concrete in order to maximize the amount of coarse product produced. The feed particle size should be sufficiently large enough and crusher and operations must be capable of maximizing a large percentage of 3" coarse product such that a target of optimum production of the source pile is produced meeting CA-6 gradation, as directed by the Commissioner. For RCB production, essentially all the source pile may be produced as RCB. The Commissioner will periodically check the crushing operations and percentages of CA-6 or RCB gradations produced. Oversized product is to be re-fed through the jaw crusher.

A grizzly screen may be required for removals. The Commissioner will make the final determination of the adequacy of the Contractor's crushing operations.

- B. Crusher and screen(s) to be track or wheel mounted in order to facilitate quick site movement as directed by the Commissioner. The equipment must be capable of being portable enough to facilitate movements of short distances on site in order to better access the recyclable materials stockpiles and accommodate operational constraints of an active airport, if so directed by the Commissioner, without any additional mobilization/demobilization costs to the City.
- C. A magnetic or other suitable device or method of separating steel from the concrete and asphalt to be crushed into the aggregate gradations listed must be employed. Hand picking may also be required in order to remove steel/metals. The Contractor must take possession of the steel/metals for legal recycling off the airport property at his discretion. No steel/metals are to remain on the airport property. Comply with the requirements of Section 01524 – Construction Waste Management.
- D. Verification of production for payment purposes will be through the means of a belt scale located on the jaw type crusher discharge belt. The scale must be initially calibrated by a certified outside agency or calibration service utilizing weights traceable to the National Institute of Standards and Technology (NIST) in the presence of the Commissioner. Thereafter, the belt scale must be re-calibrated weekly by the Contractor, in the presence of the Commissioner, to ensure accurate measurement. The scale must have a digital display and be read daily in the presence of the Commissioner for verification and be capable of printing weigh tickets for submission to the Commissioner on a daily basis.
- E. Contractor to furnish, set up and calibrate a portable truck scale for Commissioner's use in weighing the finished product for the duration of crushing of the recyclable materials stockpiles. The scale must be calibrated by the certified outside agency or calibration service utilizing weights traceable to the National Institute of Standards and Technology (NIST) in the presence of the Commissioner at the start of operations. The Commissioner may request that the portable scale remain for a period of time after crushing operations have ceased. The scale must have a digital readout display and be capable of printing weigh tickets for submission to the Commissioner on a daily basis.
- F. Equipment and fuel shall comply with the requirements of Section 01111 – Air Quality-Equipment Emissions.

- G. Impact type crushers may be allowed for producing crushed and/or screened recycled asphalt pavement (RAP) meeting IDOT CA-6 gradation, at the discretion of the Commissioner. The use of impact type crushers must be submitted to the Commissioner and approved before use.

PART 4 OPERATION/PRODUCTION

4.01 GENERAL

- A. The Contractor will be operating his equipment on and in the vicinity of an operating airport. The Contractor will be required to carry out his operations in a manner that will minimize interference with air traffic, and will be required to cooperate with the FAA, Airport Operations, the Commissioner, the Chicago Department of Aviation, the airlines, surrounding communities and other contractors working in the area. The Contractor must not interfere with any public access along any public street at any time and obtain any necessary permits and submit copies to the Commissioner. Comply with requirements of Section M-103 – Airport Safety and Security.
- B. The Commissioner will periodically check the crushing operations and percentages and quality of products produced. The Commissioner will make the final determination of the adequacy of the Contractor's operations and the amounts and proportions of products being produced.
- C. The first pass of the jaw type crusher is to be screened over a portable tracked or wheel mounted screen in order to remove deleterious material. Oversized product is to be re-fed through the jaw type crusher. Remove deleterious materials separated in the crushing process and dispose of these materials in accordance with Paragraph 2.01.B. The use of a grizzly screen may be required for this operation. Hand picking may also be required in order to remove deleterious materials such as reinforcing bars, PVC pipes, geotextile fabric, etc.
- D. The Contractor is to visually survey the feed stockpiles and modify his processes as required and furnish equipment and labor capable of removing, minimizing or distributing any deleterious materials or RAP in a random manner in the finished product. Comply with applicable IDOT Policy Memorandums regarding recycling Portland cement concrete into aggregate. Use of a grizzly screen may be required. Maintain stockpiles in order to minimize the incorporation of deleterious material.
- E. The Contractor must properly manage and secure all stockpiles. Sites

for stockpiles must be cleaned of deleterious materials which could contaminate the stockpiles. Separate free-draining stockpiles free of segregation must be provided for the various products produced. Stockpiles must be kept separate to prevent intermingling at the base. If partitions are used, they must be of sufficient heights to prevent intermingling. Maintain haul roads in the vicinity of access to stockpiles. When loading out of stockpiles, the vertical faces must be limited to reasonable heights to eliminate segregation due to tumbling. Maintain height of stockpiles to prevent segregation and comply with Airport Operations or FAA height restrictions. Segregation or degradation due to improper handling, stockpiling or loading out of stockpiles will be just cause for rejection of the material. The Commissioner will make the final determination as to the acceptability of each product.

- F. The Contractor must protect any and all existing utilities and facilities to remain on the site. The Contractor must contact J.U.L.I.E. and/or DIGGER, as appropriate, the Chicago Department of Aviation, FAA and any other entity as required to locate and mark all utilities in the vicinity of the Work, prior to any activity. Provide the Commissioner with applicable J.U.L.I.E./DIGGER locate numbers.

PART 5 METHOD OF MEASUREMENT

5.01 MEASUREMENT

- A. The quantity of crushed product will not be measured separately for payment.

PART 6 BASIS OF PAYMENT

6.01 PAYMENT

- A. Concrete and asphalt crushing shall not be paid for separately but shall be incidental to the associated P-154 Frost Protection Course pay items. The P-154 unit prices shall be full compensation for furnishing all equipment and materials; for all preparation, pre-processing and processing of the recycled materials; removal and disposal of deleterious materials within the Airport; removing and recycling steel/metals off of the Airport; and for all labor, equipment, tools, incidentals and all work necessary to complete the item. This work will include removal of the crushing equipment and of any necessary site facilities and site restorations at the end of operations.

END OF SECTION 02245

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WATER DISTRIBUTION

SECTION 02510

PART 1 GENERAL

1.01 SECTIONS INCLUDES:

- A. Work under this Section is subject to the requirements of the Contract Documents.
- B. Furnish and install all Water Distribution Work as shown on the Drawings and as specified herein, including but not limited to the following:
 - 1. Pipe for water mains must be of the following materials:

AWWA Cement-lined ductile iron pipe using push on, mechanical, or proprietary restrained joints: AWWA C111/A21.11, and AWWA C151/A21.51, 250 psi minimum working pressure. Follower glands must be ductile iron. Cement mortar lining must be per AWWA C104/A21.4. Pipe joints must conform to AWWA C111/ANSI A21.11.

AWWA C900 PVC pipe (sizes 4 in. thru 12 in), and AWWA C905 (sizes 14 in. thru 36 in): Pipe must be restrained using proprietary restrained joints including Megalugs Series 1100 as manufactured by EBAA Iron Company.

Pipes for water services 2 inches in diameter and smaller are to be Type K (soft temper) seamless copper water tubing for underground service, conforming to ASTM B88 Standards.
 - 2. Contractor shall be responsible for obtaining a permit from the City of Chicago Department of Water Management for the proposed water main work shown on the drawings.
 - 3. All pipes must be furnished and installed complete with all necessary jointing facilities, connections (pressure or otherwise) and materials, fittings, adapters and other appurtenances required for proper installation in and completion of the pipelines to be constructed. Pipe must be of the size as shown on the Drawings or as specified.
 - 4. Restrained joints must be provided for horizontal and vertical bends between 10 and 90 degree deflection angles and on each side of all valves and tees. Restrained joints must be as specified elsewhere in this Section. The length of restrained joints must be in accordance with Detail D-12 Thrust

Restraint/Restrained Joint Pipe Details of the latest edition of the Chicago Department of Water Management (CDWM) *Standard Details for Water Main Installation*.

5. Thrust blocks are to be installed where indicated in the Contract Documents (Drawing details) and are to be used in conjunction with the restrained joints.
6. All valves 3" to 16" in diameter must be non-rising stem resilient wedge, compression seated gate valves, with operating nut, designed to take full pressure on either face, furnished in full compliance with AWWA C509. All valves must open by turning clockwise. All larger valves must be butterfly style, designed, manufactured, tested and inspected in accordance with AWWA C504.
7. All valves must be of sufficient strength to withstand and operate satisfactorily under the designed working pressures and must be subject to a minimum factory test pressure of 300 pounds per square inch. The valves must be Class "A".
8. Service connection from the existing water main must be a pressure connection, without interrupting the existing water supply. See section 2.14, HOT TAPS for additional details.
9. Before providing the pipe and fittings, the Contractor must submit fully dimensioned Shop Drawings or Catalogs showing all proposed work.
10. All work must comply with City of Chicago Department of Water Management Design Guidelines for Watermain Installations. If this Specification conflicts with the Department of Water Engineering Standards, the more severe Specification will apply.
11. All ductile iron pipe must be encased with a polyethylene wrap as indicated in the Contract Documents. Further, all bolts, nuts, megalugs, and fittings must be encased with the polyethylene wrap.
12. New ductile iron pipe water main system must be cathodically protected. Existing D.I.P. being repaired or reconstructed, if not cathodically protected previously, must be encased in polywrap.

1.02 RELATED WORK

- A. As specified in the following Sections:

1. Section P-157 – Trench Backfilling

1.03 REFERENCES:

- A. AWWA (American Water Works Association)
- B. ANSI (American National Standards Institute)
- C. Applicable provisions of the Chicago Department of Water Management Design Guidelines and Standard Specifications for Water Main Construction; Standard Details for Water Main Installation

1.04 SUBMITTALS

- A. Submit the following:
 - 1. Product Material Data
 - 2. Test Reports
 - a. Submit test reports necessary to show compliance with the Contract Documents
 - 3. Manufacturer's Certification
 - a. Submit certification that product(s) meet(s) or exceed(s) the specified requirements.
- B. Before starting procurement of the water mains and fittings, the Contractor must submit fully dimensioned Shop Drawings or catalogs showing all proposed work which accurately and distinctly present the following:
 - 1. Details of the pipe and special connections
 - 2. Laying lengths of fittings and adapters
 - 3. Connecting joint details
 - 4. Assembly of connecting joints
 - 5. Details of manufacture
 - 6. Kinds of materials
 - 7. Methods and instructions for assembling joints
 - 8. Complete engineering layout and pipe laying schedule indicating class or design for each piece of pipe
 - 9. Layout and sizing schedule for air release valves, indicating stationing, elevations, high points and low points, flow velocity, and type and size of valve.

1.05 QUALITY CONTROL:

- A. As specified by Section Q-100 Quality Control Program.
- B. Contractor Qualifications: Installation of water main must be performed only by a qualified Installer. The term qualified means experienced in performing the Work required by this Section. The Contractor must submit evidence of such qualifications upon request by the Commissioner.
- C. Perform Work in accordance with the latest edition of the appropriate divisions, of the following:
 - 1. City of Chicago Department of Water Management Permit Requirement and Fee.
 - 2. Standard Specifications for Water and Sewer Main Construction, Illinois Society of Professional Engineers.
 - 3. Manufacturer's Installation Instructions
 - 4. Applicable AWWA/ANSI sections.

1.06 WARRANTIES AND GUARANTEES:

- A. Manufacturer's Standard Warranties and Guarantees and/or as per General Conditions/Requirements of Contract Documents

1.07 EXTRA MATERIALS AND SPARE PARTS:

- A. (Not Used)

1.08 ENVIRONMENTAL REQUIREMENTS:

- A. (Not Used)

1.09 SPECIAL REQUIREMENTS:

- A. (Not Used)

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. American Cast Iron Pipe Company
- B. United States Pipe and Foundry Company
- C. Griffin Pipe Product Co.

2.02 DUCTILE IRON PIPE:

- A. Ductile iron pipe must conform to the requirements of ANSI Standard A21.51 (AWWA C151), joints to conform to ANSI A21.11 (AWWA C111), and the cement lining conform to ANSI A21.4 (AWWA C104) with the following additions or substitutions:
1. Section 51.2:
 - a. Sub-section 51.2.6 – Make the following addition:
 - (1) Bells must be so designed to afford a watertight joint without additional jointing material and capable of withstanding pressures without leakage exceeding those that will rupture pipe of this class and thickness.
 - (2) All pipe must be supplied with all accessories necessary for the number of pipe lengths delivered.
 - B. Exterior of pipe must be coated with a petroleum asphaltic material in conformance with ANSI A21.10 (AWWA C110, Section 10-10). Interior of pipe must be cement lined in accordance with ANSI A21.4 (AWWA C104).
 - C. Section 51.10:
 1. Make the following additions:
 - a. Each pipe must be identified with a manufacturing run number traceable for certification.
 - b. Pipe joints must be push-on type joints unless otherwise shown on the Drawings, specified, or directed by the Commissioner. Push-on type joints must conform to ANSI A21.11 (AWWA C111).
 - c. Restrained joints when shown on the Drawings, specified or directed by the Commissioner must be Megalug or mechanical joint restraint glands. Mechanical joints must conform to ANSI A21.10 (AWWA C110).
 - d. Ductile iron pipe supplied by the Contractor must be per ANSI A21.51(AWWA C151) latest revision with thickness class as follows:

<u>Diameter</u>	<u>Class</u>
4 and 6 inches	55
8 to 12 inches	56
14 inches	55
16 inches	54

18 and 20 inches	53
24 inches	54
30 to 60 inches	52

- e. The Contractor must submit to the Commissioner certified copies of all test reports.

2.03 PVC PIPE:

- A. PVC pipe supplied by the Contractor must be per AWWA C900 for pipe diameters 4in through 12 in. and C905 for 14 in through 36 in. Pipes with diameters larger than 36 in must be ductile iron as specified above. Pipe must be installed per AWWA C605-Underground Installation of PVC Pressure Pipe and Fittings for Water

2.04 DEPTH OF PIPE COVER

- A. Unless otherwise shown on the Drawings, or directed by the Commissioner, all watermains and services must be installed so a minimum pipe cover is provided as described in the following table:

<u>Size of Pipe</u>	<u>Standard Cover and Tolerance</u>
3/4" to 3"	5'-6" ±3"
4"	5'-6" ±3"
6"	5'-6" ±3"
8"	5'-3" ±3"
12"	5'-0" ±2"
16"	4'-6" ±2"
24"	4'-0" ± 1
30" to 42"	3'-6" (depends on the field conditions)
48" to 60"	3'-0" (depends on the field conditions)

2.05 FITTINGS:

- A. Fittings to be furnished and installed must be Megalug or mechanical joint using retainer glands except as indicated on the Drawings. They must be 250 psi pressure class castings in accordance with ANSI A21.10 (AWWA Standard C110) as revised. Laying lengths, wall thicknesses and variations must be per ANSI A21.10 (AWWA C110). Compact fittings are not allowed. If no air release valves are required, as a minimum, install 1-1/2" corporation cocks placed at the high points of the water main for purging air during initial filling.
- B. All gasketing materials must conform to the latest revision of AWWA C-111, and C-110, and ASTM C564 for potable water. Only rubber gaskets must be used.

- C. The Contractor must provide the Commissioner with a written statement that all tests have been made and met as specified.
- D. The fittings must be smooth and free from defects of every nature which would make them unfit for the use which they were intended. No plugging of fittings will be allowed. Repairing of defects by welding will not be allowed.
- E. All castings must be coated inside and outside with a petroleum asphaltic material in conformance with Section 4.3 of AWWA C110 (ANSI A21.10). A cement-mortar lining is not required.
- F. All unfit castings must be removed from the job site by the Contractor and replaced by him with fittings in conformance with the Specifications at no cost to the City.
- G. Every casting must have distinctly cast upon it the initials of the manufacturer's name. Each casting must also have cast upon it figures showing the year in which it was cast and a number signifying the order in which it was cast, thus:

90	90	90
1	2	3

- H. The letters and figures must be cast on the outside and must not be less than two inches in length and 1/16 inch in relief for castings eight inches in diameter and larger. For small sizes of castings, the letters may be one inch in length.
- I. The Contractor must furnish all necessary rubber joint gaskets, joint lubricant, nuts and bolts and sets of other equipment, special tools, and accessories that may be required to assemble pipe and fittings.
- J. PVC pressure fittings must be of the following type:
 - 1. Ductile Iron fittings with mechanical joint ends and in accordance with AWWA C110 and C153.
 - 2. PVC fittings in accordance with AWWA C900, C905, C907, and ASTM D2466.
 - 3. Fabricated fittings with fusion bonded epoxy coating and lining.

2.06 AIR RELEASE VALVES:

- A. Air Relief Valves
 - 1. Body and cover of cast iron; float of stainless steel; seat of Buna-N; needle of stainless steel; linkage and other internal

parts such as pins, retaining rings, and screws of stainless steel.

2. Relief valves must be designed for use with potable water, rated for a standard operating pressure of 150 psi.
3. All air release valves, including combination air valves must follow the City of Chicago Standards in accordance with ANSI/AWWA C512.
4. Manual air release and combination air release valves must have ductile iron (ASTM A 536, Grade 65-45-12) or gray cast iron (ASTM A126, Class B or ASTM A48, Class 35) bodies and covers with threaded or flanged connections for use in systems which meet minimum standards of water at temperatures of 125 degrees Fahrenheit and maximum working pressures of 300 psig. Flange dimensions and drilling must conform to ANSI/ASME B16.1, Class 125 or Class 250. Threaded connections must conform to specifications for tapered pipe threads as dictated by National Pipe Threads (NPT) per ANSI/ASME B1.20.1. Float must be stainless steel, meeting ASTM 240. Air release valves must have interior and exterior coating in accordance with approved NSF standards and AWWA Standard C512-92.
5. Air release valves must have 1-½" corporation cocks and be placed at the high points of the water main as shown on the Drawings.
6. The following manufacturers should be used as sources of supply for the combination air release valve.
 - a. Air release valves, Model 202C.2
 - (1) Val-Matic Valve & Manufacturing Corp.
905 Riverside Drive
Elmhurst, Illinois 60126
Phone: (630) 941-7600
 - b. Air release valves, Model S 145C
 - (1) APCO Willamette
Valve & Primer Corporation
1420 S. Wright Boulevard
Schaumburg, IL 60193 - 4599
Phone: (847) 524-9000
 - c. Or approved equal

7. Manual air release valve must consist of a bronze 2" ball valve three piece model. Manual air release valve must have 2" diameter galvanized steel Schedule 80 vent piping and screen and ½" drain valve as shown elsewhere on the Drawings.

2.07 GATE VALVES:

- A. All gate valves must be the City of Chicago Standard gate valve design clockwise open gate valves in accordance with ANSI/AWWA C500 operating nut and removable bonnet as manufactured by the East Jordan Iron Works, Markham, Illinois. The resilient seated gate valves must be in accordance with ANSI/AWWA C509.
- B. Gate valves to be installed in a horizontal position in a horizontal line which are to be designed for 300 pounds minimum factory test pressure must be equipped with bronze rollers and bronze tracks secured to the body.
- C. Tests must be made in the shop with a hydrostatic water pressure and proven tight at factory test pressures up to 300 psi. The cost of the test must be included in the costs of the valves and will not be paid for separately. Any valves which leak or which show any defects must be rejected. Certificates from the manufacturer that the tests have been successfully completed must be furnished to the Commissioner.
- D. Rubber seats must mate with Type 304 stainless steel whether on the body or on the disc, and must be adjustable and replaceable in the field.
- E. Shafts of valves must be turned, ground, and polished. Valve shafts must be of 18-8 type 304 stainless steel and may be a one piece unit extending full size thru the valve disc and valve bearings. Stub shafts will be acceptable.
- F. Valve seats must be of rubber or Buna N compound. Seats must be recess mounted and mechanically retained on the body or clamped to the disc.
- G. Valves must have sleeve type, corrosion resistant, self-lubricating bearings.
- H. Mechanical joint must be restrained at valve ends using "Megalug" or approved equal restraining glands.

- I. Valves operators must hold the valve in any intermediate position between fully open or fully closed without creeping or fluttering.
- J. Adjustable stops must be provided to stop valve in the fully opened and fully closed positions. Each valve operator must include AWWA input shaft stop.
- K. All surfaces of the valves must be clean, dry, and free from grease before painting. Valve interior and exterior surfaces, except seating surfaces, must have two coats of black asphalt varnish in accordance with FS TT-V51 c and AWWA C504.
- L. The valves must be installed in a horizontal main with the input shaft of the gear reducer vertical. Valves must be satisfactory for applications involving frequent operation and for applications involving operation after long periods of inactivity.
- M. Valve operators must be manual and must be worm gear type and must be fitted with City of Chicago Standard operating nut. Units must be designed for buried and submerged service and must be fully gasketed and grease packed.
- N. Valves must have a stainless steel tag permanently mounted on top of the bonnet (so that it is visible in the vault when the valve is in its installed position) marked with the number of turns required to operate the valve from a fully open to a fully closed position.
- O. The word "OPEN" must be displayed in ½ inch high letters and a 2 inch long arrow indicating direction of opening valve cast on the flange or top of the valve bonnet near operating stem nut as per the Chicago Department of Water Management Standard Specifications.
- P. A square head nut is required for operation of valve.

2.08 BUTTERFLY VALVES:

- A. All valves larger than 16" must be butterfly valves. All butterfly valves must be the City of Chicago Standard butterfly valve open with a clockwise rotation of the nut in accordance with ANSI/AWWA C504.
- B. Shaft seals must be either split V type packing or "O" ring seals. Shaft seals consisting of stuffing box with pull down packing are not acceptable. The valve shaft must be 304 or 316 stainless steel.
- C. The valve body must be made of cast iron conforming to ASTM A126, Class B or ASTM A48, Class 40 alloy cast iron ASTM A436, Type I and 2. The valve disc must be cast iron conforming to ASTM A 48,

Class 40 and it must have a seating edge of 304 or 326 stainless steel. The valve seats for 24-inch and larger butterfly valves must be capable of adjustment or replacement at the installation site.

- D. Valve discs must be secured to shafts by means of solid, smooth-sided stainless steel or monel taper pins or dowel pins having a circular cross section. Each taper pin or dowel pin must be extended through the shaft and mechanically secured in place.
- E. The valve and valve operators must be rated buried service, except electric actuators.
- F. Valve operators must conform to AWWA C504 for Class 150 B. Manual operators must be worm gear, self-locking type designed to hold the valve in any intermediate position type designed to hold the valve in any intermediate position without creeping or fluttering. Operators must be equipped with torque overload protection to prevent over travel of the disc in the open and closed position. Operators must provide position indication on the housing of the operator.
- G. Valve operators must be equipped with a Chicago standard style hub nut. The hub nut must be attached to the input shaft of the operator by means of a shear pin. The shear pin must be sized such that it fails when 350-pounds of input is applied to the hub nut.
- H. Corrosion resistant nameplates, as described in AWWA C504, must be permanently attached to both the valve and valve operator. In addition to the normal valve data, the plate must also include the number of turns required to operate the valve and direction to open.
- I. All valves must have flow through discs.
- J. Separate limit stop device must also be installed in accordance with City of Chicago Department of Water Engineering Standards Section 02082.
- K. Restrained Megalug joints must be used for all Butterfly valves.

2.09 DUCTILE IRON PIPE TAPPING SLEEVES:

- A. The tapping sleeve must be constructed in two sections, and be provided with mechanical joints. The tapping sleeve must not be ordered until the Contractor has exposed and calipered the existing water main.
- B. The tapping sleeve must be as manufactured by Clow, Mueller, or Robar.

- C. The tapping sleeve and valve must be installed in a valve unit as shown on the Contract Drawings.

2.10 FIRE HYDRANTS AND CORPORATION COCKS:

- A. Fire Hydrants, Valves and Corporation Cocks: Such items must conform to City of Chicago Standards. The following manufacturers should be used as sources of supply for the above items.
 - 1. City of Chicago Standard Fire Hydrants and Gate Valves:
 - a. East Jordan Iron Works
310 Garnet Drive
New Lenox, Illinois 60451-3502
Telephone: 815/740-1640
 - b. Or approved equal
 - 2. City of Chicago Standard Corporation Cocks:
 - a. Mueller Company
500 W. Eldorado
Decatur, Illinois 62522
Telephone: 217/423-4471
 - b. A.Y. McDonald Manufacturing Company
P.O. Box 508
Dubuque, Iowa 52004-0508
Telephone: 319/583-7311
 - c. The Ford Meter Box Company
775 Manchester Avenue
P.O. Box 443
Wabash, IN 46992-0443
Telephone: 260/563-3171
- B. Reference: *City of Chicago Department of Water Management Standard Details for Water Main Installation* for Fire Hydrants installation requirements.
- C. Fire hydrants should have a minimum bury of 5 ft.
- D. Fire hydrant must be provided with a service shut off valve or an adjacent valve vault, whichever is applicable, for repair and maintenance purposes.
- E. Fire hydrant spacing at O'Hare Airport must not exceed 800 feet where

allowed and applicable to airport construction. Actual hydrant locations must be coordinated with the Chicago Fire Department.

- F. Fire hydrants for roadway tunnels must be located within 30 feet to 40 feet from the face of the tunnel entrance.
- G. Roadway tunnels must have one (1) fire hydrant located at each end of the tunnel.

2.11 WATER METER AND VAULT:

- A. The water meter must be mounted in a reinforced concrete vault and constructed according to the plan dimensions as specified or as shown on the Drawings.
- B. All pipes and fittings inside the vault must be flanged and must conform to U.S.A. Standard A2151-1965 (AWWA C 151-65) and must have an outside bituminous coating of asphalt base and a cement mortar lining conforming to U.S.A. Standard A21.4-64 (AWWA C104-53).
- C. All meter vaults and valve basins must be equipped with Neenah Foundry frame and lid casting. All castings and lids must be ductile iron. No center brace will be permitted in the cover frame. Iron rung ladder anchored to the wall must be provided for meter reader. Access cover to be 23 inches in diameter, installed above ladder in a corner. No mechanical joint fittings permitted in meter vault. Frames and lids must be aircraft load rated if located airside and subject to aircraft loading. At landside and other locations, they must be rated for AASHTO HS-20 loading. Acceptable manufacturers are Neenah Foundry Company and East Jordan Metal Works, Inc.
- D. Water meter installed in facilities inside O'Hare Airport must be compatible with the Chicago Department of Aviation's automatic meter reading collection system at the Airport.
 - 1. The meter must be Model SRH Compound Meter manufactured by Sensus Technologies.
 - 2. The water meter head must include an electronic communication module connected by 3 - #18 conductors housed in a galvanized steel conduit and routed to a Sensus water proof and traffic proof "Touchpad" remote plug. The "Touchpad" remote plug shall be mounted either to the top of concrete slab or hatch cover at grade. If the touchpad is hatch cover mounted, provision must be included to allow proper and free opening/closing of the cover.

3. Upon completion of the cold water meter installation, the Contractor must submit a Notification Letter containing the following information: (1) water meter location, (2) remote location, (3) water meter size, and (4) water meter type. The Notification Letter must be sent to:

Deputy Commissioner of Facilities
Chicago Department of Aviation
Chicago O'Hare International Airport
10510 W. Zemke Road
Aviation Administration Building
Chicago, Illinois 60666

A copy of the Notification Letter must be sent to:

Manager of Water Ecology Section
Chicago Department of Aviation
Chicago O'Hare International Airport
H & R Plant
Chicago, Illinois 60666

2.12 GASKETS

- A. All gaskets for pipe, fittings, and appurtenances must be vulcanized natural or vulcanized synthetic rubber, non-porous, free of foreign materials and visible defects. Recycled rubber must not be used.
- B. When soil conditions do not permit the use of natural or synthetic rubber gaskets and when directed by the Commissioner, all gaskets for pipe, fittings, and appurtenances must be Nitrile (acrylonitrile butadiene), non-porous, free of foreign materials and visible defects.
- C. Gaskets for flanged joints must be of the ring type meeting the requirements of ANSI Standard B16.21. Gaskets must be made by the Crane Company, Garlock Packing Company, U. S. Rubber Company, or approved equal. Gaskets must be 1/16 inch thick.
- D. Gaskets must be stored in a cool place and protected from light, heat, oil, or grease until installed. Any gasket showing signs of cracking, weathering, abrasion, or other deterioration will be rejected.

2.13 HOT TAPS

- A. Connection to existing water line, which is operational, shall be hot (pressure) tapped – without interrupting water supply and without damaging the existing pipe line. Contractor shall submit the

connection plan to the Commissioner for approval. No connection work shall be started without proper approval and notification.

2.14 SHUT-OFF BOXES

- A. For water services 2-inches in diameter and smaller, shut-off boxes must be Chicago Shut-off Water Boxes, Type B, as manufactured by C.P. Test Services – Valvco Inc. Any equivalent products will only be allowed if they meet City of Chicago standards and are acceptable to the Water Management Department. Water pipes 16" diameter or larger will require valve basins as shown in the plans, and/or as noted.

2.15 POLYETHYLENE ENCASEMENT

- A. Polyethylene encasement material must be 4-mil, cross laminated, high-density polyethylene tubing in accordance with AWWA C105.

PART 3 EXECUTION

3.01 DESCRIPTION

- A. All pipes, fittings, and accessories must be delivered, unloaded, strung, and laid as specified herein.
- B. The water mains must be laid with covers shown on the Drawings or as specified. The pipes must be laid true to line and grade.
- C. Suitable fittings must be used where shown and where grade or alignment changes require offsets greater than those recommended by the pipe manufacturer.
- D. All pipe must be laid with bedding as shown on the Contract Drawings.
- E. Each manufacturer supplying pipe for water mains under this Contract must furnish all facilities, personnel, and materials to conduct tests required as applicable to the type of pipe being supplied. The costs of all plant tests required as proof of the acceptability of the water mains must be borne by the Contractor.

3.02 TRANSPORTATION, DELIVERY, AND STORAGE:

- A. Every precaution must be taken to prevent injury to the pipe during transportation and delivery to the site. Extreme care must be taken in loading and unloading the pipe and fittings. Such work must be done slowly with skids or suitable power equipment and the pipe must be under perfect control at all times. Under no condition will the pipe be dropped, bumped, dragged, pushed, or moved in a way which will

cause damage to the pipe. When handling the pipe with a crane, a suitable pipe hook or rope sling around the pipe must be used. Under no condition must the sling be allowed to pass through the pipe unless adequate measures are taken to prevent damage to the pipe ends and lining.

- B. Store materials in such a manner as to ensure the preservation of their quality and fitness for the Work. Protect materials against damage from mechanical abuse, chemicals, and other foreign matters during storage. All stored materials must be inspected at the time of use in the Work, even though they may have been inspected and approved before being placed in storage.
- C. If, in the process of transportation, handling, or laying any pipe is damaged such pipe or pipes must be replaced or repaired by the Contractor at his own expense.
- D. The Contractor must furnish and install suitable blocking and stakes so as to prevent the pipe from rolling.

3.03 PIPE LAYING – GENERAL:

- A. Laying and jointing pipelines must include the installation of underground pipelines. Pipeline materials, coatings and lining must be as specified or shown. Piping must be installed where as shown or specified. Pipeline installation must be in accordance with standards as recommended by the manufacturer for all pipeline materials, as specified in AWWA C600, and as modified or supplemented by these Specifications. PVC pipe must be laid as specified in AWWA Manual 23, AWWA Standard C605.
- B. Proper and suitable tools and appliances for the safe and convenient cutting, handling, and laying of the pipe and fittings must be used.
- C. Before being laid, all pipe, fittings and specials must be thoroughly examined for defect and no piece will be installed which is known to be defective. If any defective piece should be discovered after having been installed, it must be removed and replaced with a sound one in a satisfactory manner by the Contractor at his own expense.
- D. Protective watermain polyethylene wrap (polywrap), 4 mils minimum thickness, cross laminated, is to be installed on all ductile iron pipe and secured with 2 inch compatible adhesive tape per the detail on the Drawings. The polyethylene tubing must comply with AWWA C105.

- E. The pipe and fittings must be thoroughly cleaned before they are laid and must be kept clean until they are accepted in the completed work. Special care must be exercised to avoid leaving bits of wood, dirt, and other foreign particles in the pipe. If any such particles are discovered before the final acceptance of the work, they must be removed and the pipe and fittings replaced at the Contractor's expense. All lines must be kept absolutely clean during construction and must be stopped off with watertight bulkheads at the end of each day's work. Remove dirt or foreign matter by sweeping with a clean broom used only for this purpose. Then, swab the pipe interior with a bactericidal solution prepared in accordance with AWWA C601. Pipelines must be laid accurately to line and grade only after the trench has been dewatered and the foundation and bedding has been prepared in accordance with the Specifications. Exposed ends of uncompleted lines must be capped or otherwise temporally sealed at all times when pipe laying is not actually in progress.
- F. Ductile iron pipe must be neatly cut perpendicular to the axis of the pipe with mechanical pipe cutters without damaging the pipe, lining or coating.
- G. Gaskets for pipe joints must be stored in a cool place and protected from light, sunlight, heat, oil, or grease until installed. Any gaskets showing signs of checking, weathering, or other deterioration must be rejected.

3.04 PIPE LAYING IN TRENCHES

- A. All coated and wrapped pipelines must be laid in trench excavation as shown on the Drawings. The pipe must be properly secured against movement and pipe joints must be made in the excavation as required.
- B. The Contractor must excavate the trench for pipelines to a minimum depth of six inches below the bottom of the pipe. A uniform layer of bedding material on which the pipe must be laid will then be placed and tamped in the trench. At each joint, enough depth and width must be provided around the pipe so that the joints can be properly made. The width of the trench for pipelines must be the minimum of one foot on either side of the outside diameter of the pipe. Bends must be anchored as shown on the Drawings and specified in the Section or as specified by the Commissioner. Pipes must have solid bearing throughout the entire length.
- C. For PVC pipe installation maximum aggregate sizes for pipe zone material must not exceed 1-inch.

- D. Pipe laying will be permitted only in dry trenches having a stable bottom. Where groundwater is encountered, the Contractor must make every effort to secure an absolutely dry trench bottom. If all efforts fail to obtain this condition and the Commissioner determines that the trench bottom is unsuitable for pipe foundation, he must order in writing Trench Stabilization.
- E. If, in the opinion of the Commissioner, the Contractor has failed to obtain an absolutely dry trench bottom by insufficient use of all known methods of trench dewatering, the Commissioner may then order the Contractor to excavate below grade and place sufficient stabilization stone fill material over the trench bottom at the Contractor's own expense.
- F. Lay pipe in a straight line unless shown otherwise or if approved by Commissioner. Maximum pipe joint deflection, if permitted, must be three-fourths of the pipe manufacturers recommendation.
- G. Long radius curves, either horizontal or vertical, may be laid with standard pipe by deflections at the joints, If the pipe is shown curved and no special fittings are shown, the curves can be made by deflection of the joints with standard lengths of pipe. Maximum deflection at each joint must be as recommended by the manufacturer.
- H. Where field conditions require deflection of joints to provide curves not anticipated by the Contract Drawings, the Commissioner must determine the methods to be used. No additional payment will be made for laying pipe on curves as shown, nor for field changes involving standard lengths of pipe deflected at the joints. When special fittings not shown are required to meet field conditions, additional payment must be made for special fittings.
- I. When rubber gasketed pipe is laid on a curve, the pipe must be jointed in a straight alignment and then deflected to the curved alignment.

3.05 WATER MAIN AND SEWER SEPARATION:

- A. The water mains shown on the Contract Drawings have been located and designed to be in accordance with Illinois Standards regarding sewer and water main separation.
- B. If a sewer is encountered during construction which has not been shown and which is closer than 10 feet horizontally and less than 18 inches below the bottom of the water main, or is above the water main, construction must be as follows:
 - 1. If the sewer is parallel to the water main, the sewer must be re-

constructed of materials and with joint equivalent to water main standards of construction, and must demonstrate water tightness.

2. When a new water main crosses under a new or existing sewer, the water main must be sleeved in an encasing pipe for a minimum distance of 10' - 0" on each side of the sewer centerline. The pipe installed within the casing must have restrained joints. The encasing pipe must be as described in paragraph 3.11 of this Section.

3.06 LEAD JOINTS FOR DUCTILE IRON PIPE:

- A. Lead joints for ductile iron pipe must not be used.

3.07 MECHANICAL JOINTS FOR DUCTILE IRON PIPE:

- A. In making up mechanical joints, the spigot must be centered in the bell. The surfaces with which the rubber gasket comes in contact must be brushed thoroughly with a wire brush just prior to assembly of the joint. Lubricant must be brushed over the gasket just prior to installation. The gasket and gland must be placed in position with the baits inserted and the nuts tightened finger tight. The nuts must be tightened by means of a torque wrench in such a manner that the gland must be brought up evenly into the joint. Torque values must be in accordance with manufacturer's instructions; otherwise, the following range of bolt torques must be applied:

<u>Bolt Size (Inches)</u>	<u>Range of Torque (Feet - Pounds)</u>
5/8	45 - 60
3/4	75 - 90
1	85 - 100
1-1/4	105 - 120

If effective sealing is not obtained at the maximum torque listed above, the joint must be disassembled and reassembled after thorough cleaning.

3.08 VALVE SETTING:

- A. Valves must be carefully erected in their proper positions, free from all distortion and strain, with Megalug or approved equal mechanical restrained joint ends and must be packed and left in satisfactory operating conditions.
- B. Valves must be tested prior to installation by the Contractor as far as

practicable and any defects in valves or connections must be corrected to the satisfaction of the Commissioner.

3.09 ASSEMBLY OF PUSH-ON RUBBER GASKET JOINTS:

- A. Thoroughly brush the gasket seat in the bell with a wire brush and wipe the gasket and gasket seat with a cloth. Place the gasket in the socket with the large round end entering first so that the groove fits over the bead in the seat. Apply a thin film of NSF 61 approved joint lubricant to the inside surface of the gasket that will come into contact with the entering pipe.
- B. Thoroughly brush the plain end of the pipe with a wire brush and place it in alignment with the bell of the pipe to which it is to be joined. Make up the joint by exerting sufficient force on the entering pipe so that its plain end is moved past the gasket until it makes contact with the base of the socket. Make all joints in the same manner to allow electrical continuity in the pipeline.

3.10 TEMPORARY BULKHEADS:

- A. At the ends of Contract Sections or where continuous trenching cannot be performed to keep roadways open or where future water mains or structures (by others) have not been completed and are not ready to be connected, temporary bulkheads approved by the Commissioner must be built at no additional cost.

3.11 SHORT TUNNEL CONSTRUCTION:

- A. Pipes to be placed in short tunnels must be jointed prior to being pushed into position. Pipe must be pushed into position in a manner arranged to keep joints tight and to prevent deflections.

3.12 WATER PIPE IN CASING PIPE:

- A. Where shown, casing pipe consisting of steel pipe or reinforced concrete pipe must be jacked into place or installed in open cut in accordance with CDA/OMP, IDOT, Chicago Department of Water Management standards. Obtain written approvals from the agencies having jurisdiction.
- B. Submit to the Commissioner for approval, details of the methods to be employed.
- C. Steel casing pipe must have a minimum wall thickness of 3/8 inch and joints must be continuously welded.

- D. The casing pipe must be watertight and of sufficient inside diameter to pass the bells/joints of the water main. Further, the encasing pipe must be designed to support any load imposed by the filled water main, the sewer, the overburden, and anticipated live loads. The water main must be provided with insulating sled type spacers to insure that the water main is connected in the encasing pipe. Ends of the encasing pipe must be sealed with Thunderline Corporation "Link-Seals" or by other approved means.

3.13 ANCHORAGE:

- A. The Contractor must provide anchorage against thrust for water mains and appurtenances wherever the deflection of the pipeline exceeds 10 degrees (if allowable by manufacturer's recommendations). The anchorage must be accomplished by placing concrete between undisturbed earth and the fitting to be anchored in accordance with the City of Chicago standard thrust block. All anchorage must be designed to withstand a hydrostatic pressure of 150 psi minimum or 150% of the working pressure as determined by the Designer, whichever is greater. The Contractor must submit calculations of all thrust restraints to the Commissioner.
- B. All concrete used in the construction of thrust block anchors must be in accordance with Section P-610 Structural Portland Cement Concrete.
- C. Blocking to prevent movement of lines under pressure at bends, tees, caps, valves, and hydrants must be Portland cement concrete, minimum of 12 inches thick, placed between undisturbed ground and the fittings, and anchored so that pipe and fitting joints are accessible for repairs. Concrete must extend from 6 inches below the pipe or fitting to 12 inches above. Horizontal and vertical bends between zero and 10 degrees deflection angle will not require thrust blocks or harnessed or restrained joints. Horizontal and vertical bends between 10 and 90 degree deflection angles will require concrete thrust blocks. Harnessed or restrained joints must be provided at the bend or wye and for a minimum of two lengths of pipe on both sides of the bend except as noted.
- D. All tees, plugs, blow off drains, valves, and caps must have concrete thrust blocks as indicated.
- E. Mechanical joints with retainer glands must be used to restrain joints for ductile iron pipe.
 - 1. Megalug and approved equal restrained mechanical joint must conform to ASTM Spec. A536-65T. All special castings must

be made of good quality ductile cast iron of such character and so adapted in chemical composition to produce spheroidal graphitic structure. They must be of such character to provide superior mechanical properties of strength, toughness, and ductility. The iron must be soft enough for satisfactory drilling and cutting.

2. The minimum physical properties must be as follows:

Tensile strength	60,000 psi
Yield strength	42,000 psi
Elongation in 2" Test Coupon	10%

3. Joints assembled with this gland must be capable of withstanding minimum working pressure of 150 psi.
4. In addition to the standard required test, the following requirements must be met: Keel Block Tests as detailed in ASTM Spec. A536-65T Standard 0.50 inch diameter tensile test bars must be machined from keel block coupons cast from each heat and of the same hardness range as the special castings. Minimum test requirements are as indicated above.

- F. The Contractor must furnish to the Commissioner, detailed Specifications of all materials necessary to complete the work as outlined in this Contract and not directly specified herein prior to the installation of any of these materials.
- G. No separate payment will be made for anchorage. All cost for this work will be considered included in the items requiring anchorage.

3.14 BACKFILLING

- A. Backfilling of the water main must be in accordance with Specification Section P-157 Trench Backfilling.
- B. Trench backfill must be done in such a way so as to prevent damage to any pipe, utilities, and structures.
- C. All backfilling must be done as soon as possible after the water main piping has been installed and inspected for leakage (hydrostatic testing) and joint integrity, and repairs made, if necessary, and as soon as the mortar for masonry or thrust blocks have sufficiently set to resist the backfill pressure and construction load.

3.15 CORROSION CONTROL

- A. All new ductile iron pipe water main system installation must be fully

cathodically protected and isolated in accordance with applicable provisions of Section 4-04 Cathodic Protection of the *OMP Vol. II Design and Construction Standards*, and the *Chicago O'Hare International Airport Cathodic Protection Monitoring and Maintenance Manual*.

3.16 HYDROSTATIC TESTING AND CHLORINATION:

- A. After pipes have been laid and cleaned of dirt and foreign materials, the pipe lines as a whole, or in convenient sections, must be filled with water for a period of not less than twenty-four hours and then subjected to a minimum pressure of 150 psi or 150% of the working pressure as determined by the Designer, whichever is greater, for a period of not less than 4 hours with no leakage permitted. Any observed leaks, or any defective pipes, fittings, valves, or specials must be repaired, as directed by the Commissioner, at the expense of the Contractor and tests must be repeated until the section of piping under test must be within prescribed limits.
- B. The Contractor must provide all necessary labor and equipment, etc. required for making tests.
 - 1. The Contractor must be responsible for compliance with all sanitary requirements of the Specifications, particularly in sterilization of water mains, branches, equipment and installations. Sterilization must meet all sanitary requirements of City of Chicago Department of Water Management, State of Illinois Department of Public Health, and U.S. Department of Health, Education and Welfare Public Health Service and AWWA C651-Disinfecting Water Mains. If requested, sterilization must be performed in the presence of, and to the satisfaction of an Inspector assigned by the City of Chicago.
 - 2. Corporation cocks in valve basins and temporary sampling cocks must be used to collect source samples and enough representative water samples for laboratory examination.
 - 3. Install two 1" corporation cocks on each side of every valve for testing and sampling purposes.
 - 4. Preliminary Flushing: Each valve section of the completed main must be flushed, prior to sterilization, as thoroughly as possible with water pressure and outlets available. If no hydrant is provided at the end of the main section, a tap must be installed at the main section extremity, large enough to develop a velocity in the main of at least 2.5 fps. The flushing operation must be done after the pressure test has been made.

5. Sterilization:

- a. Before being placed in service, all new mains and existing piping disturbed in any manner by the work, must be sterilized. Draining the water from existing piping or even lowering the water pressure more than one-half must constitute disturbances of the piping.
- b. The sterilization of water mains, valves, and other appurtenances incorporated into the main construction, must be done by chlorine gas-water mixture. This must be applied by means of a chlorinating measuring apparatus with proper devices for regulating the flow and providing the effective diffusion into the water within the main being sterilized. Chlorinating devices dispensing chlorine gas or chlorine solution must provide means for preventing the backflow of water into the chlorine cylinder or apparatus.
- c. In certain instances, when the use of chlorine gas is not practical, as in congested or confined areas, upon approval of the Commissioner, a chlorine bearing compound of known chlorine content, prepared in solution form may be substituted for chlorine gas. Acceptable compounds are calcium hypochlorite power or granules and sodium hypochlorite solution. All chlorination procedures must be in accordance with AWWA C-651 and the appropriate guidelines of the IEPA and the Illinois Department of Public Health.
 - (1) The high-test calcium hypochlorite must contain 65-70% available chlorine. In the preparation of this solution, the powder must be first made into a paste and then gradually thinned with water to approximately one percent chlorine solution (10,000 parts per million). A one percent chlorine solution requires one and one-quarter pound (1 1/4 lb.) of highest calcium hypochlorite (70%) available chlorine to ten gallons of water.
 - (2) The liquid sodium hypochlorite must have 12.5% available chlorine. The concentration of the sodium hypochlorite solution must be checked using a chemical metering pump and Hach DPD test kit.

- d. The point of chlorine application must be at the beginning of the water main construction and/or any valve section thereof, through a one-inch corporation cock, installed close to and on the downstream side of the regulating gate valve controlling the flow of water into the main. During the sterilization, the flow of water must be controlled so that it is proportionate to the amount of chlorine applied to the main being sterilized. The rate of chlorine application must be in such proportion to the rate of water flow entering the main, that the chlorine as applied must produce fifty parts per million (420 pounds per million gallons) chlorine concentration in the water within the main.
- e. During the sterilizing operation, valves, hydrants, and other mechanical devices controlling the flow of water must be operated to permit full effectiveness of the chlorine solution within the main being sterilized will not flow back into the supply line nor flow into mains already in service. A chlorine concentration test must be made, in turn, at each of the hydrants and/or taps provided for that purpose.

6. Retention Period

- a. After the sterilizing operation has been completed, and, upon test, proved satisfactory, the heavily chlorinated water must be retained in the main long enough to destroy all nonspore forming bacteria. This period must be at least twenty-four hours. At the completion of the retention period, the chlorine concentration of the water within the main must be at least twenty-five parts per million (210 pounds per millions gallons) of chlorine.

7. Final Flushing and Tests

- a. After the required period of retention has elapsed, the heavily chlorinated water must be flushed out completely to waste until the replacement water throughout the length of the main must, upon test, be proved comparable in chlorine concentration to the water supply source.
- b. Disposal of chlorinated water and flushing water must comply with the requirements of Section P-156 Temporary Air and Water Pollution, Soil Erosion, and Sediment Control, IEPA, and the City of Chicago

regulations and any other environmental or regulatory requirements and coordinated with the Commissioner.

- c. No separate measurement or payment will be made for hydrostatic testing or chlorination. All costs for this work will be considered included in the items requiring hydrostatic testing and chlorination.

8. Tests

- a. When the water in the treated main is proven comparable to that of the source, collect water samples at each of the sampling taps and submit to a laboratory on two separate days. Samples will not be collected from hydrants or unsterilized hose connections. If the results of the bacteriological examination are satisfactory, place the main in service. If the initial disinfecting fails to result in approval, repeat the disinfecting procedure until satisfactory results are obtained.
- b. Bacteriological analyses must be run by qualified personnel and laboratory hired by the Contractor at no cost to the City/Commissioner.

3.17 INTERRUPTION OF AIRPORT WATER SERVICE:

- A. Interruption of Airport water service will not be permitted without prior written authorization of the Commissioner. The Contractor must be responsible to notify the Commissioner, and the Chief of the Airport Fire Department at least 72 hours prior to tapping or installing connections into the existing water distribution system.
- B. The Contractor must comply with limitations of week, days, and hours imposed by these departments to minimize potential disruptions of service resulting from the construction.
- C. The Contractor must submit procedure for tapping connections to existing water distribution system.

3.18 GENERAL CLEAN-UP

- A. All rubbish and debris resulting from the Work of this Section must be collected, removed from the site and disposed of legally.
- B. All work areas must be left in a broom clean condition.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Ductile Iron Pipe (DIP), Class 53 and 54 Water Main will be measured per linear foot of pipe in place, completed, and accepted. Measurement will be along the centerline of the pipe. All fittings, including all valves, will be included in the linear footage as typical pipe sections in the pipeline being measured.
- B. Cathodic protection for the Water Main will not be paid separately, but it will be included in the Pay Item – Water Main.
- C. Thrust blocks will not be paid separately but will be included in the Pay Item – Water Main.
- D. Restrained Pipe Fittings of the Water Main will not be paid separately, but it will be included in the Pay Item – Water Main.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment will be made at the Contract unit price per linear foot for class and size of water main actually installed as specified. These unit prices must be payment in full for all materials, labor, and equipment required for: support of trench walls; excavation, shoring and bracing; dewatering of trenches; supply and installation of pipe; annular fill; pipe casing where shown on the Drawings, pipe; bends and all fittings; restrained fittings; valves; joint materials; water meters where shown; pressure and leakage testing; supply of bedding and backfill material; bedding and backfill placement, compaction, and compaction testing; correction of defects; installation of thrust blocks, chlorination, cathodic protection, tapping into existing water main for connecting the Water Main, installation of flushing system, curb stop, shut-off box, and all associated equipment, for the pipes and all other Work required to complete the installation which is not included under other Pay Items.
- B. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
02510-01	1½" DIA. TYPE K COPPER WATER SERVICE	LF
02510-02	HOT TAPS – 16"	EA

END OF SECTION 02510

SANITARY SEWERS

SECTION 02637

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Work under this Section is subject to the requirements of the Contract Documents.
- B. Furnish and install all labor, materials, tools, and equipment required for furnishing and installing Sanitary Sewer pipe, including, but not necessarily limited to, trench excavation and disposal of all unsuitable material; special fabrication and field installation of pipe; connections to existing sewers and manholes; modifications of existing sewers; bedding; backfilling of trenches with specified trench material; and other appurtenant or related work associated with the construction of sanitary sewers.
- C. Install products and materials (furnished in other Sections) as shown on the Drawings and as specified herein, including but not limited to the materials listed in Part 2, below.
- D. Except as modified herein, the work must conform to Section 550 of the Standard Specifications for Road and Bridge Construction, latest edition, by the Illinois Department of Transportation (SSRBC).

1.02 RELATED WORK:

- A. As specified in the following divisions:
 - 1. Section D-751 – Manholes, Catch Basins, Inspection Holes, and Manhole Adjustments
 - 2. Section P-157 – Trench Backfilling

1.03 REFERENCES:

- A. ASTM C 76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- B. ASTM C 425 – Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
- C. ASTM C 443 – Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

- D. ASTM C 700 – Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.

1.04 SUBMITTALS:

- A. Submit the following:
 - 1. Shop Drawings
 - 2. Samples and/or Product Data
 - a. Product Data
 - 3. Tests Reports
 - a. Submit test reports necessary to show compliance with the Contract Documents.
 - b. Video Recording and Report – Submit a DVD format video recording and report of the interior of the completed sanitary sewers, services, and structures showing a complete, clean installation.
 - 4. Manufacturer's Certification
 - a. Submit certification that product(s) meet(s) or exceed(s) the specified requirements.
 - 5. Operation and Maintenance Manuals
 - a. Provide maintenance instruction.

1.05 QUALITY CONTROL:

- A. Contractor Qualifications: Installation of sanitary sewer must be performed only by a qualified Installer. The term qualified means experienced in performing the Work required by this Section. The Contractor must have a minimum of five (5) years documented experience in Projects similar in size and scope to this Project. The Contractor must submit evidence of such qualifications upon request by the Commissioner.
- B. Prior to the start of work, permits are required from the City of Chicago Department of Water Management for the installation of sanitary sewers. A Department of Water Management permit must be obtained only by a Licensed Drain Layer possessing a current Sewer and Drain License issued by the Department of Water Management.

- C. Perform Work in accordance with the latest edition, of the appropriate divisions, of the following:
 - 1. City of Chicago Department of Water Management Permit Requirement and Fee
 - 2. Standard Specification for Water and Sewer Main Construction, Illinois Society of Professional Engineers
- D. As specified by Specification Section Q-100 Quality Control Program.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Materials must be delivered to the Project bearing Manufacturer's name and material identification. Materials must be stored in strict accordance with the Manufacturer's printed directions, copies of which must be furnished to the Commissioner.
- B. Protect materials against damage from mechanical abuse, plaster, salts, acids, staining and other foreign matter by an approved means during transportation, storage and erection and until completion of construction Work. All unsatisfactory materials shall be removed from the premises, and all damaged materials replaced with new materials.
- C. Access and Storage Areas
 - 1. All access routes and storage areas must be subject to the approval of the Commissioner in order to reduce interference with Airport Operations.

1.07 WARRANTIES AND GUARANTEES:

- A. (Not Used)

1.08 EXTRA MATERIALS AND SPARE PARTS:

- A. (Not Used)

1.09 ENVIRONMENTAL REQUIREMENTS:

- A. (Not Used)

1.10 SPECIAL REQUIREMENTS:

- A. (Not Used)

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS:

A. Ductile Iron Pipe and Fittings:

1. Cement lined mechanical joint ductile iron pipe - Ductile iron pipe, Class 56, smaller than 24 in. diameter must conform to ANSI/AWWA C151/A21.51, and cement lining must conform to ANSI/AWWA, C104/A21.4.
2. Fittings - Fittings for ductile iron pipe: Body must conform to ANSI/AWWA C110/A21.10. Joints must conform to ANSI A21.11, 250 psig pressure rating.
3. Mechanical Joints - Mechanical joints and joint accessories including gaskets must conform to ANSI A21.11, and only neoprene gaskets must be allowed. Cable bands must be provided across the joints to maintain positive electrical conductivity.
4. Since the gaskets may be exposed to petroleum products, a swelling test based on Methods 6001 and 6211 of Fed. Std. 601 must be used with No. 3 oil for 70 hours at 212 degrees F, The swelling must not exceed 100% by volume. (Gaskets must meet low-temperature brittleness requirement of ASTM D 2137 Standard Test Method for Rubber Property – Brittleness Point of Flexible Polymers and Coated Fabric.
5. All ductile iron sewer pipes and discrete segments of D.I.P. or other metal piping used in the repair or reconstruction of existing non-metallic piping systems must be encased in polyethylene wrap as required by the Regulations for Sewer Construction and Stormwater Management of the City of Chicago Department of Water Management. Protective polyethylene wrap (polywrap), 4 mils minimum thickness, is to be installed on all ductile iron pipe and secured with 2 inch compatible adhesive tape per detail on the Drawings. The polyethylene tubing must comply with AWWA C105.
6. Ductile iron sanitary pipes installed as a system, must be cathodically protected.

B. Extra Strength Vitrified Clay Pipe

1. For pipe sizes 21 inches or smaller, use Extra Strength Vitrified Clay Pipe and Fittings in conformance with ASTM C 700.
2. Compression Joints for Vitrified Clay Pipe must conform to ASTM C 425.

C. RUBBER BOOTS

1. All sanitary manholes shall have precast "Rubber Boots" that conform to ASTM C-923 for all pipe connections. Precast sections shall consist of modified groove tongue and rubber gasket type joints

PART 3 EXECUTION

3.01 LOCATION:

- A. Pipe must be laid to the lines and grades as shown on the Contract Drawings.

3.02 BACKFILLING:

- A. Pipe must be installed and backfilled as shown in the details on the Contract Drawings and per Section P-157 Trench Backfilling.
- B. After the backfill is completed, the Contractor must dispose of all surplus material and rubbish off site. Excess dirt and excavated material must be embanked within the project embankment limits in accordance with section P-152 Excavation and Embankment, and will be considered incidental to the work. The Contractor must restore all disturbed areas to their original condition. Where the original condition is grass, topsoil and sod or permanent seeding must be used for restoration as shown on the drawings, all costs for restoration will be included in the Contract unit price. Any future settlement of trenches must be restored at the Contractor's expense.

3.03 TESTING:

- A. Mandrel all sanitary sewers with a 95% go/no-go mandrel in the presence of and to the approval of the Commissioner. Mandrelling must be performed a minimum of 30 days after completion of the sewer installation and all backfilling operations.
- B. After the pipes have been mandrelled and cleaned of all dirt and foreign materials, the pipe lines, as a whole or in convenient sections,

must be tested by plugging the section to be tested and applying a starting gauge pressure of 4 psi, let stabilize, then start test at 3.5 psi and have pressure drop no more than 1 psi in time allotted per ASTM C828 - Standard Test Method for Low-Pressure Air Test. Any observed leaks must be repaired as directed by the Commissioner at the expense of the Contractor and that Section retested to the satisfaction of the Commissioner.

- C. Prior to turnover of the completed installation, and a minimum of 30 days after completion of backfilling operations, the interior of all sanitary sewers, service connections, and structures must be televised in the presence of the Commissioner showing a complete, clean installation. Any debris or deficiencies encountered must be cleaned or repaired, to the satisfaction of the Commissioner, and the segment(s) must then be re-televised showing a complete, clean installation. The television camera used must be high-resolution color, must be equipped with a revolving head, and must be equipped with a footage counter which records on the video recording. Submit the video recording in DVD format to the Commissioner for viewing, acceptance and for the Project files. The costs associated with televising, cleaning, and repair must be considered incidental to the installation of the sanitary sewer and no additional payment will be made for this work.

3.04 GENERAL CLEAN-UP:

- A. All rubbish and debris resulting from the Work of this Section must be collected, removed from the site and disposed of legally.
- B. All work areas must be left in a broom clean condition.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. The length of Sanitary Sewer pipe will be measured in linear feet of sanitary sewer pipe in place, complete and accepted. It will be measured along the centerline of the pipe from end or inside face of the pipe to the end or inside face. The several classes, types and sizes must be measured separately. Flexible coupling connections, casing pipe end seals, and all fittings must be included in the footage as typical sanitary sewer pipe sections in the sanitary sewer pipeline being measured.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. All extra materials needed to complete this item and installation of sanitary sewer pipe is incidental and the responsibility of the Contractor. This includes any items designated in these Specifications and as detailed on the Contract Drawings. This price includes full compensation for furnishing all materials; and incidentals including flexible coupling connections, casing pipe end seals, fittings, fill for the voids, vertical vent, etc.
- B. Payment will be made under the following item:

ITEM NO.	DESCRIPTION	UOM
02637-01	SANITARY SEWER, 4" ESVCP	LF

END OF SECTION 02637

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DUST CONTROL

SECTION 02710

PART 1 DESCRIPTION

1.01 GENERAL

- A. This work consists of the exclusive control of dust resulting from construction operations and is not intended for use in the compaction of earth embankments.

PART 2 PRODUCTS

2.01 GENERAL

- A. Water for the Project is to be obtained in accordance with the requirements of Article XIV. J, 2b of Part Two, General Conditions.
- B. Due to the heavy civil construction in the proximity of the ASR-9 facility, the HVAC intake air filters shall be replaced since much of the construction will create an inordinate abundance of dust. The filter shall have a Minimum Efficiency Reporting Value of MERV 8 (when evaluated under the guidelines of ASHRAE Standard 52.2-1999). Initial resistance to airflow shall not exceed 0.31" for a 2" deep, 0.23" for a 1" deep, or 0.27" for a 4" deep filter at respective velocities of 500, 350, or 500 fpm.

PART 3 EXECUTION

3.01 GENERAL

- A. Prior to the start of construction, the Contractor must submit a plan and methods to alleviate and prevent dust nuisance originating from earthwork and construction operations from within the Project. Work will not commence until a dust control plan has been accepted and approved by the Commissioner.
- B. Dust will be controlled by the uniform application of sprinkled water and will be applied only when advised by the Commissioner in a manner meeting the Commissioner's approval.
- C. All equipment used for this work must meet the Commissioner's approval.
- D. The Contractor will investigate the availability of an adequate supply of suitable water, make all arrangements (including permit if required) for

the purchase of the water and provide the necessary facilities to furnish water for use during construction, solely at the Contractor's expense. Water may be obtained from creeks and streams on the Airport property. The availability and quality of the water obtained from these sources is not guaranteed.

- E. The Contractor must have 3 sweeper trucks on site, in-use at all times while work is being performed adjacent to existing airside pavement. The use of the sweepers will be per direction of the Commissioner to ensure all airside pavement remain free of construction debris or dirt/mud resulting from construction activities.
- F. The Contractor must submit an ASR-9 HVAC intake air filter shop drawing for review and approval by the FAA and the Commissioner. The Contractor must not order the filter until shop drawings have been approved.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. With the exception of the Allowance for ASR-9 Building HVAC Filters, Dust Control will not be measured separately for payment, but will be considered as included in the overall Contract price. This includes all labor, equipment and materials necessary to limit airborne dust and dust/dirt/mud on airside pavement.
- B. Allowance for ASR-9 Building HVAC Filters will be subject to prior review and approval by the Commissioner. Unused portions of this allowance will not be paid to the Contractor, but will be returned to the City in the form of an appropriate credit.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. With the exception of expenses from the Allowance for ASR-9 Building HVAC Filters, all costs associated with meeting these requirements will not be paid for separately but will be considered included in the overall Contract price.
- B. Allowance for ASR-9 Building HVAC Filters will compensate the Contractor for costs associated with furnishing and installing ASR-9 HVAC intake air filters and any other FAA Facility on a bi-monthly basis and prior to project completion. The price must be full compensation for furnishing all labor, equipment, tools, and all work

necessary to complete the item. The Contractor must receive written notice from the Commissioner to proceed with the work. The work will be paid for as shown in Article X, "Changes in the Work," of the Part 2, General Conditions. Any remaining balance from the Allowance will be retained by the City.

- C. Payment will be made under the following item:

ITEM NO.	DESCRIPTION	UOM
02710-01	ALLOWANCE FOR ASR-9 BUILDING HVAC FILTERS	AL

END OF SECTION 02710

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AGGREGATE SURFACE COURSE

SECTION 02713

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Work under this Section is for aggregate roadway work, including aggregate roadways, aggregate shoulder work along Tank Farm Road, and for creating and improving temporary construction access roads as shown in the contract documents. This work will also consist of furnishing and constructing aggregate surface course in accordance with Section 351 and aggregate surface course in accordance with Section 402 of the IDOT "Standard Specifications for Road and Bridge Construction" (SSRBC), latest edition and any Supplemental Specifications and Recurring Special Provisions, except as modified herein. Work is subject to the requirements of the Contract Documents.
- B. Furnish and install all granular material which consists of a surface course, hereinafter referred to as the Aggregate Surface Course, composed of granular materials constructed on a prepared sub grade or underlying course in accordance with these Specifications, and in conformity with the dimensions and typical cross section shown on the Drawings, or as directed by the Commissioner.

1.02 RELATED WORK:

- A. As specified in the following divisions:
 - 1. P-152 Excavation and Embankment
 - 2. P-154 Frost Protection Course
 - 3. P-629 Geotextile Fabric

1.03 REFERENCES:

- A. Illinois Department of Transportation – Standard Specifications for Road and Bridge Construction (SSRBC), latest edition.

1.04 SUBMITTALS:

- A. Submit the following
 - 1. Samples and/or Product Data

- a. Product Data:
 - (1) Gradation of aggregate materials
- 2. Test Reports
 - a. Submit test reports necessary to show compliance with the Contract Documents.
 - (1) Proctor of the aggregate materials in accordance with ASTM D1557.
 - (2) Proctor of existing subgrade in accordance with ASTM D1557.

1.05 QUALITY CONTROL:

- A. As specified by Section Q-100 Quality Control Program.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. (Not Used)

PART 2 PRODUCTS:

2.01 MATERIALS:

- A. The aggregate surface course material must consist of crushed stone or crushed recycled concrete conforming to the requirements of Article 1004 or if bituminous pavement grindings are used per Article 402.02 (a) of the Illinois Department of Transportation's Standard Specifications for Road and Bridge Construction, latest edition (SSRBC).
- B. For the material to be used for the geotextile fabric see Section P-629 Geotextile Fabric.

PART 3 EXECUTION

3.01 GENERAL NOTES:

- A. The aggregate surface course must be placed where designated on the Drawings or as directed by the Commissioner. The material must be shaped and thoroughly compacted within the tolerances specified.
- B. Stabilization stone must only be placed in areas of severely adverse sub grade conditions and as directed by the Commissioner. Stabilization stone must be crushed stone or crushed recycled

concrete having a gradation of CA-1, quality D, conforming to Article 1004.01 of the IDOT SSRBC.

- C. Granular bases which, due to grain sizes or shapes, are not sufficiently stable to support without movement the construction equipment must be mechanically stabilized to the depth necessary to provide such stability as directed by the Commissioner. The mechanical stabilization must principally include the addition of the fine-grained medium to bind the particles of the surface material sufficiently to furnish a stable bearing strength.

3.02 EXCAVATING AND PREPARING UNDERLYING SUBGRADE:

- A. Before any aggregate surface material is placed, the underlying course must be prepared and conditioned as specified. The course must be checked and accepted by the Commissioner before placing and spreading operations are started.
- B. The existing ground must be excavated and graded to the required lines and grades to provide proper depths for the surface, unless the Commissioner authorizes over-excavation to remove unsuitable materials. Should the Contractor, through negligence or other fault, excavate below the designated line, it must replace the excavation with approved materials, in an acceptable manner and condition, as approved by the Commissioner, at the Contractor's own expense.
- C. In areas where the Commissioner directs the Contractor to over-excavate below subgrade level and backfill the over-excavation with stabilization stone, the stabilization stone must be placed on a layer of non-woven geotextile filter fabric per Section P-629 Geotextile Fabric, leveled and compacted to make the subgrade firm and stable. Areas of undercut 6 inches or less must be stabilized with CA-6 and areas of undercut greater than 6 inches must be stabilized with CA-1. All undercut and backfill work to be directed by the Commissioner.
- D. After the subgrade has been substantially completed, the full width must be conditioned by removing any soft other unstable material which will not compact properly. The resulting areas and all low spots, holes or depressions, must be brought to grade with suitable select material. Scarifying, blading, and rolling and other methods must be performed to provide a thoroughly compacted subgrade shaped to the lines and grades shown on the Drawings.
- E. The grade must be maintained so that the surface is well drained at all times. When necessary, temporary drainage and drainage ditches

must be installed to intercept or divert surface water which may affect the work.

- F. Compact the subgrade to 95 percent of its maximum density and +/- 2% optimum moisture content as determined in accordance with ASTM D1557.
- G. To protect the subgrade and to ensure proper drainage, the spreading of the aggregate surface course must begin along the centerline of the pavement on a crowned section or on the high side of pavements with a one-way slope.
- H. All excess excavation and excavated materials that cannot be reused at site must be legally disposed of off the Airport property.

3.03 MATERIALS ACCEPTANCE IN EXISTING CONDITION:

- A. When the entire aggregate surface or stabilization stone material is secured in a uniform and satisfactory condition and contains the required moisture, such approved material may be moved directly to the spreading equipment for placing. The material may be obtained from gravel pits, stockpiles, or may be produced from a crushing and screening plant with the proper blending. The materials from these sources must meet the requirements for gradation, quality, and consistency. It is the intent of this Section of the Specifications to secure materials that will not require further mixing. The moisture content of the material must be that required to obtain maximum density. Any minor deficiency or excess of moisture may be corrected by surface sprinkling or by aeration. In such instances, some mixing or manipulation may be required, immediately preceding the rolling, to obtain the required moisture content. The final operation must be blading or dragging, if necessary, to obtain a smooth uniform surface true to line and grade.

3.04 PLANT MIXING:

- A. When materials from several sources are to be blended and mixed, the material must be processed in a central or travel mixing plant. The material must be thoroughly mixed with the required amount of water. After the mixing is complete, the material must be transported to and spread on the underlying course without undue loss of the moisture content.

3.05 GENERAL METHODS FOR PLACING:

- A. The aggregate surface course must be constructed to the thickness shown on the Drawings. The aggregate surface course must be constructed in lifts not more than 4 inches thick when compacted, except that if tests indicate that the desired compaction and results are being obtained, the compacted thickness of any lift may be increased to a maximum of 8 inches. The material, as spread, must be of uniform gradation with no pockets of fine or coarse materials. The aggregate surface course, unless otherwise permitted by the Commissioner, must not be spread more than 2,000 square yards in advance of the rolling or as approved by the Commissioner. Any necessary sprinkling must be kept within this limit. No material will be placed in snow or on a soft, muddy, or frozen course.
- B. When more than one layer is required, the construction procedure described herein must apply similarly to each layer.
- C. During the placing and spreading, sufficient caution must be exercised to prevent the incorporation of sub grade, shoulder, or foreign material in the aggregate surface course mixture. All contaminated materials must be removed and replaced at no additional cost to the City.
- D. Where geotextile fabric is required to be placed under the aggregate course, it must be placed over the sub grade in accordance with the manufacturer's recommendations and Section P-629 Geotextile Fabric. The aggregate surface course material must be back-dumped on the fabric in a sequence of operations beginning at the outer edges of the area with subsequent placement toward the middle. Dumping of the material directly on the fabric must only be permitted to establish an initial working platform. No vehicles or construction equipment must be allowed on the fabric prior to the placement of the aggregate surface course. Fabric which is damaged during installation or subsequent placement of aggregate surface course must be repaired or replaced by the Contractor at his own expense to the satisfaction of the Commissioner.

3.06 FINISHING AND COMPACTING:

- A. After spreading or mixing, the material must be thoroughly compacted by rolling and sprinkling, when necessary. Sufficient rollers must be furnished to adequately handle the rate of placing and spreading of the aggregate surface course.
- B. The field density of the compacted material must be at least 95 percent of the maximum density and +/-2% of the optimum moisture

content of laboratory specimens prepared from samples of the sub base material delivered to the job site for CA-6 material. The laboratory specimens must be compacted and tested in accordance with ASTM D1557.

- C. The course will not be rolled when the underlying course is soft or yielding or when the rolling causes undulation in the sub base. When the rolling develops irregularities that exceed ½ inch when tested with a 16'-0" straightedge, the irregular surface must be loosened and then refilled with the same kind of material as that used in constructing the course and again rolled as required above.
- D. Along places inaccessible to rollers, the surface material must be tamped thoroughly with mechanical or hand tampers.
- E. Sprinkling during rolling, if necessary, must be in the amount and by equipment approved by the Commissioner. Water must not be added in such a manner or in a quantity that free water will reach the underlying layer and cause it to become soft.
- F. The Contractor will be responsible for all Quality Control testing for all material and installation.

3.07 EQUIPMENT

- A. The Contractor may use any type of earth moving, compaction, and watering equipment it may desire or has at its disposal, provided that the equipment is in satisfactory condition and is of sufficient capacity to perform the work as specified. The only requirements specified are that tamping rollers (generally referred to as Sheepsfoot Rollers) will be considered the proper type of equipment for compaction of cohesive soils and vibratory/mechanical tamping equipment will be applicable for compacting granular soils. Subgrade rollers can be used to smooth minor surface deviations in both types of subgrade/embankment, but in no case will a steel wheel or vibratory roller be used to compact cohesive embankment. In all cases, the adequacy of the equipment will be determined by the Commissioner. Failure to obtain the specified results or failure to meet the schedule planned by the Contractor and acceptable to the Commissioner, due to inadequate equipment will not be cause for delay or additional payment. The Contractor must furnish, operate, and maintain such equipment as is necessary to control density, section, and smoothness of grade.

- B. The Commissioner will make the determination as to cohesive and non-cohesive soil in regards to selecting the proper type of equipment required to compact the material.
- C. The requirements of Section 01111, Air Quality – Equipment Emissions apply to this Specification Section.

3.08 SURFACE TEST:

- A. After the course is completely compacted, the surface must be tested for smoothness and accuracy of grade and crown; any portion found to lack the required smoothness or to fail in accuracy of grade or crown must be scarified, reshaped, recompact, and otherwise manipulated as the Commissioner may direct until the required smoothness and accuracy are obtained. The finished surface must not be above the theoretical vertical grade and may not vary more than ½ inch when tested with a 16'-0" straightedge applied parallel with, and at right angles to the centerline.

3.09 THICKNESS:

- A. The thickness of the completed surface course must be determined by depth tests or cores taken at intervals so each test must represent no more than 500 square yards or as approved by the Commissioner. When the deficiency in thickness is more than ½ inch, the Contractor must correct such areas by scarifying, adding satisfactory mixture, rolling, sprinkling, reshaping, and finishing in accordance with these Specifications. The Contractor must replace at his/her expense the aggregate surface material where borings are taken for test purposes.

3.10 PROTECTION:

- A. Work on aggregate surface course must not be conducted during freezing temperature nor when the subgrade is wet. When the surface material contains frozen material or when the underlying course is frozen, the construction must be stopped.

3.11 MAINTENANCE:

- A. Following the final shaping of the material, the surface must be maintained throughout its entire length by the use of standard motor graders and rollers until, in the judgment of the Commissioner; the aggregate surface course meets all requirements and is acceptable for the construction of the next course. The Contractor is totally responsible for the preparation, maintenance and protection of the aggregate surface course and no additional compensation will be considered for any reworking of the material for any reason.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT:

- A. Allowance for Haul Road Maintenance will cover costs of furnishing materials and maintaining haul roads as shown on the plans as requested by the Commissioner. Expenses from the Allowance will be subject to prior review and approval by the Commissioner.
- B. Allowance for Temporary IWARR Bypass Road will cover costs of furnishing materials and constructing a temporary IWARR bypass road as shown on the plans as requested by the Commissioner. Expenses from the Allowance will be subject to prior review and approval by the Commissioner.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT:

- A. Item 02713-01 – Allowance for Haul Road Maintenance: The Contractor must receive written notice from the Commissioner and Chief Procurement Officer to proceed with the work. The work will be paid for as shown in General Conditions, Article X, Changes in the Work, 3. Time and Materials Basis. Any remaining balance from the Allowance will be retained by the City.
- B. Item 02713-02 – Allowance for Temporary IWARR Bypass Road: The Contractor must receive written notice from the Commissioner and Chief Procurement Officer to proceed with the work. The work will be paid for as shown in General Conditions, Article X, Changes in the Work, 3. Time and Materials Basis. Any remaining balance from the Allowance will be retained by the City.
- C. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
02713-01	ALLOWANCE FOR HAUL ROAD MAINTENANCE	AL
02713-02	ALLOWANCE FOR TEMPORARY IWAAR BYPASS ROAD	AL

END OF SECTION 02713

CONCRETE PAVEMENTS

SECTION 02714

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Work under this Section is subject to the requirements of the Contract Documents.
- B. Furnish and install all Concrete Pavement work as shown on the Drawings, and as specified herein, including but not limited to the following:
 - 1. Concrete curb and gutter, curb and raised medians.
 - 2. Curing and sealing concrete.
 - 3. Expansion joints.

1.02 REFERENCES:

- A. (Not Used)

1.03 SUBMITTALS:

- A. Submit the following
 - 1. Samples and/or Product Data
 - a. Product Data
 - b. Samples
 - (1) Curing material, 1 pint, or 12" x 12" sheet.
 - (2) Joint filler, 12" length of each type.
 - (3) Concrete Mix Design.
 - 2. Test Reports
 - a. Submit test reports necessary to show compliance with the Contract Documents.
 - b. The Contractor must employ an approved Quality Control (QC) testing laboratory which must make tests and perform inspection in accordance with these Specifications, at no cost to the Commissioner including:
 - (1) Laboratory Test Report.
 - (2) Batch Plant Inspection Report.

3. Manufacturer's Certification

- a. Submit certification that products meet or exceed the specified requirements.

1.04 QUALITY CONTROL:

A. Concrete Quality:

1. The Contractor must employ, at his expense, an independent Quality Control (QC) testing laboratory, approved by the Commissioner, meeting the requirements of ASTM C1077, to design the mix of concrete required in accordance with the Specifications and Drawings. Mix designs prepared by Concrete Suppliers must be tested and verified for compliance with the Specifications by the independent QC testing laboratory.
2. No concrete must be placed until mix designs and 7 and 28 day test results are submitted by the Contractor and accepted by the Commissioner.
3. The adequacy of a design must be verified by QC tests on a minimum of 6 cylinders; 2 tested at 3 days, 2 tested at 7 days and 2 at 28 days, in accordance with ASTM C 192 and C-39; by slump test for the first two loads, the last load, every 50 cubic yards, and every time cylinder samples are taken in accordance with ASTM C 143, air test for the first two loads, the last load, every 50 cubic yards, and every time cylinder samples are taken in accordance with ASTM C 231, and temperature test for the first two loads, the last load, every 50 cubic yards, and every time cylinder samples are taken in accordance with ASTM C 1064. The number of tests required must be one (1) set of specimens for each day's placement of each 100 cu yards of concrete, or fraction thereof. The Contractor must make and initially cure and store the test specimens in accordance with ASTM C31. The Contractor's technician preparing the specimens must be currently certified to perform the required concrete sampling and testing. The Contractor must transport and deliver the test specimens to the Commissioner's laboratory for testing using a Chain of Custody form provided by the Commissioner. The Contractor must be responsible for developing a system of recording the initial curing temperatures and this data must be sent to the Commissioner's laboratory with the test specimens. The Commissioner will make the actual tests on the specimens in accordance with ASTM C39 at no expense to the Contractor.

4. If at anytime during construction the concrete resulting from the approved mix design proves to be unsatisfactory for any reason, such as lack of workability, of insufficient strength, the Contractor must immediately notify the QC testing laboratory and the Commissioner. The QC laboratory must verify the deficiency with additional testing and modify the design, subject to the Commissioner's approval, until a satisfactory concrete is obtained.
5. Strength requirements of concrete must be as noted on the Drawings. Concrete must be proportioned to achieve an average strength of 500 psi higher than design strength shown. If no design strength is shown, the design strength of the concrete must be 4000 psi at 28 days.
6. In cases where 28 day strength of cylinders falls below the required strength, the Commissioner will have the right to require core tests to be made on portions of concrete poured represented by the cylinders, at the Contractor's expense. Any portion of concrete work failing to meet required core tests must be removed and replaced with satisfactory work at no additional cost to the City. In all cases where strength of the laboratory control cylinders, shown by these tests for any portion of concrete poured falls below the minimum ultimate compressive strengths specified, the Commissioner will have the right to order a change in mix or in water content for remaining portions of pavement and to require conditions of temperature and moisture necessary to secure required strengths.
7. When an approved water reducing admixture is used in accordance with manufacturer's recommendations, cement requirements may be reduced. Mix designs must indicate use of admixtures.
8. Slump for Portland Cement Concrete (PCC) pavement must be $\frac{3}{4}$ inch to 1-1/2 inches; except that a slump above 1-1/2" may be used, up to a maximum of 3 inches, provided that the mixture's water/cement ratio does not exceed 0.45. Concrete mixes containing plasticizers must have a maximum slump of 8". The testing laboratory retained by the Commissioner will have the right to reject any concrete which arrives at job site in excess of specified slump. No water will be added to design mix unless as directed in writing by Commissioner's representative. Slump must be determined in accordance with ASTM C 143.

9. All concrete exposed to weather or in contact with earth or backfill must be air-entrained. Air-entrained concrete must be made with an air-entraining admixture. Air content must be within limits of 5 to 8 percent, net at time of placement. Air content must be determined in accordance with ASTM C 231.
 10. Minimum cementitious content for PCC pavement must be 535 pounds per cu. yd. of central mixed concrete. Fine aggregate will not be less than $\frac{1}{3}$, not more than $\frac{1}{2}$ of total aggregate. Unless otherwise specified, the maximum water/cement ratio for normal weight concrete must be 0.45. When fly ash, ground granulated blast furnace slag, or microsilica are used as part of the cement in a concrete mix, the water/cement ratio will be based on the total cementitious material contained in the mixture.
 11. A plasticizing admixture may be used when approved by the Commissioner for the purpose of reducing water requirements for a given consistency and strength of concrete and for increasing workability. Mixture must be used in accordance with manufacturer's recommendations. A maximum reduction in cement content of $\frac{1}{2}$ sack of cement per cubic yard may be made, provided all other requirements are met.
 12. The temperature of the mixed concrete must not be less than 50 degrees F and not more than 90 degrees F at the time of placement. Temperature must be determined in accordance with ASTM C 1064.
- B. Perform Work in accordance with the latest edition, of the appropriate divisions, of the following:
1. ACI 311.1R "ACI Manual of Concrete Inspection".
 2. ACI 304R "Guide for Measuring, Mixing, Transporting and Placing Concrete", except minimum cement content must be herein specified.
 3. CSI "Manual of Standard Practice"
 4. ACI 318 "Building Code Requirements for Structural Concrete".
 5. ASTM C 94 "Specifications for Ready Mixed Concrete".
 6. ACI 305R "Hot Weather Concreting".
 7. ACI 306R "Cold Weather Concreting".

8. ACI 308R "Guide to Curing Concrete".
9. ACI 309R "Guide to Consolidation of Concrete".
10. ACI 347 "Guide to Formwork for Concrete".
11. "Standard Specifications for Road and Bridge Construction" prepared by the Illinois Department of Transportation latest edition is a separate book. The "Standard Specifications for Road and Bridge Construction" is referred to in the following articles as the Standard Specifications" and except as may be otherwise stated, the work to be done under this Section must conform to the requirements of said "Standard Specifications". Contractor's field office and laboratory is not a requirement.
 - a. Where the "Standard Specification" refers to the "Engineer", it must be understood to mean "Commissioner", except in cases where it is deemed to be QC testing by the Contractor.
 - b. Unless otherwise noted on Drawings or specified, the applicable articles of the following Sections of the "Standard Specifications" must govern:
 - c. Sections 420, 423 and 424.

(Note: Articles of the SSRBC covering method of measurement and basis of payment are not applicable.)
12. Perform work in accordance with Section 01400 Contractor QC Program for Building Projects (or Section Q-100 Quality Control Program).

1.05 DELIVERY, STORAGE AND HANDLING:

A. (Not Used)

1.06 WARRANTIES AND GUARANTEES:

A. (Not Used)

1.07 EXTRA MATERIALS AND SPARE PARTS:

A. (Not Used)

1.08 SPECIAL REQUIREMENTS:

A. Temperatures:

1. When hot weather conditions as defined in ACI 305 exist, place and cure concrete in accordance with same.
2. When cold weather conditions as defined in ACI 306 exist, place and cure concrete in accordance with requirements of same.

PART 2 PRODUCTS

2.01 MATERIALS:

- A. Portland Cement - ASTM C 150, Type I cement; or Type III (high-early strength cement) as approved by the Commissioner.
- B. Fly Ash – ASTM C 618
- C. Aggregate for Normal Weight Concrete - All fine and coarse aggregate must conform to IDOT SSRBC Articles 1003.02 and 1004.02, respectively.
 1. Fine Aggregates - Natural hard clean sand.
 2. Coarse Aggregates - Crushed stone or gravel.
- D. Water - Clean, fresh, potable.
- E. Welded Wire Fabric - ASTM A1 85.
- F. Admixtures - Concrete admixtures must comply with ASTM C 494 (Water reducing) or ASTM C 260 (Air Entraining), produced by recognized manufacturers subject to Commissioner's approval.
 1. Air Entraining Admixture - ASTM C 260, "Air Mix" (The Euclid Chemical Company); "MB-VR" (Master Builders); "Darex" (W.R. Grace & Co.); "Sika AER" (Sika Chemical Company); or approved equal. Add only to normal Portland cement concrete to meet requirements specified for air content.
 2. Water Reducing Admixture - ASTM C 494, Type A, and not containing any; chloride ions added during manufacture, "Eucon WR-75" (The Euclid Chemical Company); "Pozzolith" 122N (Master Builders); "WRDA with Hycol" (W.R. Grace & Co.); "Plastocrete" (Sika Chemical Company)-, or approved equal.
 3. Water Reducing, Retarding Admixture - ASTM C 494, Type D. When high temperatures, placing or humidity conditions dictate, "Eucon Retarder-75" (The Euclid Chemical Company); "Pozzolith 100-XR" (Master Builders); "Daratard HC" (W.R.

Grace & Co.); "Plastiment" (Sika Chemical Company); or approved equal.

4. Plasticizing Admixture - "Pozzolith-N" (Master Builders)- "WRDA" (W.R. Grace & Co.); "Plastiment" (Sika Chemical Company); or approved equal. When ambient temperature is expected to exceed 80 degrees F during placing and finishing operations, use "Pozzolith - R" (Master Builders); "Daratard" (W.R. Grace & Co.); or approved equal.
 5. Calcium chloride must not be used.
- G. Bonding Agent - Epoxy type, 100 per cent solids "Euco Epoxy #452 (dry surface), #463" (dry or damp surface), (The Euclid Chemical Company); "Sikadur Hi-Mod" (dry or damp surface) (Sika Chemical Co.); "Duralbond 102" (dry or damp surface), (Dural International Corp.), or approved equal.
- H. Patching and Surfacing Compound - Epoxy type, 100 per cent solids, "Euco Epoxy #456 Mortar (dry surface), #460 (dry or damp surface)", (The Euclid Chemical Company); "Sikadur Lo-Mod Mortar" (dry or damp surface) (Sika Chemical Co.); "Duraltex" (dry or damp surface), (Dural International Corp.), or approved equal.
- I. Surface Retardant - (Exposed Aggregate finish) "Lithochrome - Top Surface Grade" (L.M.Scofield Co.); "Top-Stop" (W.R. Meadows); "Concrete Surface Retarder" (The Euclid Chemical Company), or approved equal.
- J. Form Material - Provide metal or wood templates and forms conforming to profiles, lines and dimensions as shown, of substantial design and construction to maintain position and shape when concrete is placed. All forms must be subject to the acceptance of the Commissioner.
- K. Form Oil - Suitable for the type of forms used and the conditions of use.
- L. Expansion Joint Filler - ASTM D994 - "Asphalt Expansion Joint Filler" (W.R. Meadows); "Asphalt Expansion Joint (Atlas Construction Supply Inc.); "Right-Joint Asphalt Expansion Joint" (Right Point LLC), or approved equal. Expansion Joint must be full depth of joint.
- M. Construction Joints - Between all concrete pours suspended for thirty (30) minutes or more, must be a construction joint as shown and detailed on the Plans.

N. Curing Materials:

1. Absorptive Cover - Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with ASSHO M 182, Class 3 or cotton mats complying with ASTM C 440.
2. Moisture-Retaining Cover - One of the following:
 - a. Waterproof Paper - ASTM C 171, Type 1 or Type 11.
 - b. Polyethylene Sheeting - AASHO M 171.
 - c. Polyethylene-coated burlap.
3. Liquid Membrane Curing Compound - ASTM C 309, Type 1, resin type, clear, unless otherwise directed, for vertical and horizontal surfaces, "Horn Clear-Seal" (W. R. Grace & Co.); "Acri Seal S" Toch Brothers Division, (Carboline Company); "Kure-N-Seal" (Sonneborn-Contech), or approved equal.

2.02 MIXING CONCRETE:

- A. Concrete for this Project must be ready-mix concrete; must be batched and delivered from a plant approved by the Commissioner and in strict accordance with the requirements set forth in ASTM C 94, subject to all provisions specified herein regarding materials, strength, proportioning, consistency and delivery time. Additional amounts of water to the batch, either at the plant or at the Job site will not be permitted, except upon specific approval of the Commissioner in each instance and only if confirmed by calculations utilizing batch weights performed by the Contractor's QC laboratory to not exceed the design water to cement ratio.
- B. The rate of delivery of the ready mixed concrete must be such that the interval between placing of successive batches must be 30 minutes or less to prevent "cold joints". The elapsed time between the introduction of mixing water to the cement and aggregate and completion of discharge must not exceed one (1) hour.
- C. Minimum mixing for each batch must be that required to produce a uniform mixture of materials but in no case less than 70 revolutions after all materials are in the mixer, including water.
- D. The ready-mixed concrete producer must submit duplicate delivery tickets, one (1) for the Contractor and one (1) for the Commissioner, with each load of concrete delivered to the job. Delivery tickets must provide the following information:

1. Date.
 2. Name of ready-mix concrete plant.
 3. Contractor.
 4. Job Location.
 5. Type (Standard or High Early Strength) and brand of cement.
 6. Cement content in bags per cubic yard of cement.
 7. Truck number.
 8. Time dispatched and time unloaded.
 9. Amount of concrete in load in cubic yards.
 10. Admixtures in concrete, if any.
 11. Type and maximum size of aggregate.
 12. Water added at job, if any.
 13. Name of person who authorized addition of water.
- E. Close control of mixing time must be maintained for air-entrained concrete.
- F. The testing laboratory engaged by the Contractor must periodically check batch proportions and yield strength, and must have continuous access to the mixer.

PART 3 EXECUTION

3.01 INSPECTION:

- A. Before pouring concrete, examine substrate surfaces to determine that they are free of conditions which might be detrimental to proper and timely completion of the work. Start of work must indicate acceptance of the substrate.

3.02 PREPARATION:

- A. Sub-grade and sub-base - Before proceeding with the installation of paving or concrete work, the Contractor must carefully examine the sub-base and must perform any minor grading, shaping, filling or other preparatory work required in the opinion of the testing laboratory or the Commissioner prior to placing the base course. Building up of sub-

grade under forms after they are in place will not be permitted.

3.03 PLACING CONCRETE:

- A. Concrete must not be placed until all reinforcement is securely and properly fastened in its correct position; all anchors, sleeves, inserts, pipes, conduits, and other items required to be embedded therein have been inspected and approved by the Commissioner.
- B. In no case will concrete be placed upon frozen base course or subgrade material. Discontinue concrete operations when the air temperature is expected to fall below 40 degrees F during the 24 hour period after placing concrete or when the air temperature is likely to remain below 30 degrees F during the succeeding 6 days; unless provisions for heating aggregates, sand and water have been made, the Contractor has submitted a Cold Weather Paving Plan, and the methods proposed for protecting the concrete has been approved by the Commissioner. In such cases, provide heated concrete in accordance with ASTM C 94 and follow procedures as outlined in ACI 306R "Cold Weather Concreting".
- C. Accelerating or antifreeze admixtures must not be used. The Contractor is responsible for the protection of finished concrete against all damage or injury, including freezing until the work has been completed and accepted. The Contractor will be held responsible for any defective work resulting from freezing or injury in any manner during placing and curing, and must replace such work at his or her expense.
- D. Concrete consolidation must be performed in accordance with ACI 309R "Guide for Consolidation of Concrete".

3.04 CONCRETE PAVEMENT - SIDEWALKS - CURBS - GUTTERS:

- A. Construct all concrete pavements, side walks, curbs, etc., indicated on the Drawings, to the lines, grades and Sections indicated. Concrete must be proportioned and mixed as specified, strengths as scheduled. Air entraining must be incorporated in the mix by adding an approved admixtures air content of concrete must be within limits of 5% to 8% net at time of placement, in accordance with ASTM C 231.
- B. Unless otherwise indicated or noted on Drawings, lay out pavements into Sections not exceeding 40 feet in length, separated by expansion joints extending full depth of slab. Unless otherwise shown, expansion filler must be 3/4 inch thick, of material as specified.
- C. Unless otherwise indicated or noted on Drawings, expansion joints in curbs must be spaced not more than 40 feet on centers. Unless

otherwise shown, joints must be 3/4 inch thick.

- D. Pitch work as indicated on the Drawings for drainage, approximately 1/8 inch per foot, or as required between the new work and existing work to remain, to assure an even transition is made. Level off slabs with strike-off rod and finish to true and even surface with floats and trowel, leaving a smooth surface. After the water sheen has disappeared, the surface must be given a final finish by brushing with a brush drawn across the sidewalk at right angles to the edges of the walk, with adjacent strokes slightly overlapping, producing a uniform, slightly roughened surface with parallel brush strokes. Wheel chair ramps must be similarly finished, except for heavier brooming transverse to slope of ramps.
- E. The surface must be divided by grooves saw cut at right angles to the center line of the pavement or sidewalk. These grooves must be 1/2 inch deep and not less than inch and not more than 1/4 inch in width. Unless otherwise noted on Drawings, spacing of grooves between expansion joints is not to exceed 5'-0" centers.
- F. Forms for concrete curbs and combination concrete curbs and gutters must be removed within 24 hours after the concrete has been placed. Minor defects must be filled with mortar composed of one part Portland cement and two parts of fine aggregate. The exposed surfaces must be finished smooth and given a light brush finish, while the concrete is still green. The edges must be rounded with approved finishing tools having the radii shown on the Drawings.
- G. After the concrete has set sufficiently, the spaces in back of the curb or combination curb and gutter must be backfilled to the required elevation with approved material which must be compacted until firm and solid and neatly grade.
- H. Traffic, loading or backfilling must not be allowed on concrete surfaces for 7 days after the concrete has been placed or until 75% of design strength is achieved. If the Contractor seeks permission from the Commissioner to place traffic, loads, or to backfill before 7 days, the Contractor QC and his laboratory must make and break additional cylinders for this purpose in the Contractor's approved laboratory, subject to verification by the Commissioner.

3.05 CURING AND PROTECTION:

- A. Protect freshly placed concrete from defacement, premature drying and excessive cold or hot temperature, and maintain without drying at a relatively constant temperature for a period of time necessary for hydration of cement and proper hardening.

- B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing.
- C. Begin final curing procedures immediately following initial curing and before concrete has dried. Provide continuous moist curing above 50 degrees F for at least 7 days, regardless of ambient air temperatures. Demonstrate to the Commissioner that temperature is maintained by means of a high-low or recording thermometer. Continue final curing for at least 168 hours (7 days).
- D. Cure concrete in accordance with ACI 308R "Guide to Curing Concrete".
- E. Concrete must be cured by one of the following methods or by combinations thereof, as approved:
 - 1. Moisture Curing - Cover concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers. At the Contractor's option, moisture curing may also be provided by ponding or continuous water spraying, where approved by the Commissioner.
 - 2. Moisture Retaining Cover Curing - Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - 3. Membrane Curing - Apply membrane-forming curing compound to damp concrete surfaces as soon as water film has disappeared and surface is hard enough to carry applicator's weight without damage. Apply uniformly in 2 - coat continuous operation by power-spray equipment in accordance with manufacturer's directions. Maintain continuity of coating and repair all damage during curing period.
- F. Unless otherwise specified herein or as directed by the Commissioner, Moisture curing or a combination of moisture curing and moisture retaining cover curing must be employed for all exterior concrete pavement work which is to receive a "Surface Sealer".

3.06 SURFACE SEALER:

- A. All concrete pavements, sidewalks, curbs and gutters must be cured in

accordance with Section 1022 of Illinois Department of Transportation Standard Specifications for Road and Bridge Construction latest edition. All exterior concrete placed after October 1, which may be subject to deicing chemicals must be protected with a two-coat application of boiled linseed oil as described in Section 420.18 of SSRBC.

- B. Pavement, sidewalks, curbs and gutters poured before October 1, will not require a linseed oil sealer.

3.07 HOT AND COLD WEATHER CONCRETING:

- A. In hot weather, mix, place, and cure concrete according to ACI 305R "Hot Weather Concreting".
- B. In cold weather, mix, place and cure concrete according to ACI 306R "Cold Weather Concreting".
- C. The Contractor must submit detailed procedures for production, transportation, placement, protection, curing, testing and temperature monitoring of concrete during hot or cold weather. The Hot or Cold Weather Concreting Plan must include procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

3.08 CLEAN-UP:

- A. All rubbish and debris resulting from the work of this Section must be collected, removed from the site and disposed of legally.
- B. All work must be left in a broom clean condition.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Combination concrete curb and gutter will be measured for payment in linear feet.
- B. Portland Cement Concrete Parkway and Concrete Median Surface will be measured for payment per square foot. Detectable warnings will not be measured separately and will be considered incidental to the Portland Cement Concrete median.

PART 5 BASIS FOR PAYMENT

5.01 PAYMENT

- A. Payment will be made at the Contract unit price for Combination Concrete Curb and Gutter, for type specified.

B. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
02714-01	COMBINATION CONCRETE CURB AND GUTTER, TYPE B-6.12	LF
02714-02	COMBINATION CONCRETE CURB AND GUTTER, TYPE B-6.18	LF

END OF SECTION 02714

PAVEMENT MARKING

SECTION 02783

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Work under this section is subject to the requirements of the Contract Documents.
- B. The Contractor must furnish all labor, materials, tools and equipment required to install Thermoplastic Pavement Markings on the pavements as shown on the Plans, as specified herein and as directed by the Commissioner.
- C. The work must conform to the applicable provisions of Section 780 of the "Standard Specifications for Road and Bridge Construction", Illinois Department of Transportation, latest edition.

1.02 RELATED WORK

- A. Related Work specified elsewhere includes:
 - 1. Section 01502 – Traffic Control
 - 2. Section P-620 Pavement Marking

1.03 REFERENCES

- A. "Standard Specifications for Road and Bridge Construction", Illinois Department of Transportation, latest edition.
 - 1. This publication will be herein referred to as the "Standard Specifications".
- B. Titles, designations, dates of issue or revisions of reference standards are those in effect on the date of these "Standard Specifications" unless otherwise specified herein.
- C. Where the "Standard Specifications" refer to the "Engineer", it will be understood to mean "Commissioner".

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials for Thermoplastic Pavement Markings must conform to Articles 1095.01, 1095.02 and 1095.07 of the Standard Specifications.

PART 3 EXECUTION

3.01 THERMOPLASTIC PAVEMENT MARKINGS

- A. Thermoplastic pavement markings must be installed in accordance with the applicable portions of Section 780 of the Standard Specifications.
- B. Removal of existing pavement markings from the existing pavement and curbs where new pavement markings are to be placed must be in accordance with Article 780.05 of the Standard Specifications and will be considered to be included in the cost of the pay item for the respective line width, symbol or letter.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Lines applied under this item will be measured in feet of pavement marking line of line type and width specified.
- B. Symbols, such as painted stop sign or painted yield sign, will be measured per each symbols painted. The symbol will be measured when completed and in compliance with the detail provided in the plans.
- C. Removal of existing pavement marking from the existing pavement will not be measured for payment, but will be considered included as part of the new pavement markings.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment will be made at the Contract unit price for Pavement Marking of the type and size described, which price will be payment in full for all labor, materials, tools, equipment and all work necessary to complete the Work as specified, as shown on the Plans and as directed by the Commissioner.
- B. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
02783-01	PAVEMENT MARKING LINE, 4" (YELLOW)	LF
02783-02	PAVEMENT MARKING LINE, 4" (WHITE)	LF
02783-03	PAVEMENT MARKING LINE, 12" (WHITE)	LF
02783-04	PAVEMENT MARKING LINE, 24" (WHITE)	LF
02783-05	PAVEMENT MARKING LINE, LETTERS & SYMBOLS	EA

END OF SECTION 02783

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TRAFFIC SIGNS

SECTION 02839

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Work under this section is subject to the requirements of the Contract Documents.
- B. This work will consist of furnishing and installing signs, posts, post foundations, hardware and all other related items at the locations shown in the plans or as directed by the Commissioner. This work will include all excavation and backfill; furnishing and placing concrete; regrading; furnishing and installing galvanized steel post; furnishing and installing all mounting devices, hardware, and related appurtenances; and all labor, tools, and equipment necessary to complete the work as specified, including clean-up and restoration of the location.

1.02 REFERENCES

- A. Illinois Department of Transportation – “Standard Specifications for Road and Bridge Construction”, latest edition.
 - 1. This publication will herein be referred to as the “Standard Specifications”.
- B. Supplemental Specifications and Recurring Special Provisions, Illinois Department of Transportation, latest edition.
- C. Titles, designations, dates of issue or revisions of reference standards are those in effect on the date of these “Standard Specifications” unless otherwise specified herein.

1.03 STANDARDS

- A. Signing Plan, as shown in the drawings.
- B. Applicable portions of Sections 720, 729, 1090, 1091 and 1092 of the Standard Specifications, except as herein modified.
- C. Applicable portions of IDOT Highway Standard 701901, 720001, 720006, 720011 and 729001.

1.04 SUBMITTALS

- A. The Contractor must submit shop drawings for the Commissioner's approval for the sign panels, steel posts and aluminum posts.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

- A. Concrete materials must meet the requirements of Sections P-610 Structural Portland Cement Concrete.

2.02 METAL POST (GROUND MOUNTED INSTALLATION)

- A. The material for the metal posts, standard installation, must conform to the requirements of Section 1006.29 of the Standard Specifications.

2.03 SIGN PANEL

- A. Sign base material must conform to the requirements of Article 1090.01, Type 2, of the Standard Specifications.
- B. Sign face materials must conform to the requirements of Article 1091.01 of the Standard Specifications.
- C. Sign legend and supplemental panels must conform to details in the drawings and the applicable portions of Article 1092.01.

PART 3 EXECUTION

3.01 CONCRETE PLACEMENT

- A. Work under this item must be performed in accordance with section P-610 Structural Portland Cement Concrete.

3.02 METAL POST (GROUND MOUNTED INSTALLATION)

- A. The metal posts must be set as outlined in Section 729 of the Standard Specifications.

3.03 SIGN PANELS

- A. The signs must be installed in accordance with Section 720 of the Standard Specifications.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Sign panels will be measured for payment per each in terms of their dimensions. The posts, mounting device, hardware and concrete footings will not be measured separately for payment but will be considered included in the unit price for the respective Sign Panels.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. The accepted quantities of Sign Panel will be paid for at the contract unit price per each size of panel. The price will be full compensation for furnishing all sign panels, posts, concrete foundations, mounting brackets, hardware accessories, and for all preparation, excavation, disposal of excavated material, installation of these materials, backfilling and compaction, and for all labor, equipment, tools, and all work necessary to complete the Pay Item.
- B. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
02839-01	TRAFFIC SIGN COMPLETE, 24-30	EA
02839-02	TRAFFIC SIGN COMPLETE, 30-30	EA
02839-03	TRAFFIC SIGN COMPLETE, 58-8	EA
02839-04	TRAFFIC SIGN COMPLETE, 30-30-30	EA

END OF SECTION 02839

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DELINEATORS

SECTION 02845

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Work under this section is subject to the requirements of the Contract Documents.

1.02 DESCRIPTION OF WORK

- A. This work consists of furnishing and installing flexible roadside delineator units at the locations as shown on the Plans or as directed by the Commissioner.

1.03 RELATED WORK

- A. Related Work specified elsewhere includes:
 - 1. Section P-610 – Structural Portland Cement Concrete

PART 2 PRODUCTS

2.01 FLEXIBLE DELINEATOR POSTS

- A. A two-piece round soil mount delineator post will consist of a flexible, above ground post made from durable, non-discoloring polyethylene plastic to which reflective sheeting is applied, and a drivable tubular galvanized metal anchor. The post will be tubular in shape and a minimum of two and one-quarter (2 ¼) inches in diameter. A one and three-quarter (1 ¾) inch diameter (or to fit) interior reinforcement tube will be located and secured in the lower portion of the post. The total above ground height of the post must be a minimum of forty-eight (48) inches. The post will be white and resistant to ultraviolet and infrared radiation. The post must be capable of recovering from repeated vehicle impacts. The post must insert and lock into the metal anchor without any additional fastening hardware.
- B. A band of reflective sheeting meeting Federal Highway Specification FP-92, Type III, Class 2 will be applied near the top of the post providing 360 degree visibility. The reflective sheeting will be white (silver) in color and applied in a 9 inch height beginning at 1 inch below the top of the post.

- C. Delineator posts installed along access roads to NAVAIDS will meet the above requirements except the posts will be orange.

PART 3 INSTALLATION

3.01 GENERAL

- A. Delineators will be installed in accordance with the layouts and details as shown on the Plans.
- B. All delineators installed may be installed with closed-end soil anchors.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. The quantity of delineators to be paid for will be the number of delineators installed in accordance with the Plans and Specifications and accepted by the Commissioner.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment will be made at the Contract unit price per each delineator. This price will be full compensation for furnishing all materials and for all labor, equipment, tools, and all work necessary to complete this item.
- B. Payment will be made under the following item:

ITEM NO. DESCRIPTION UOM		
02845-01	FLEXIBLE DELINEATORS	EA

END OF SECTION 02845

CONCRETE FORMS AND ACCESSORIES

SECTION 03100

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Work under this Section is subject to the requirements of the Contract Documents.
- B. Furnish and install all Concrete Forms and Accessories as shown on the Drawings and as specified herein, including but not limited to the following:
 - 1. Wood Formwork.
 - 2. Temporary Bracing.
 - 3. Metal ties and other hardware for forms.
- C. Install all items as shown on the Drawings and as specified to be furnished under other Sections, including but not limited to the following:
 - 1. Sleeves, inserts and accessories.

1.02 RELATED WORK:

- A. As specified in the following divisions:
 - 1. Section P-152 – Excavation and Embankment
 - 2. Section 03200 – Concrete Reinforcement
 - 3. Section 03300 - Cast-in-place Concrete

1.03 REFERENCES:

- A. ACI 318 “Building Code Requirements for Structural Concrete”, American Concrete Institute.
- B. ACI SP-4 “Formwork for Concrete”, American Concrete Institute.
- C. ACI 347 “Guide to Formwork for Concrete”, American Concrete Institute.

- D. Copies of the above publications must be made available by the Contractor on the job site at all times.

1.04 SUBMITTALS:

- A. Submit the following

- 1. Shop Drawings

- a. Submit schematic diagrams and placement of framing for walls, showing shoring, re-shoring, etc. with a sequential outline describing stripping times and re-shoring placements. Submit data and Drawings sealed by a licensed Structural Engineer in Illinois for record purposes only.

- 2. Samples and/or Product Data

- a. Product Data

- (1) Submit copies of Manufacturer's Specifications and installation instructions for:

- (a) Form release agent
 - (b) Proprietary forming systems
 - (c) Proprietary embedments and accessories

- b. Samples

- (1) Submit four (4) samples of each of the following materials:

- (a) Plywood for exposed and smooth surfaces (18" x 18").
 - (b) Pint of mineral formwork oil.
 - (c) Pint of form release agent.
 - (d) Form ties each type.
 - (e) Dovetails anchor slots.

- 3. Test Reports

- a. Submit test reports necessary to show compliance with the Contract Documents.

- B. Manufacturer's Certification

- 1. Submit certification that products meet or exceed the specified requirements.

1.05 QUALITY CONTROL:

- A. Contractor Qualifications: Installation of concrete forms and accessories must be performed only by a qualified installer. The term qualified means experienced in performing the Work required by this Section. The qualified installer must have documented experience on Projects similar in size and scope to this Project. The installer must submit evidence of such qualifications upon request by the Commissioner.
 - 1. Before starting any Work under this Section, the Contractor and Subcontractor's must submit to the Commissioner a list of the Projects completed. The list must indicate each Project's name, location, cost and, the name and telephone number of the contact person for the verification of any information, upon request by the Commissioner.
- B. Perform Work in accordance with the latest edition, of the appropriate divisions, of the following:
 - 1. ACI 315, Details and Detailing of Concrete Reinforcement, as published by the American Concrete Institute.
 - 2. ACI Detailing Manual, (SP-66), as published by the American Concrete Institute.
 - 3. ACI 318, Building Code Requirements for Structural Concrete, as published by the American Concrete Institute.
 - 4. AWS D1.4 Recommended Practice for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction, as published by the American Welding Society.
 - 5. CRSI, Manual of Standard Practice, as published by the Concrete Reinforcing Steel Institute.
 - 6. ACI 117, Standard Specifications for Tolerances for Concrete Construction and Materials, as published by the American Concrete institute.
 - 7. CRSI, Placing Reinforcing Bars, as published by the Concrete Reinforcing Steel institute.

1.06 DELIVERY, STORAGE, AND HANDLING:

- A. Materials must be stored in strict accordance with the Manufacturer's printed directions, copies of which must be furnished to the Commissioner.
- B. Deliver and handle materials in such a manner as to prevent damage.
 - 1. All damaged or otherwise unsuitable material, when so ascertained, must be immediately removed from the job site.
- C. Protect materials against damage from mechanical abuse, plaster, salts, acids, staining and other foreign matter by an approved means during transportation, storage and erection and until completion of construction work. All unsatisfactory materials must be removed from the premises, and all damaged materials replaced with new materials.
- D. Access and Storage Areas
 - 1. All access routes and storage areas must be subject to the approval of the Commissioner in order to reduce interference with Airport Operations.

1.07 WARRANTIES AND GUARANTEES:

- A. Not used.

1.08 SPECIAL REQUIREMENTS:

- A. Field Measurements - Before proceeding with the fabrication of the Work, the Contractor must verify all dimensions and take such measurements as are required for proper fabrication and installation of the work.
- B. Coordination - Coordinate Work of this Section with related Work specified in the other divisions/sections of the Contract Documents.

PART 2 PRODUCTS

2.01 FORMWORK MATERIAL:

- A. Wood Form Sheathing
 - 1. Finish No. 1 (Concealed Below Grade Concrete) - $\frac{3}{4}$ " exterior plywood, B-B Concrete Form Class II, PS-1-74, or 1" (nominal) wood T & G.

2. Finish No. 2 (Exposed Non-Architectural Concrete) - Same as for Finish No. 1.
 3. Finish No.3 (Smooth Concrete) - $\frac{3}{4}$ " exterior type, resin coated Plywood, High Density Concrete Form Overlay, Class 1, PS-1-74.
- B. Wood sheeting or lagging -- minimum 2" x 6" lumber.
- C. Supporting members for formwork must be the following
1. Construction grade Douglas Fir or No. 1 Southern Pine. Lumber must be straight and true and free from warps and cracks.
- D. Form Coating
1. Non-staining mineral formwork oil or form release agent.

2.02 FORM TIES - MATERIALS & ACCEPTABLE MANUFACTURERS:

- A. Snap form ties
1. Notched to assure break-back 1" behind the finished concrete surface and leaving no larger than a $\frac{1}{4}$ " to $\frac{5}{16}$ " diameter hole.
 2. Products of one of the following Manufacturers will be acceptable:
 - a. Dayton Superior Corp., Miamisburg, OH
 - b. Meadows Burke, Tampa, Florida
 - c. Williams Form Engineering Corp., Belmont, MI
 3. Holes remaining after removal of forms must be clean cut and without fractures, spalls, willows, depressions, or other surface disfigurations.
- B. Rod form ties
1. Outside stud rod (she-bolt) assembly.
 2. Products of one of the following Manufacturers will be acceptable:
 - a. Dayton Superior Corp., Miamisburg, OH
 - b. Meadows Burke, Tampa, Florida

- c. Williams Form Engineering Corp., Belmont, MI

2.03 ACCESSORIES:

- A. Sleeves, pipes, pipe supports, conduits, miscellaneous items, and other embeds to be built into forms must be provided to the Contractor by the trade involved, however certain items required by the pipe trades may be furnished and installed by those trades as hereinafter specified.

PART 3 EXECUTION

3.01 INSPECTION:

- A. Before commencing installation, examine substrate surfaces to determine that they are free of conditions which might be detrimental to proper and timely completion of the Work. Start of Work must indicate acceptance of the substrate.

3.02 FORMWORK CONSTRUCTION:

- A. Construct forms accurately to dimensions and true to line, with vertical work plumb and horizontal work properly cambered.
1. Forms must be substantial, mortar tight, braced and tied so as to maintain position and shape during placing of the reinforcing and concrete.
 2. Wavy surfaces and bulged wall or slab surfaces resulting from settlement or springing of form work will not be acceptable.
- B. Forms must be designed and constructed to facilitate easy removal without damage to exposed surfaces, and to provide smooth concrete surfaces free of off-sets.
1. Corners must be true to lines and profiled as detailed.
 2. Form joints exposed to view must be kept to a minimum and must be located symmetrically within each modular unit.
- C. Forms must be of such thickness that they must remain true to shape.
1. Use clamps, pins, and other connecting devices designed to hold the forms rigidly in place.
 2. Forms which do not present a smooth surface or line up properly must not be used.

3. Keep forms free from rust, grease, or other foreign matter which would discolor the concrete.
 4. Concrete must have smooth clean surfaces and be free of honeycombing or rough exposed aggregate areas when forms are stripped.
- D. Provide forms in sufficient quantity to permit rapid progress of the work. Clean forms after each use.
- E. Before reinforcing steel is set, wood forms must be coated with an approved non-staining form oil, or wet with water (except in freezing weather). Metal forms must be coated with an approved non-staining rust preventive form oil.
1. Stained forms must not be used.
 2. Remove oil on any reinforcement before placing concrete.
- F. After forms have been placed, see that all trades have been properly notified and are given sufficient time to complete the installation of their Work.
1. Placing of reinforcement must proceed progressively with the Work of other trades and each must arrange its working schedules so as to avoid disturbing or moving of work already installed by one trade to admit the work of another's.
 2. Each trade must be entirely responsible for the proper installation and securing of its work and each must keep its work under observation during placing of the concrete.
- G. Provide recesses and openings of the proper sizes and shapes required for the installation of work requiring openings. Furnish forms of the sizes and shapes necessary, except where sleeves are specified under other Sections of the Specifications.
- H. Provide temporary openings to facilitate cleaning and inspection immediately before depositing concrete. Thoroughly clean all forms before placing concrete.
- I. All form material is subject to Commissioner's approval before construction of forms.
1. Forms for exposed concrete may be re-used only if the surfaces have not absorbed moisture and have not splintered, warped,

discolored, stained, rusted or peeled; subject to the Commissioner's approval.

- J. Construction joints must occur at approved locations.
- K. Provide wood sheeting or lagging for below grade formwork as required.
 - 1. Drive sheeting or lagging to a sufficient depth below bottom of surface formed to anchor it securely in the soil.
- L. Forms must produce smooth, even surfaces of dense concrete, and clean sharp arises at outside corners.
- M. Observe forms and check for alignment and level as the work proceeds. Provide needed adjustment or additional bracing promptly.
- N. Place bulkheads where end of days work requires a joint in a wall, beam or slab.
 - 1. Reinforcing steel must extend through the bulkhead.
 - 2. All joints must be keyed for one half of the member thickness unless otherwise directed.
 - 3. Location of bulkheads must be as approved by the Commissioner.
- O. Where indicated on the Drawings or details, rounded or chamfered exposed corners must be formed of $\frac{1}{2}$ " radius or $\frac{3}{4}$ ", 45 degree poly vinyl chloride or neoprene extruded corner strips inserted in the forms. Splices and joints in strips must be in accordance with the Manufacturer's instructions.

3.03 TOLERANCES:

- A. Unless otherwise shown or required the allowable tolerances in formwork must conform to ACI 347.

3.04 SURVEY OF FORMWORK:

- A. The Contractor must employ a Professional Engineer or Surveyor registered in the State of Illinois to check the lines and levels of the completed formwork by instrument survey, before concrete is placed, and the Contractor must make whatever corrections or adjustments to the formwork necessary to correct deviations from the specified tolerances.

- B. Sleeves, pipe supports, conduits, miscellaneous items, and other embeds must also be surveyed for proper location, elevation, and size and then verified by the corresponding trade and the Commissioner prior to concrete placement.
- C. Concrete must not be placed until the Contractor's Quality Control (QC) organization and the Commissioner's representative have inspected and approved the layout, grade, and plumbness of the formwork in place. The Contractor must submit the survey and a written record of acceptance signed by the Contractor's QC organization, Surveyor, Foreman/Superintendent, corresponding trade(s) and the Commissioner's representative documenting that the work has been installed in accordance with the plans and specifications.
- D. Formwork must likewise be checked during placement of the concrete to ensure that the forms, shores, tie rods and clamps have not been knocked out of the established line, level and cross Section by concrete pouring methods or equipment.

3.05 FORM REMOVAL:

- A. Forms or shoring must not be removed without the Commissioner's approval.
- B. Formwork not supporting weight of concrete, such as sides of beams, columns and similar parts of the work may be removed after moist curing at not less than 50 degrees F for 24 hours after placing concrete, provided that concrete is sufficiently hard to not be damaged by form removal operations and provided that curing and protection operations are maintained.
- C. Removal of forms and shoring must be in accordance with ACI 318 and ACI 347. It is the Contractor's responsibility to submit a plan for formwork removal to the Commissioner, accounting for all loads and conditions, in accordance with ACI 318 and ACI 347. As a minimum, where not specified, formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days or until concrete has attained 100% of design minimum compressive strength at 28 days, or in accordance with the structural drawings.

3.06 ACCESSORIES:

- A. Accurately place and securely support items to build into forms.

- B. Sleeves for pipe lines and inserts for support of pipe hangers must be furnished and installed by the respective trades involved and the Contractor must be responsible for maintaining these items plumb, in alignment and in place.

3.07 SCREEDS:

- A. Set wood and metal screeds with true and straight top edges to proper elevations (approximately 8'-0" apart) for concrete slabs.

3.08 FILLING-IN

- A. Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown on the Drawings after work of other trader is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown on the Drawings or required to complete the work.

3.09 GENERAL CLEAN-UP:

- A. All rubbish and debris resulting from the Work of this Section must be collected, removed from the site and disposed of legally.
- B. All work areas must be left in a broom clean condition.

PART 4 MEASUREMENT AND PAYMENT

4.01 PAYMENT

- A. No separate payment will be made for items described in this specification. All costs for this work will be considered incidental to those items requiring the various work items delineated in this specification.

END OF SECTION 03100

CONCRETE REINFORCEMENT

SECTION 03200

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Work under this Section is subject to the requirements of the Contract Documents.
- B. Furnish and install all Concrete Reinforcement as shown on the Drawings and as specified herein, including but not limited to the following:
 - 1. Reinforcing bars, ties, spirals for beams, slabs, footings, foundations and columns, etc. as shown and designated on the Drawings.
 - 2. All necessary accessories including support bars, spacers, tie wires, support accessories, etc.
 - 3. All welded wire mesh where required and shown on the Drawings.

1.02 RELATED WORK:

- A. As specified in the following divisions:
 - 1. Section 03100 - Concrete Forms and Accessories
 - 2. Section 03300 - Cast-in-place Concrete

1.03 REFERENCES:

- A. ACI 315 "Details and Detailing of Concrete Reinforcement", American Concrete Institute.
- B. ACI 318 "Building Code Requirements for Structural Concrete", American Concrete Institute.
- C. ACI 306R "Cold Weather Concreting", American Concrete Institute.
- D. ASTM A615 "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement."

1.04 SUBMITTALS:

A. Submit the following

1. Shop Drawings

- a. Shop Drawings must be detailed in accordance with the requirements of ACI detailing manual.
 - (1) The shop drawing must include bar schedule, joint details of bars, insert locations, bending diagrams, and setting Drawings, showing all openings through slabs and walls, and welded, metallic sleeve splice and mechanical threaded connections.
 - (2) Fabrication and placing for all reinforcing steel, must conform with the "Manual of Standard Practice for Detailing Reinforced Concrete Structures" ACI 315, latest edition.

2. Samples and/or Product Data

- a. Product Data
- b.
 - (1) Current International Conference of Building Officials (ICBO) Research Report or equivalent code agency report listing findings to include acceptance, special inspection requirements, and restrictions for mechanical splices Samples
 - (1) Each type of bar supports and other accessories, two (2) each.

3. Test Reports

- a. Submit test reports necessary to show compliance with the Contract Documents.
 - (1) Tensile and bending tests on each bundles of steel. Furnish two (2) copies of the Manufacturer's certificates or mill tests of all reinforcing steel.
 - (2) Test results of field testing.

4. Manufacturer's Certification

- a. Submit certification that products meet or exceed the specified requirements.

1.05 QUALITY CONTROL:

- A. Contractor Qualifications: Installation of concrete reinforcements must be performed only by a qualified installer. The term qualified means experienced in performing the Work required by this Section. The qualified installer must have documented experience on Projects similar in size and scope to this Project. The installer must submit evidence of such qualifications upon request by the Commissioner.
- B. Perform Work in accordance with the latest edition, of the appropriate divisions, of the following:
 - 1. ACI 315, Details and Detailing of Concrete Reinforcement, as published by the American Concrete Institute, latest edition.
 - 2. ACI Detailing Manual, (SP-66), as published by the American Concrete institute, latest edition.
 - 3. ACI 318, Building Code Requirements for Structural Concrete, as published by the American Concrete Institute, latest edition.
 - 4. AWS D1.4, Recommended Practice for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction, as published by the American Welding Society, latest edition.
 - 5. CRSI, Manual of Standard Practice, as published by the Concrete Reinforcing Steel Institute, latest edition.
 - 6. ACI 117, Standard Specifications for Tolerances for Concrete Construction and Materials, as published by the American Concrete Institute, latest edition.
 - 7. CRSI, Placing Reinforcing Bars, as published by the Concrete Reinforcing Steel Institute, latest edition.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Materials must be stored in strict accordance with ACI 318, revised to date, and/or suppliers directions, copies of which must be furnished to the Commissioner.
- B. Protect materials against damage from mechanical abuse, salts, acids, and other foreign matter by an approved means during transportation, storage, and erection until completion of construction work. All unsatisfactory materials must be removed from the premises, and all damaged materials replaced with new materials.

1. Properly label all bars with weatherproof tags to facilitate identification.

C. Access and Storage Areas

1. All access routes and storage areas must be subject to the approval of the Commissioner in order to reduce interference with Airport Operations.

1.07 WARRANTIES AND GUARANTEES:

- A. Not used.

1.08 SPECIAL REQUIREMENTS:

- A. Field Measurements - Before proceeding with the fabrication on the work, the Contractor must verify all dimensions and take such measurements as are required for proper fabrication and installation of the work.
- B. Coordination - Coordinate Work of this Section with related Work specified in the other divisions/sections of the Contract Documents.

PART 2 PRODUCTS

2.01 MATERIALS:

- A. Steel Bars must be new deformed billet steel bars, complying with ASTM A 615, grade 60 typical unless noted otherwise.
- B. ASTM A706, Grade 60, for reinforcing to be welded.
- C. Welded Wire Fabric must comply with ASTM A 185 and A497.
- D. Accessories
1. Bar supports and other accessories necessary to hold bars in proper position while concrete is being placed.
 - a. Bar supports for reinforcement over vapor barrier or waterproofing must have 16 gauge flat sheet metal bases for legs.
 - b. Bar supports which come in contact with forms for concrete exposed to view in the finished exterior or interior structure must have plastic or plastic tipped legs.
 - c. Precast concrete bar supports, cementitious fiber-reinforced bar supports, or all-plastic bar supports and

side form spacers meeting requirements of CRSI Manual of Standard Practice.

- d. Tie Wire: Black, soft-annealed 16-gauge wire with nylon, epoxy or plastic-coating.

PART 3 EXECUTION

3.01 INSPECTION:

- A. Before commencing installation, examine substrate surfaces to determine that they are free of conditions which might be detrimental to proper and timely completion of the Work. Start of Work must indicate acceptance of the substrate.

3.02 INSTALLATION:

- A. Before and after being placed, reinforcement must be thoroughly cleaned of snow, ice, mud, loose rust, or mill scale that will destroy or reduce the bond.
- B. Reinforcement must be furnished in full lengths insofar as possible. Splicing of bars will not be permitted where full lengths are indicated unless approved in writing by the A/E.
- C. Vertical bars must be in single lengths, unless otherwise indicated on the Drawings.
- D. Splices must be well distributed and located at points as approved.
 - 1. Splices will not be permitted at points where the Section is not sufficient to provide a minimum distance of 2" between the splice and the nearest adjacent bar or the surface of the concrete.
- E. Spliced bars and welded wire fabric reinforcement must be lapped no less than shown in Chapter 25 of ACI 318, latest edition, unless otherwise indicated on the Drawings.
- F. Welded Splices: Accomplish by full penetration groove welds and develop a minimum of 125 percent of yield strength of bar.
- G. Mechanical Splices and Connections:
 - 1. Use only in areas specifically approved in writing by Engineer.
- H. Placing of reinforcement must conform to the Drawings.

1. It must be positioned accurately and securely against displacement with annealed iron ties of not less than 16 gauge or suitable clips at intersections.
 2. Reinforcement must be supported on metal chairs, spacers or metal hangers.
 3. Devices must be sufficiently rigid to hold reinforcement in proper position during construction operations and placing of concrete.
- I. Spacers and chairs must be spaced not to exceed 1'-0" for each 1/8" diameter of the rod, and in no case over 4'-0" on center. High chairs must be spaced not over 3'-0" on center and must be properly secured against overturning.
- J. Reinforcement in footings and other concrete near earth, not supported by ties or forms, must be supported at correct distance above the earth by means of metal wyees or by precast concrete blocks of the proper height.
1. If precast concrete blocks are used, they must be pyramid or cone shaped with base area large enough to prevent overturning and with notched top or tie wires embedded in the precast concrete blocks for receiving reinforcement.
- K. Main reinforcement must be supported at the following minimum clearances, unless otherwise shown or specified.
1. $\frac{3}{4}$ " from bottom of slabs on forms and joists and walls.
 2. 2" from top of slabs on grade.
 3. 2" from bottom of beams.
 4. 2" for No. 6 and larger, and 1-1/2" for No. 5 and smaller, from face of formed concrete walls in contact with earth or exposed to weather.
 5. 3" for all members cast against and permanently in contact with ground.
- L. Protect vapor barrier under slabs from damage or puncture during the placing of reinforcement. If damages occur, repair to the satisfaction of the Commissioner before placing concrete.

- M. Straightening and Re-bending: Field bending of reinforcing steel bars is not permitted. Unless permitted by the Engineer, do not cut reinforcing bars in field.
- N. Concrete must not be placed until the Contractor's Quality Control organization and Commissioner's representative have inspected and approved the reinforcing steel for bar size, count, spacing, lap splicing, and cleanliness. The Contractor must provide a written record of acceptance signed by the Contractor's QC organization, Surveyor, Foreman/Superintendent, corresponding trade(s) and Commissioner's representative documenting that the work has been installed in accordance with the plans and specifications.

3.03 GENERAL CLEAN-UP:

- A. All rubbish and debris resulting from the Work of this Section must be collected, removed from the site and disposed of legally.
- B. All work areas must be left in a broom clean condition.

PART 4 MEASUREMENT AND PAYMENT

4.01 PAYMENT

- A. No separate payment will be made for items described in this specification. All costs for this work will be considered incidental to those items requiring the various work items delineated in this specification.

END OF SECTION 03200

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CAST-IN-PLACE CONCRETE

SECTION 03300

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Work under this Section is subject to the requirements of the Contract Documents.
- B. Furnish and install all Cast-in-Place Concrete Work as shown on the Drawings and as specified herein, including but not limited to the following:
 - 1. All concrete work, plain and reinforced.
 - 2. Footings, foundations and foundation walls
 - 3. All supplementary pumping and dewatering as required to complete the work of this Section.
 - 4. Furnishing, placing and compacting of drainage layer under.
 - 5. Filling “box-outs” with concrete after insertion of the utility.
 - 6. Hydraulic cement in slab-to-wall joint including forming and stripping for same.
 - 7. Grouts.

1.02 RELATED WORK:

- A. As specified in the following divisions:
 - 1. Section 03100 – Concrete Forms and Accessories
 - 2. Section 03200 – Concrete Reinforcement

1.03 REFERENCES:

- A. ACI 117R “Standard Specification for Tolerances for Concrete Construction and Materials”.
- B. ACI 211.1 “Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete”, as published by The American Concrete Institute (ACI).

- C. ACI 302.1R “Guide for Concrete Floor and Slab Construction”.
- D. ACI 311R “ACI Manual of Concrete Inspection”.
- E. ACI 304R “Guide for Measuring, Mixing, Transporting and Placing Concrete”, except minimum cement content must be herein specified.
- F. ACI 211.1 “Manual of Standard Practice”.
- G. ACI 301 “Specifications for Structural Concrete for Buildings”.
- H. ACI 305R “Hot Weather Concreting”.
- I. ACI 306R “Cold Weather Concreting”.
- J. ACI 308R “Guide to Curing Concrete”.
- K. ACI 309R “Guide for Consolidation of Concrete”.
- L. ACI 315 “Details and Detailing of Concrete Reinforcement”.
- M. ACI 318 “Building Code Requirements for Structural Concrete”.
- N. ACI 347 “Guide to Formwork for Concrete”.
- O. ASTM A82 “Standard Specification for Steel Wire, Plain, for Concrete Reinforcement”.
- P. ASTM A185 “Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement”.
- Q. ASTM A497 “Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement”.
- R. ASTM A615 “Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement”.
- S. ASTM A706 “Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement”.
- T. ASTM A767 “Standard Specification for Zinc-Coated Steel Bars for Concrete Reinforcement”.
- U. ASTM A775 “Standard Specification for Epoxy-Coated Reinforcing Steel Bars”.
- V. ASTM C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.

- W. ASTM C33, Standard Specification for Concrete Aggregates.
- X. ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- Y. ASTM C 94 "Specifications for Ready Mixed Concrete".
- Z. ASTM C143, Standard Test Method for Slump of Hydraulic-Cement Concrete.
- AA. ASTM C150, Standard Specification for Portland Cement.
- BB. ASTM C172, Standard Practice for Sampling Freshly Mixed Concrete.
- CC. ASTM C173, Standard Test Method for Air Content of Freshly Mixed Concrete by Volumetric Method.
- DD. ASTM C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
- EE. ASTM C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- FF. ASTM C260, Standard Specification for Air-Entraining Admixtures for Concrete.
- GG. ASTM C309, Standard Specification for Liquid Membrane – Forming Compounds for Curing Concrete.
- HH. ASTM 311, Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete.
- II. ASTM C494, Standard Specification for Chemical Admixtures for Concrete.
- JJ. ASTM C595, Standard Specification for Blended Hydraulic Cements.
- KK. ASTM C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
- LL. ASTM C881, Standard Specification for Epoxy-Resin Bonding Systems for Concrete.
- MM. ASTM C1218, Standard Test Method for Water-Soluble Chloride in Mortar and Cement.

- NN. Unless otherwise indicated, the latest edition of the Specifications, shall govern the Work. Copies of the above publications must be made available by the Contractor on the job site at all times.
- OO. Concrete work must comply with federal, state and local building codes; including the City of Chicago Building Code.

1.04 SUBMITTALS:

A. Submit the following

1. Shop Drawings

- a. Shop Drawings must include bar lists, joint details of bars, insert locations, bending diagrams, and setting Drawings, showing all openings through slabs and walls.
- b. Fabrication and placing Drawings for all reinforcing steel, conforming with the "Manual of Standard Practice for Detailing Reinforced Concrete Structures" ACI 315.
- c. Concrete Pour Schedule.

2. Samples and/or Product Data

a. Product Data

- (1) Portland Cement
- (2) Normal Weight Aggregates
- (3) Concrete Admixtures
- (4) Bonding and Repair Materials
- (5) Patching and Surfacing Compounds
- (6) Grout Materials
- (7) Water Stops
- (8) Joint Fillers
- (9) Inserts
- (10) Curing and Sealing Compounds

b. Samples

- (1) Curing material, 1 pint or 12" x 12" sheet.
- (2) Joint filler, 12" lengths.

- (3) Perimeter insulation, 12" x 12" where required.
- (4) Surface sealer, 1 pint.
- (5) Pint of mineral formwork oil.
- (6) Pint of form release agent.
- (7) Form ties - one (1) of each type.
- (8) Bar supports and other accessories, two (2) each.

3. Tests Procedure

- a. The Contractor will employ an approved QC Testing Laboratory which will perform compressive strength tests and perform inspection in accordance with these Specifications, at no cost to the Commissioner. The Contractor must cooperate with the Testing Laboratory and Commissioner in every respect.
 - (1) One (1) set of strength tests must consist of four (4) standard cylinders of every 100 cubic yards of concrete or fraction thereof placed in any one (1) day.
 - (2) Each class of mix must be represented by not less than a set of four (4) tests regardless of concrete quantity placed at the time.
 - (3) One cylinder must be tested at 7 Days, two at 28 Days and one retained in reserve for later testing if required, in accordance with ASTM C39.
 - (4) Determine air content for air entrained concrete at least for the first two loads, the last load, every 50 cubic yards, and every time cylinder samples are taken in accordance with ASTM C173 or C231.
 - (5) Slump Tests – Test for slump at least for the first two loads, the last load, every 50 cubic yards, and every time cylinder samples are taken and as required by the Commissioner in accordance with ASTM C143. Keep a slump cone at the site at all times.
 - (6) Temperature – Test for temperature, at least the first two loads, the last load, every 50 cubic yards, and every time cylinder samples are taken in accordance with ASTM C1064.
- b. Concrete strength tests will be evaluated in accordance with ACI 214 "Recommended Practice for Evaluation of

Compression Test Rules of Field Concrete.”

Compressive strength of concrete must conform to the following criteria:

- (1) The average of any three (3) sets of consecutive strength tests of laboratory cured specimens for each class of concrete must exceed or equal the specified strength for that class and no individual strength test result must fall below the required strength by more than 500 psi.

- c. If compressive strength tests fail to meet the above minimum requirements, concrete represented by such tests must be considered questionable and must be subjected to the following further testing at the expense of the Contractor:

- (1) Core samples must be secured, prepared and tested in accordance with ASTM C42.
- (2) If the core tests specified above fail to meet strength requirements or should it be impractical to take such cores the Commissioner may order load tests which must be conducted and the results evaluated in accordance with Chapter 20 of ACI 318.
- (3) Failure of any portion of the structure to pass a load test will result in rejection of such portion and the Contractor must remove and reconstruct such condemned areas at his expense.

- d. When, in the opinion of the Commissioner, the laboratory tests are not indicative of the quality of concrete in place, additional tests of the hardened concrete may be taken. The Contractor must bear the cost of such tests.

4. Test Reports

- a. The testing laboratory must submit five (5) copies of its test cylinder reports which are to include as far as applicable the following items:
 - (1) Amount and location of the pour in structure, type of the structure, date of the pour.
 - (2) Concrete design mix number and concrete design strength.
 - (3) Proportion, type, and amount of cement.

- (4) Aggregates and admixture used.
- (5) Surface water, water added, and total water used.
- (6) Slump, air content, and temperature of heated concrete.
- (7) Capacity and condition of mixing truck.
- (8) Period of inspection and number and size of batches delivered.
- (9) Age of testing, method of curing.
- (10) Truck number, time of transit, date and supplier's name.

5. Inspection of Batch Plant Operation

- a. Required to insure that concrete delivered to the job site complies with the Specifications and design mix. The QC testing laboratory must provide this service as directed by the Commissioner.

6. Plant Inspection Reports

- a. Must be submitted in four (4) copies, and include the following items:
 - (1) Location of plant and job site location.
 - (2) Concrete design mix number and concrete design strength.
 - (3) Type, source, and amount of cement.
 - (4) Aggregates and admixture used.
 - (5) Surface water, water added, and total water used.
 - (6) Slump, air content, and temperature of heated concrete.
 - (7) Capacity and condition of batching installation.
 - (8) Condition of heating installation.
 - (9) Period of inspection and number and size of batches delivered.

7. Records and Schedules

- a. The Contractor must maintain concrete pouring schedules and records with marked Drawings indicating the time and date of placing concrete in the various Sections of the work.

- (1) Keep these Drawings on file for reference, and deliver to the Commissioner upon completion of the Work.

8. Concrete Mix Design and Control

- a. The Contractor must employ, at his expense, an independent QC testing laboratory that meets the requirements of ASTM C1077 and approved by the Commissioner, to design the mix or mixes for each type of concrete required in accordance with the Specifications and Drawings. Mix designs prepared by Concrete manufacturers must be tested and verified by the QC testing laboratory to conform with the Specifications and submitted to the Commissioner for review and acceptance.
- b. No concrete must be placed until mix designs and 28 day test results are submitted and approved.
- c. The Contractor must request mix design, or designs, in writing and furnish this testing laboratory with necessary material to prepare the mix, or mixes, a minimum of 35 days prior to placement of concrete.
- d. The adequacy of a design must be verified by tests on a minimum of 6 cylinders; 2 tested at 3 days, 2 tested at 7 days and 2 at 28 days, in accordance with ASTM C 192 and C 39 and by slump test in accordance with ASTM C 143, and by air test in accordance with ASTM C231.
- e. The testing laboratory through the Contractor must submit copies of the mix design, or designs, and test results to the Commissioner for approval before concrete is placed. If there is more than one design, each design must indicate where it is to be used.
- f. If at anytime during construction the concrete resulting from the approved mix design proves to be unsatisfactory for any reason, such as lack of workability; insufficient strength, the Contractor must immediately notify the QC testing laboratory and the Commissioner. The laboratory must verify the deficiency with additional testing and modify the design, subject to the Commissioner's approval, until a satisfactory concrete is obtained.
- g. Strength requirements of concrete must be noted on the Drawings. Concrete must be proportioned to achieve an average strength of at least 500 psi higher than design

strength shown. If no design strength is shown, the design strength must be 4,000 psi at 28 days.

- h. When an approved water reducing admixture is used in accordance with Manufacturer's recommendations, cement requirements may be reduced. Mix designs must indicate use of admixtures.
- i. Slump must be 3" plus or minus 1" for footings and foundations walls, and 3" plus or minus ½" for balance of structure. Slump for Portland Cement Concrete (PCC) pavement must be ¾" to 1-1/2"; except that a slump above 1-1/2" may be used, up to a maximum of 3", provided that the mixture's water/cement ratio does not exceed 0.42. Concrete mixes containing plasticizers must have a maximum slump of 8." The Contractor's independent QC testing laboratory and the Commissioner must have the right to reject any concrete which arrives at job site in excess of specified slump. No water must be added to design mix unless as determined in accordance with ASTM C 143 and only if calculations performed by the Contractor's QC laboratory with batch weights confirm that the design water to cement ratio is not exceeded, subject to the Commissioner's approval on a case by case basis.
- j. All concrete exposed to weather or in contact with earth or backfill, including interior slab on grade, must be air-entrained. Air-entrained concrete must be made with an air-entraining admixture. Total air content must be 6 percent (plus or minus 1 percent), determined in accordance with ASTM C231, or as indicated hereinafter under "Concrete Types" - estimate of quantities.
- k. Minimum cement content must be 535 pounds per cubic yard of concrete. The water/cement ratio must be determined on a mass (weight) basis. Select water/cement ratio on the basis of strength, workability and finishing requirements. Unless otherwise specified, the maximum water/cement ratio for normal weight concrete must be 0.45. When a maximum water/cement ratio is specified, the water must include wash water, mixing water, water in admixture, free moisture in the aggregates, and water that may be added at the jobsite. When fly ash, ground granulated blast furnace slag, or micro silica are used as part of the cement in a concrete

mix, the water/cement ratio will be based on the total cementitious material contained in the mixture.

- I. A plasticizing admixture may be used when approved by the Commissioner for the purpose of reducing water requirements for a given consistency and strength of concrete and for increasing workability. Mixture must be used in accordance with Manufacturer's recommendations.

9. Manufacturer's Certification

- a. Submit certification that products meet or exceed the specified requirements.

1.05 QUALITY CONTROL:

- A. Contractor Qualifications: Installation of cast-in-place concrete work must be performed only by a qualified installer. The term qualified means experienced in performing the Work required by this Section. The qualified installer must have a minimum of five (5) years documented experience on Projects similar in size and scope to this Project. The installer must submit evidence of such qualifications upon request by the Commissioner.
- B. Perform Work in accordance with the latest edition, of the appropriate divisions, of the following:
 1. ACI 315, Details and Detailing of Concrete Reinforcement, as published by the American Concrete Institute, current edition.
 2. ACI Detailing Manual, (SP-66), as published by the American Concrete Institute, current edition.
 3. ACI 318, Building Code Requirements for Structural Concrete, as published by the American Concrete Institute, current edition.
 4. AWS D1.4, Recommended Practice for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction, as published by the American Welding Society, current edition.
 5. CRSI, Manual of Standard Practice, as published by the Concrete Reinforcing Steel Institute, current edition.

6. ACI 117R, Standard Specification for Tolerances for Concrete Construction and Materials, as published by the American Concrete institute, current edition.
 7. CRSI, Placing Reinforcing Bars, as published by the Concrete Reinforcing Steel Institute, current edition.
 8. ACT 305R Hot Weather Concreting, as published by the American Concrete Institute, current edition.
 9. ACI 306R Cold Weather Concreting, as published by the American Concrete Institute, current edition.
- C. Perform work in accordance with Section Q-100 Quality Control Program.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Materials must be stored in strict accordance with the Manufacturer's printed directions, copies of which must be furnished to the Commissioner.
- B. Protect materials against damage from mechanical abuse, plaster, salts, acids, and other foreign matter by an approved means during transportation, storage and erection and until completion of construction work. All unsatisfactory materials must be removed from the premises, and all damaged materials replaced with new materials.
 1. Protect materials against damage from mechanical abuse, salts, acids, and other foreign matter by an approved means during transportation, storage and erection and until completion of construction work. All unsatisfactory materials must be removed from the premises, and all damaged materials replaced with new materials.
 2. Properly label all bars with weatherproof tags to facilitate identification.
- C. Access and Storage Areas
 1. All access routes and storage areas must be subject to the approval of the Commissioner in order to reduce interference with Airport Operations.

1.07 WARRANTIES AND GUARANTEES:

- A. The Contractor shall repair or replace defective materials and workmanship during the Contract Period and for one (1) year from the date of Substantial Completion of the Project. Any equipment, materials, and workmanship repaired or replaced shall have the warranty period extended for a period of one (1) additional year from the date of repairs and/or replacements.
- B. Refer to Part Two of Three, General Conditions for additional requirements.

1.08 ENVIRONMENTAL REQUIREMENTS:

- A. When cold weather conditions as defined in ACI 306R exist, place and cure concrete in accordance with requirements of same.
- B. When hot weather conditions as defined in ACI 305R exist, place and cure concrete in accordance with same.
- C. The Contractor must submit detailed procedures for production, transportation, placement, protection, curing, testing and temperature monitoring of concrete during hot or cold weather. The Hot or Cold Weather Concreting Plan must include procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

1.09 SPECIAL REQUIREMENTS:

- A. Field Measurements - Before proceeding with the fabrication of the work, the Contractor must verify all dimensions and take such measurements as are required for proper fabrication and installation of the work.
- B. Coordination - Coordinate Work of this Section with related Work specified in the other divisions/sections of the Contract Documents.

PART 2 PRODUCTS

2.01 PERFORMANCE CRITERIA:

- A. General
 - 1. Regular concrete work must consist of Portland cement, fine aggregate, coarse aggregate, plasticizing admixture, and water. Other types of concrete must vary the cement, aggregates, and admixtures as required to produce the desired features. Concrete must be proportioned, mixed, placed, cured, and

finished as hereinafter specified. Each material for the entire job must come from the same source. The following types of concrete must be used where indicated on the Drawings or specified:

- a. Regular Concrete.
- b. Air entrained concrete.
- c. Lean concrete.

B. Admixtures

- 1. Used in concrete must be produced by reputable manufacturers and used in accordance with the Manufacturer's printed directions, subject to approval of the Commissioner.

C. Portland Cement

- 1. ASTM C 150, Type I normal Portland cement; or Type III (High-early strength cement) as approved by the Commissioner.

D. Aggregate for Normal Weight Concrete

- 1. All fine and coarse aggregate must conform to ASTM C 33.
- 2. Fine Aggregates - Natural or artificial, hard clean sand.
- 3. Coarse Aggregates - Crushed stone or gravel, except blast furnace slag will not be accepted. Aggregate sizes must meet the following:
 - a. Size 57, for footings foundations, walls, beams, slabs on fill and reinforced slabs 6" or greater thickness.
 - b. Size 7, for applied toppings.
 - c. Size 67, for other concrete, unless otherwise specified.

E. Water

- 1. Must be clean, fresh, potable.

F. Admixtures

- 1. Concrete admixtures must comply with ASTM C 494 (Water reducing) or ASTM C 260 (Air Entraining), produced by recognized Manufacturers subject to Commissioner's approval.
- 2. Air Entraining Admixture

- a. ASTM C 260, Add only to normal Portland cement concrete to meet requirements specified for air content.
 - b. Products of one of the following Manufacturers will be acceptable:
 - (1) "Air Mix", (The Euclid Chemical Company, Cleveland, OH 44110.)
 - (2) "MasterAir VR 10", (Master Builders, Inc., Downers Grove, IL 60515.)
 - (3) "Darex or Daravair", (W.R. Grace & Co., Bedford Park, IL 60638.)
 - (4) "Sika AER", (Sika Corp., Lynhurst, NJ 07071.)
3. Water Reducing Admixture
- a. ASTM C 494, Type A, and not containing any; chloride ions added during manufacture.
 - b. Products of one of the following Manufacturers will be acceptable:
 - (1) "Eucon WR-75", (The Euclid Chemical Company, Cleveland, OH 44110.)
 - (2) "Pozzolith" 122N, (Master Builders, Inc., Downers Grove, IL 60515.)
 - (3) "WRDA with Hycol", (W.R. Grace & Co., Bedford Park, IL 60638.)
 - (4) "Plastocrete 161", (Sika Corp., Lynhurst, NJ 07071.)
4. Water Reducing, Retarding Admixture
- a. ASTM C 494, Type D. When high temperatures, placing or humidity conditions dictate
 - b. Products of one of the following Manufacturers will be acceptable:
 - (1) "Eucon Retarder-75", (The Euclid Chemical Company, Cleveland, OH 44110.)
 - (2) "Pozzolith 100-XR", (Master Builders, Inc., Downers Grove, IL 60515.)
 - (3) "Daratard 17", (W.R. Grace & Co., Bedford Park, IL 60638.)
 - (4) "Plastiment", (Sika Corp., Lynhurst, NJ 07071.)

5. Water Reducing, Accelerating Admixture
 - a. ASTM C 494, Types C or E. When increased initial set is required without corrosive effect on metals.
 - b. Products of one of the following Manufacturers will be acceptable:
 - (1) "Accelguard", (The Euclid Chemical Company, Cleveland, OH 44110.)
 - (2) "Pozzolith 122-HE", (Master Builders, Inc., Downers Grove, IL 60515.)
 - (3) "Daracel M", (W.R. Grace & Co., Bedford Park, IL 60638.)
6. Plasticizing Admixture
 - a. Products of one of the following Manufacturers will be acceptable:
 - (1) "Pozzolith-N or Polyheed N or Rheomac VMA", (Master Builders, Inc., Downers Grove, IL 60515.)
 - (2) "WRDA", (W.R. Grace & Co., Bedford Park, IL 60638.)
 - (3) "Sikament or Sikacrete", (Sika Corp., Lynhurst, NJ 07071.)
 - b. When ambient temperature is expected to exceed 80 degrees F during placing and finishing operations.
 - (1) Products of one of the following Manufacturers will be acceptable:
 - (a) "Pozzolith - R", (Master Builders, Inc., Downers Grove, IL 60515.)
 - (b) "Daratard", (W.R. Grace & Co., Bedford Park, IL 60638.)
 - (c) "Plastol 6200EXT", (Euclid Chemical).
7. Fly Ash
 - a. ASTM C-618, used in accordance with industries recommendations as plasticizing agent.
8. Calcium chloride must not be used.

G. Bonding Agent

1. Products of one of the following Manufacturers will be acceptable:
 - a. Epoxy type, 100% solids
 - (1) "Euco Epoxy #452 (dry surface), #463" (dry or damp surface), The Euclid Chemical Company, Cleveland, OH 44110.
 - (2) "Sikadur Hi-Mod" (dry or damp surface), Sika Corp., Lynhurst, NJ 07071.
 - (3) "Duralbond 102" (dry or damp surface), Dural International Corp.

H. Patching and Surfacing Compound

1. Products of one of the following Manufacturers will be acceptable:
 - a. Epoxy type, 100 % solids
 - (1) "Euco Epoxy #456 Mortar (dry surface), #460 (dry or damp surface)", (The Euclid Chemical Company, Cleveland, OH 44110.)
 - (2) "Sikadur Lo-Mod Mortar", (dry or damp surface), Sika Corp., Lynhurst, NJ 07071.
 - (3) "Duraltex" (dry or damp surface), (Dural International Corp.).

I. Waterstops

1. Products of one of the following Manufacturers will be acceptable:
 - a. "Durajoint", (W.R. Grace & Co., Bedford Park, IL 60638.)
 - b. "Sealtight Waterstops", (W.R. Grace & Co., Bedford Park, IL 60638.)
 - c. "Greenstreak Waterstops", (Sika Corp., Lynhurst, NJ 07071.)
2. Products of type numbers as called for on the Drawings.

J. Curing Materials

1. Absorptive Cover

- a. Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with ASSHO M 182, Class 3 or cotton mats complying with ASTM C 440.
- 2. Moisture-Retaining Cover
 - a. Provide one (1) of the following:
 - (1) Waterproof Paper - ASTM C 171, Type 1 or Type 11.
 - (2) Polyethylene Sheeting - AASHO M 171.
 - (3) Polyethylene-coated burlap.
- 3. Liquid Membrane Curing Compound
 - a. ASTM C 309, Type 1, resin type, clear, unless otherwise directed, for vertical and horizontal surfaces guaranteed not to affect the bond of applied finished.
 - b. Products of one of the following Manufacturers will be acceptable:
 - (1) "Horn Clear-Seal" - W.R. Grace & Co., Bedford Park, IL 60638.
 - (2) "Acri Seal S" - Toch Brothers Division, Carboline Company, St. Louis MO 63144;
 - (3) "Kure-N-Seal" - Sonneborn-Contech Shakopee, MN 55379.

2.01 CONCRETE TYPES AND USES:

- A. Minimum cement content as indicated below. Should tests indicate greater cement content is required, such must be used at no additional cost to the City. Use Type 1 unless otherwise specified.
- B. Plasticizing admixture must be used in all concrete, except lean concrete.

2.02 MIXING CONCRETE:

- A. Concrete mixing, measuring and delivery equipment must be certified by the National Ready Mix Concrete Association. Methods must be subject to Commissioner's approval and in accordance with ACI 614, and 304.

1. Ready-Mixed Concrete

- a. ASTM C 94, and as herein specified. Concrete for this Project must be ready-mix concrete and must be batched and delivered from a plant approved by the and in strict accordance with the requirements set forth in ASTM C 94, subject to all provisions specified herein regarding materials, strength, proportioning, consistency and delivery time.
 - (1) Additional amounts of water to the batch, either at the plant or at the jobsite, will not be permitted, except upon specific approval of the Commissioner in each instance and only if calculations performed by the Contractor's QC laboratory with batch weights confirm that the design water to cement ratio is not exceeded, subject to Commissioner approval on a case by case basis.
- 2. The rate of delivery of the ready mixed concrete must be such that the interval between placing of successive batches must be 30 minutes or less to prevent "cold joints." The elapsed time between the introduction of mixing water to the cement and aggregate and completion of discharge must not exceed one (1) hour.
 - a. Minimum mixing for each batch must be that required to produce a uniform mixture of materials but in no case less than 70 revolutions after all materials are in the mixer, including water.
 - b. The ready-mixed concrete producer must submit duplicate delivery tickets, one (1) for the Contractor and one (1) for the Commissioner, with each load of concrete delivered to the job. Delivery tickets must provide the following information:
 - (1) Date
 - (2) Name of ready-mix concrete plant
 - (3) Contractor
 - (4) Job Location
 - (5) Type (Standard or High Early Strength) and brand of cement.
 - (6) Cement content in bags per cubic yard of concrete.
 - (7) Truck number.

- (8) Time dispatched and time unloaded.
- (9) Amount of concrete in load in cubic yards.
- (10) Admixtures in concrete, if any.
- (11) Type and maximum size of aggregate.
- (12) Water added at job, if any.
- (13) Name of person who authorized addition of water.
- c. Close control of mixing time must be maintained for air entrained concrete.
- d. The testing laboratory engaged by the Contractor must periodically check batch proportions and yield strength, and must have continuous access to the mixer.

PART 3 EXECUTION

3.01 INSPECTION AND PREPARATION:

- A. Before commencing installation, examine substrate surfaces to determine that they are free of conditions which might be detrimental to proper and timely completion of the Work. Remove hardened concrete, debris and other foreign materials from the interior of forms and from the inside of the mixing and conveying equipment. Start of Work must indicate acceptance of the substrate.
- B. Concrete must not be placed until all reinforcement is securely and properly fastened in its correct position; all anchors, sleeves, inserts, pipes, conduits, and other items required to be embedded therein have been inspected and approved by the Commissioner.
- C. Conduit and piping embedded in concrete must be located by the trades concerned, between the bottom and top reinforcement. Where crossovers are necessary, they must not displace reinforcement from its required position.
 - 1. Conduit and piping parallel to reinforcing steel must not be supported by or tied directly to the steel.
 - 2. It must be supported on bar chairs or support bars provided solely for that purpose.
- D. Discontinue concrete operations when the air temperature reaches 40 degrees F, and is descending, and do not resume until the air temperature is 35 degrees F, and ascending, except when written approval of the Commissioner is obtained.

- E. Accelerating or antifreeze admixtures must not be used. The Contractor is responsible for the protection of finished concrete against all damage or injury, including freezing until the work has been completed and accepted.
- F. For slabs on grade, do all final grading, compacting, trimming as required to prepare the finished sub-base. Building up of sub-base under forms after they are in place will not be permitted. In no case must concrete be placed upon frozen subgrade material.
- G. All concrete work which does not conform to the requirements of the Contract Documents, including strength, tolerances and finishing, must be corrected as directed by the Commissioner at the Contractor's expense, without extension of time therefore. The Contractor must also be responsible for the cost of corrections to any other part of the work affected by or resulting from corrections to the concrete work.

3.02 WATERSTOPS:

- A. Provide waterstops for construction joints where indicated on the Drawings. Waterstops, corner pieces, and method of sealing splices must be subject to approval of the Commissioner.
- B. Waterstops of special shape must be provided as shown on the Drawings. Minimum thickness of material must be 3/16".

3.03 MUD SLAB:

- A. Where shown or noted on the Drawings, concrete for below grade floor slabs or footings must be placed on concrete mud slabs. Such slabs must be 2000 psi in accordance with the article entitled "Concrete Types." Mud slabs must be placed according to the dimensions shown on the Drawings and must be acceptable for proper placing of waterproof membrane and reinforcing steel.
- B. Floor slabs that will not be waterproofed, and any other structure so indicated on the Drawings, may be placed directly on an approved subgrade.

3.04 CONSTRUCTION JOINTS:

- A. Construction joints must be as approved by the Commissioner with keyed joint in foundation walls and near the center of span of reinforced slabs, beams, joists, and girders, unless otherwise shown. Create additional construction joints only with approval of the Commissioner.

- B. To secure full bond at construction joints, all surfaces of concrete already placed must be thoroughly cleaned of all foreign materials and laitance, roughened with tools such as chipping hammers or wire brushes to a minimum amplitude of ¼ inch, and re-cleaned by stream of high pressure water or compressed air, then apply approved bonding agent in accordance with manufacture's recommendation and Paragraph 2.01.G.

3.05 GROUTING WORK:

- A. Mix and place pre-mixed grout in accordance with the printed instructions of the grout Manufacturer.

3.06 PLACING CONCRETE - GENERAL:

- A. When more than single strength concrete is required, the location of each concrete type must be as shown.
- B. Provide adequate runways, chutes, and other means of conveying concrete into place. Use chutes or tremies for placing concrete where a drop of more than 5'-0" is required.
- C. The concrete must be mixed only in quantities required for immediate use. Concrete must not be mixed while the temperature is below 40 degrees F without permission of the Commissioner. If permission is granted for mixing under such conditions, aggregates or water, or both, must be heated and the concrete must be placed at a temperature not less than 50 degrees F nor more than 90 degrees F. The Contractor must be held responsible for any defective work, resulting from freezing or injury in any manner during placing and curing, and must replace such work at his or her expense.
- D. If concrete is placed where the weather is such that the temperature of the concrete could exceed 90 degrees F, the Contractor must employ effective means such as pre-cooling of aggregates or using ice as necessary to maintain the temperature of concrete below 90 degrees F as it is placed.
- E. Do not place concrete until base is acceptable, reinforcement is securely and properly fastened in its correct position, and accessories and other items required to be embedded there in have been placed and anchored. Inspect reinforcement for secure fastening and accurate position.
- F. Methods of placing concrete, such as pumping or by conveyors, must be subject to review by the Commissioner. The Commissioner may

require additional post mechanical conveyance testing to ensure that the air entrainment and slump remain in conformance with these specifications.

- G. Use short troughs or pipes aids in placing concrete and arrange in such a manner that the ingredients of the concrete are not separated.
- H. Dropping the concrete a distance of more than 5'0" or depositing a larger quantity at any point and running or working it along the forms will not be permitted.
- I. Mix and place concrete exposed in the finish work to procure smooth, even surfaces of dense concrete, and clean sharp arrises and outside corners.
- J. Place concrete so that the pressure caused by the wet concrete must not exceed those used in the design of the forms.
- K. Do not place concrete for floor slabs, beams, or footings on wet, muddy, or frozen sub-grades or in ponded water. Concrete deposited under water must be carefully placed in a compact mass in its final position by means of a tremie, a closed bottom dump bucket, or other approved method and must not be disturbed after being deposited.
- L. Before placing slabs or other heavy fill over freshly placed foundation walls, piers or other filled forms, allow at least 24 hours for shrinkage and settlement.
- M. Use special care to prevent splashing concrete on forms and reinforcement, and remove any hardened deposits before covering with fresh concrete.
- N. Place concrete continuously between construction joints. When necessary, because of an emergency only, to place less than a complete horizontal layer in one (1) operation, terminate the pour with a keyed vertical joint.
- O. In any given lift, place and compact each lift before the preceding one (1) has taken its initial set. Lines of separation between the lifts, or between layers will not be acceptable. Deposit and compact the concrete so that exposed surfaces will be smooth and of uniform texture.
- P. Place concrete with the aid of internal mechanical vibrator equipment capable of 9,000 or more impulses per minute. Vibration must be transmitted directly to the concrete. The duration of vibration at any

location must be the minimum necessary to produce thorough compaction. Concrete consolidation must be performed in accordance with ACI 309R.

- Q. Place concrete flat work in layers 12" to 18" deep and in walls and large volumes in layers not over 24" deep. Vibrate into place in a manner that will not cause the ingredients to separate. Where necessary, supplement vibrators by hand spading to secure these results. Keep vibrators constantly in motion and do not hold in one location. Long enough to draw a pool of grout or water from the concrete. Maintain spare equipment to avoid breakdown.
- R. Place concrete immediately after mixing, and in no case more than 60 minutes after initial mixing. Review article "Mixing Concrete" under Part 2 "Products" for plant, mixing, batching and etc. for "Ready-Mix Concrete"
- S. Roughen, clean, and moisten construction joints before placing concrete. Apply bonding compound and place new concrete after bonding compound becomes tacky.
- T. The area to be placed must not exceed 60 ft. in any horizontal direction, nor exceed an area of 2,000 sq. ft. Minimum of 24 hours must elapse between the placing of adjacent units. Provide construction joints between units in accordance with the typical details shown.
- U. If early breaks are required for stripping forms, backfilling, or the convenience of the Contractor, additional cylinders must be made by the Contractor's QC organization and tested by the Contractor's approved QC laboratory, subject to verification by the approved laboratory working under supervision of the Commissioner.

Forms or shoring must not be removed without the Commissioner's approval.

1. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work may be removed after moist curing at not less than 50 degrees F for 24 hours after placing concrete, provided that concrete is sufficiently hard to not be damaged by form removal operations and provided that curing and protection operations are maintained.
2. Removal of forms and shoring must be in accordance with ACI 318 and ACI 347. It is the Contractor's responsibility to submit

a plan for formwork removal to the Commissioner, accounting for all loads and conditions, in accordance with ACI 318 and ACI 347. As a minimum, where not specified, formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days or until concrete has attained 100% of design minimum compressive strength at 28 days, or in accordance with structural drawings.

- V. Concrete structures must not be backfilled before 7 days or until 75% of design strength is achieved.

3.07 PLACING FOOTING AND FOUNDATIONS:

- A. Bottoms of excavations must be properly leveled off before placing concrete. Footing and foundations must be of sizes and shapes as shown on the Drawings.
 - 1. Place concrete as soon as possible after excavations have been completed and as a continuous pour unless otherwise directed.
 - 2. Where different levels are indicated for wall footings, the footings must be stepped as shown on the Drawings.
 - 3. Form vertical construction joints in footings in approved locations.

3.08 PLACING CONCRETE WALLS:

- A. Remove keying strips from tops of footings and scrub top surfaces of footings clean before forms are erected.
- B. Place concrete for foundations walls, enclosing walls, and other walls shown to be of concrete to dimensions shown or marked. Finish true and level on top for reception of floors, walls, beams, slabs, and other elements.

3.09 PLACING CONCRETE FLOORS:

- A. Floor slabs must be level, plane surfaces, unless otherwise indicated on the Drawings. Surface must be pitched to drains as required.
 - 1. All top of slab elevations must be determined by the use of preset runners supported by adjustable chairs set at the proper elevation.

- a. The Commissioner's Representative must have the right to obtain check readings, by use of a surveyors level, to verify the elevations of the runners and the supporting formwork.
 - b. The Contractor is to organize the work such that these readings may be obtained, before beginning concrete placement, and not cause any delay in the work.
- 2. Concrete for all slabs must be placed continuously between construction joints; consolidated by vibration or other suitable means; brought to the correct level with a straight edge and struck off.
 - a. Use bull floats or darbies to force the coarse aggregate down and as required to produce a smooth surface, free from humps and hollows.
- 3. All slabs must be power-floated and must also be hand-floated as specified for certain finishes.
 - a. Power-floating must begin when the water sheen has disappeared, and/or the mix has stiffened sufficiently that the weight of a man standing on it leaves only a slight imprint on the surface.
 - b. Face to the desired state, the concrete must be allowed to stiffen or become harden before beginning the second floating operation.
- 4. Additional finishing, including brooming, brushing and steel troweling; must be as specified herein.
- 5. When steel trowel finish is specified both power and hand troweling must be required.
 - a. Power troweling must begin as soon as little or no cement paste clings to the blades.
 - b. Troweling must be continued until the surface is dense, smooth, and free of all minor blemishes such as trowel marks.
- B. The maximum variation in surface tolerance for troweled finishes "B" and "D" must be 1/8" in 10'-0". If variations greater than this exist, the Commissioner may direct the Contractor to grind the surfaces to bring them within the requirements. Patching of low spots will not be permitted. Grinding must be done as soon as possible, preferably

within three (3) Days, but not until the concrete is sufficiently strong to prevent dislodging coarse aggregate particles.

1. Sprinkling of dry cement or a mixture of dry cement and sand on the surface of the fresh concrete to absorb water or to stiffen the mix will not be permitted.

Place floors perfectly true, except pitched where indicated, and at the correct levels for receiving finished floor materials. Fill in and finish around pipe sleeves which have been set to receive mechanical and electrical work.

3.10 CONCRETE FINISHES - FORMED SURFACES:

A. General

1. Remove form and form-tie-ins.
2. Perform all patching as hereinafter specified, and patch formed surfaces exposed to view as hereinafter specified under paragraph 3.11, "Patching of Formed Concrete."

B. Immediately after removing forms, inspect concrete surfaces.

1. Concrete work not formed as shown on the Drawings, or which for any reason is out of alignment or level or shows defective surfaces, must be removed unless the Commissioner grants permission to patch a defective area.
 - a. Permission to patch any special area must not be considered a waiver of the Commissioner's right to require complete removal of the defective work if the patching is not satisfactory.
2. Patching must be done before the concrete is thoroughly dry.
3. Mix patching mortar of the same materials and of the same proportions as used for the concrete, except that the coarse aggregate will be omitted.
 - a. When normal gray cement was used in the concrete, substitute light cement for the gray cement to match color of surrounding concrete.
 - b. For white concrete areas use white cement.
 - c. Dampen the dry mix and allow to stand for a period of one (1) hour during which time mix with a trowel to prevent setting.

4. Compact the mortar into place and screed off so as to leave the patch slightly higher than the surrounding surface.
 - a. Do not disturb for a period of one (1) to two (2) hours to permit initial shrinkage before final finishing.
 - b. Finish patches in such a manner and texture as to match the adjoining surface.
5. After removal of forms withdraw tie rods or break off form ties, wet the resulting holes, and fill solidly with mortar.
 - a. For holes passing entirely through the wall, use a plunger type grout gun to force the mortar through the wall starting at the back face.
 - b. Hold a piece of burlap or canvas over the hole on the outside and when the hole is completely filled, strike off the excess mortar with a cloth flush with the surface.
 - c. Fill holes not passing entirely through the wall with a small tool that will permit packing the hole solid with mortar.
 - (1) Strike off excess mortar flush with the surface of the wall using a cloth.
 - (2) In exposed face of mortar embed aggregate similar to that on adjacent surface.

C. Finish No. 1 (Concealed Below Grade Concrete)

1. Patch all form tie holes, aggregate pockets, honeycomb and defective areas as required with 1.2 Portland cement-sand mortar.

D. Finish No. 2 (Exposed Non-Architectural Concrete)

1. Same as Finish No. 1, except fins and ridges must also be removed.

3.11 PATCHING OF FORMED CONCRETE:

- A. Concrete patching, when necessary to obtain the required profiles, lines or levels, must be subject to the Commissioner's approval and must utilize the specified Bonding agents or Patching and Surfacing Compound.

- B. Prior to application of bonding agent, or patching and surfacing compound, remove all dust, dirt, grease, oil, wax or loose material from surfaces to be repaired.
- C. Build-up patching to match appearance of surrounding exposed concrete surfaces. Apply Bonding Agent to honey-combed areas, aggregate pockets or other voids and fill with mortar composed of Portland cement and selected aggregate of type and mixture as required to match existing concrete and finish to match existing surfaces. Cure new patches as required to prevent cracks.
- D. Patching and surfacing compound may be used for thin patches which are not exposed or are not required to match the color, texture, and finish of surrounding concrete surfaces.

3.12 CONCRETE FINISHED-FLOORS:

- A. Finish "A" (To receive Concrete Topping or Conventional Setting Beds)
 - 1. Not used.
- B. Finish "B" (For "Thin-Set" Setting Beds to Receive Ceramic Tile, Quarry Tile, etc.)
 - 1. Not used.
- C. Finish "C" (for Roofing or Membrane Waterproofing)
 - 1. Not used.
- D. Finish "D" (For Exposed Concrete Floors)
 - 1. Concrete finish floor surfaces, which are to remain exposed, receive resilient flooring, carpeting, hardener, or sealer must be finished with a steel trowel.
 - a. Final hand troweling must be used to remove slight imperfections left by the troweling machine and to bring the surface to a dense, smooth polished final finish.
Final hand troweling must be continued until a ringing sound is heard as the trowel passes over the surface.
- E. Joints
 - 1. Construction joints must be located as shown on Drawings or as limited by maximum single placement of 2,000 square feet of slab area. Provide all joint fillers required for poured concrete.

3.13 CURING AND PROTECTION:

- A. Protect freshly placed concrete from defacement, premature drying and excessive cold or hot temperature, and maintain without drying at a relatively constant temperature for a period of time necessary for hydration of cement and proper hardening.
- B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing.
- C. Cure concrete in accordance with ACI 308R "Guide to Curing Concrete".
- D. Begin final curing procedures immediately following initial curing and before concrete has dried. Provide continuous moist curing above 50 degrees F for at least 7 days, regardless of ambient air temperatures. Demonstrate to the Commissioner that temperature is maintained by means of a high-low or recording thermometer. Continue final curing for at least 168 hours.
- E. Concrete must be cured by one of the following methods or by combinations thereof, as approved:
 - 1. Moisture Curing
 - a. Cover concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet.
 - b. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.
 - c. At the Contractor's option, moisture curing may also be provided by ponding or continuous water spraying, where approved by the Commissioner.
 - 2. Moisture Retaining Cover Curing
 - a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive.
 - b. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - 3. Membrane Curing

- a. Apply membrane forming curing compound to damp concrete surfaces as soon as water film has disappeared and surface is hard enough to carry applicator's weight without damage.
 - b. Apply uniformly in two (2) coat continuous operation by power-spray equipment in accordance with manufacturer's directions.
 - c. Maintain continuity of coating and repair all damage during curing period.
 - d. Do not use on slabs to receive "hardener" and for "dust tight" finishes.
- F. Membrane curing is the preferred method for all exterior flatwork.
- 1. Apply membrane-forming curing compound to damp concrete surfaces as soon as water film has disappeared and surface is hard enough to carry applicator's weight without damage.
 - 2. Apply uniformly in two (2) coat continuous operation by power-spray equipment in accordance with Manufacturer's directions.
 - 3. Maintain continuity of coating and repair all damage during curing period.
- G. Cure formed concrete surfaces by moist curing until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- H. Exposed finished floors subject to rough construction usage must be adequately protected by cross sisal fiber reinforced waterproof paper, boards, or other approved means. This protection must be maintained in good condition until removal is approved by the Commissioner.

PART 4 MEASUREMENT AND PAYMENT

4.01 PAYMENT

- A. No separate payment will be made for items described in this specification. All costs for this work will be considered incidental to those items requiring the various work items delineated in this specification.

END OF SECTION 03300

PREFABRICATED MODULAR CONTROL BOOTHS

SECTION 13128

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes furnishing and installing prefabricated steel control booths such as guard booths, complete with concrete foundation (island), crash block, manual guard booth swing gate, guard booth traffic signal, and other appurtenances shown on the Drawings.
- B. Toilet facility fixtures, piping, and accessories as indicated on the Drawings and specified herein must be included with the prefabricated control booth.
- C. Conduits for power, data/video communication, and wiring as indicated on the Drawings and as specified herein.
- D. Signage mounting brackets for signs mounted to top and side of control booths.
- E. Booths will be furnished complete with factory installation and wiring of all electrical and HVAC equipment as specified herein and called for on the Contract Drawings.

1.02 RELATED DOCUMENTS

- A. Related Sections include the following:
 - 1. Section 03300 – Cast-in-Place Concrete
 - 2. Division 2 Site work
 - 3. Division 15 Sections for mechanical and plumbing requirements
 - 4. Division 16 Sections for electrical requirements

1.03 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide controls booths capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Wind Loads: Determine loads based on the following minimum design wind pressures:
 - a. Uniform pressure of 30 lbf/sq. ft., acting inward or

outward.

- B. Thermal Movements: Provide control booths that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- C. Bullet Resisting Construction: Exterior wall panels, door and glazing are to meet U. L. Level III standards for bullet resisting construction requirements.

1.04 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control booths.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Submit drawings showing location of all underground connections for coordination with field conduit and piping.
- C. Maintenance Data: For control booths to include in maintenance manuals.
- D. Warranties: Special warranties specified in this Section.

1.05 QUALITY CONTROL

- A. Not used.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to

adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not modify intended aesthetic effects, as judged solely by the Commissioner, except with Commissioner's approval. If modifications are proposed, submit comprehensive explanatory data to Commissioner for review.
- C. Welding: Qualify procedures and personnel according to the following:
 1. AWS D1.1, "Structural Welding Code – Steel"
 2. AWS D1.3, "Structural Welding Code – Sheet Steel."
- D. Regulatory Requirements: Where control booths are indicated to comply with accessibility requirements, comply with FED-STD-795, "Uniform Federal Accessibility Standards."
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. All electrical materials and methods must meet the requirements of Division 16 of these specifications and all local governing codes.
- F. Safety Glass: All glazing must meet U. L. Bullet Resistance Level III standards as shown on the drawings.
 1. Subject to compliance with requirements, permanently mark safety glass with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.
- G. Codes: The installed booth including all Mechanical, Electrical, and Plumbing work and equipments will meet or exceed the requirements of the Chicago Building codes, Ordinances and Safety Requirements.

1.06 COORDINATION

- A. Coordinate installation of anchorages for control booths. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete. Deliver such items to Project site in time for installation.

1.07 WARRANTY

- A. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace wall panels that

show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.02 MATERIALS

- A. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:
 1. Sheet: ASTM B 209
 2. Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T4 or 6061-T6.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
- C. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, commercial quality, G90 coating designation; mill phosphatized.
- D. Galvanized, Rolled Steel Tread Plate: ASTM A 786/A 786M, rolled from steel plate complying with ASTM A 572/A 572M, Grade 55; hot-dip galvanized according to ASTM A 123/A 123M.
- E. Steel Structural Tubing: ASTM A 500, Grade B, hot-dip galvanized according to ASTM A 123/A 123M.
- F. Stainless-Steel Sheet: ASTM A 666, Type 316.
- G. Plastic Laminate: NEMA LD 3, HGS or HGL grade.
- H. Plywood: DOC PS 1, Exterior grade.
- I. Particleboard: ANSI A208.1, Grade M-2.
- J. Safety Glass: All exterior glazing to be bullet resisting laminated glass, safety glazing, and must meet U. L. Bullet Resistance Level III

standards. All exterior glazing must be applied with a tinted sun glare control film that rejects 75% infrared light and ultra-violet rays.

- K. Anchorages: Provide factory installed stainless steel angles for anchoring control booths. Contractor to provide and install stainless steel expansion anchors.

2.03 PREFABRICATED CONTROL BOOTHS, GENERAL

- A. General: Provide a complete, integrated set of manufacturer's standard, mutually dependent components that form a completely assembled, prefabricated control booth, ready for installation on Project site. Control booths must be capable of withstanding structural and other loads indicated, thermally induced movement, and exposure to weather without failure or infiltration of water into booth interior. Include structural framing, roof and wall panels, door(s), windows, signage mounting brackets and all accessories complying with requirements indicated.
 - 1. Building Style: As indicated on Drawings
 - 2. Doors: As indicated on Drawings.
 - 3. ADA Accessible or Standard (non –ADA accessible) Toilet Facilities: As indicated on Drawings.
 - 4. All electrical devices, conduit, wire and connections as indicated on contract drawings.
- B. Fixed Windows: Steel sash frames glazed with interior aluminum stops as indicated on the Drawings.
 - 1. Finish: Painted
 - 2. Corner Shape: Manufacturer's standard
- C. Work Counters: Full width of control booth, reinforced; with 16-inch wide storage drawer below each counter, and 2" diameter access opening for electrical cords at each rear corner of counter.
 - 1. Material: Painted galvanized steel sheet
 - 2. Depth: As indicted on the Drawings
- D. Electrical Power Service:
 - a) Provide 100A, 480/277 V., 3 phase, 4 Wire Electrical Panel with bolt on breakers, as shown on panel schedule, main copper bus, separate copper neutral and ground busses, and 50 Amp main breaker included

c) Provide 125A, 120/208 V., 3 phase, 4 Wire Electrical Panel with bolt on breakers as shown on drawing, main copper bus, separate copper neutral and ground busses, and 125 Amp main breaker included

d) Provide 100A, 120/208 V., 1 Phase, 3 Wire Electrical Panel with bolt on breakers, as shown on panel schedule, main copper bus, separate copper neutral and ground busses, and 100 Amp main breaker included

e) Provide 30A, 120V., 1 Phase, 2 Wire Electrical Panel with bolt on breakers, main copper bus, separate copper neutral and ground busses, and 30 Amp main breaker with internal UPS included

Manufacturers of panels are Square D, General Electric, or Eaton/Cutler Hammer/Westinghouse. The enclosure for panels located in booth must be Stainless Steel with gasket, and outdoor panels to be Nema 3R.

1. Dry-type Transformer: Transformer shall be provided as indicated in the electrical drawings and in compliance with Section 16460, Transformers.
2. Provide four (4) 120 V GFI specification grade receptacles each on a dedicated 20A circuit, for booths with toilet facilities.
3. Provide 6"D x 18"W x 20"H stainless steel power junction box to be located under counter
4. Provide 6"D x 18"W x 20"H stainless steel communications junction box to be located under counter
5. Provide warning and barrier toggle switches with stainless steel junction box and cover
6. Provide gate controllers, stainless steel junction box and cover with S. S. mounting plates
7. Provide sleeves for incoming and outgoing conduit for power and communications as indicated in the Drawings
8. Provide conduits and pre-wires for the following electrical equipment and devices and connected to Electrical Panel in corresponding Booth
 - a. Roof mounted A/C unit
 - b. Surface, wall mounted heater in Guard Room
 - c. Receptacle outlets (specification grade – typical)
 - d. Lighting fixture and switch
 - e. Barrier and Warning selector switches

- f. Point of use, 2 ½ gallon electric water heater (for booths with toilet facilities only)
- g. Exhaust fan (for booths with toilet facilities only)
- h. Hand dryer (for booths with toilet facilities only)
- i. Power junction box
- j. Communications junction box
- k. Gate controllers and associated controls accessories as indicated on the Drawings
- l. Wall mounted heater in toilet
- m. UPS

9. Provide conduit sleeves as indicated in the electrical drawing.

E. Lighting Fixtures:

Booth Lighting – One (1) ceiling-mounted fluorescent (or equivalent LED as approved by Commissioner) light fixture, 48 inches long, with acrylic lens and two 32 watt lamps in each fixture. Provide single-pole switch mounted adjacent to door to control lighting fixture.

Accessible Toilet Lighting (where designated): One (1) ceiling mounted fluorescent (or equivalent LED as approved by Commissioner) light fixture, 48 inches long, with acrylic lens and two 32 watt lamps in each fixture. Provide single pole switch mounted adjacent to door to control lighting fixture.

Toilet Lighting (where designated): Not used

Exterior Lighting – Two (2) wall mounted weather-proof 37 watt LED wall pack fixtures with photo cell as illustrated on the Drawings. Esco WPL16410S or approved equivalent from Lumec, or Cooper

Lighting.Manufacturers – Lighting fixtures to be Metalux surface commercial wrap type fixture with energy saving ballast, 120 volt or Lithonia, Holophane, Lightolier or similar product.

F. Heating Unit: Wall-mounted electric heater, with wall mounted on/off switch only, 208V, 1 Phase, 5000 watt, as indicated on the drawings, with fan forced operation. Enclose heater in enameled steel cabinet and surface ceiling mount. Marley Electric, Series 500 or Qmark or Berko.

- G. Cooling Unit: Roof-mounted, thermostatically controlled, 208 volt, air-conditioning unit with 13,500 BTU cooling capacity as indicated on the Contract documents.
- H. UNINTERRUPTED POWER SERVICE (UPS) SYSTEM
1. Uninterruptible power supply systems shall be rack mountable under the counter and include UPS units, bypass switch, batteries, power interface module (PIM) and all interconnecting conduits and wiring.
 2. Uninterruptible Power Supply (UPS) with Battery Unit:
 - a) UPS unit shall be rated for 120 volt, Single phase, 60 Hertz input and output at 1250 VA / 875 WATTS.
 - b) The UPS shall be internal to the cabinet and shall be as specified herein. The UPS shall be Clary Corporation model number DT1250R (or approved equal). The UPS shall clean 100% of normal power and have the capacity to operate the equipment that requires battery back-up for 13 minutes. The battery set shall be comprised of temperature hardened, deep cycle, AGM/VRLA (Absorbed Glass Mat/Valve Regulated Lead Acid) or alternately Lithium Ion Phosphate batteries. The PIM shall include individually controlled and prioritized load sequencing, with internal surge suppression. The PIM shall have the capability to provide a minimum of four (4) power outputs and capability to define the priorities for each. The UPS shall have a network interface module for communicating UPS status to the Cisco field switch IE-3000 8TC-E. The UPS shall meet the following minimum specifications:
 1. Line Transient Protection: Passes ANSI/IEEE C62.41 Category A testing
 2. Safety Compliance: UL listed to UA1778
 3. EMC Compliance: FCC Class A
 4. Efficiency: 90% at full load
 5. Battery Capacity VA/Watts @ 0.7P.F. : 600W
 6. Voltage Nominal: 120 VAC
 7. Voltage Range: 100-142 VAC

8. Typical run time (minutes): 600W: 13 minutes.
9. Transfer time: 4 ms (maximum)
10. Battery: Sealed, maintenance-free, valve regulated, UL 1989 recognized.
11. Battery recharge time (to 95% of capacity): 8 hours with output fully loaded
12. Over current protection (on line): circuit breaker
13. Input current (maximum): 50A/120V ac
14. Operating temperature: Range minimum -40F - +165F
15. Humidity: 5% - 95% RH (non-condensing)
16. The UPS shall be in series with battery. The Contractor shall provide a manufacturer's warranty against defects in design, materials, workmanship, and performance for a period of two years from the date of Plaza acceptance.
17. The contractor shall furnish and install CAT 6E cable from the UPS to the CISCO switch.

I. Conduits for Data/Video communication (within Guard booth)

1. Unless shown otherwise on the drawings, communication wiring and equipment, including but not limited to telephone, will be provided and installed by others.

J. Electrical Grounding: As shown on the Drawings

K. Not Used.

L. Plumbing:

1. Able to connect 4" sanitary sewer and 1½" water sources (where designated)
2. Plumbing fixtures (WC, Water Heater, & LAV) and all exposed piping must be installed as per ADA Standards

3. 2 ½ gallon, point of use water heater – Ariston (under-sink electric heater), Stiebel Eltron or GE
 4. All internal cold/hot water piping and sanitary/vent piping
 5. 4" vent thru roof
 6. All rough plumbing must be concealed in a chase
 7. Floor drains – Coordinate with drainage and plumbing plans
- M. Toilet Exhaust: Wall mounted exhaust fan of 80 cfm capacity at 0.25 S. P. (where designated), controlled with light by manual ON/OFF wall switch.
- N. Toilet heating and ventilation: Wall mounted, thermostatically controlled, 208-V, 1500-W electric heater with fan forced operation. Enclose heater in enameled steel cabinet and mount at 2' – 0" above finished floor.
- O. Accessories for Toilet Rooms:
1. Mirror Unit: Provide mirror unit complying with the following:
 - a. Stainless Steel, Angle-Framed Mirror: Fabricate frame from minimum nominal 0.05-inch thick stainless steel angles, with square corners mitered, welded, and ground smooth.
 - b. Size: As indicated on the Drawings.
 2. Liquid Soap Dispenser:
 - a. Description: Designed for dispensing soap in liquid or lotion form.
 - b. Mounting: Horizontally oriented, surface mounted.
 - c. Materials: Smooth, No. 4, satin finish.
 3. Grab Bar: Provide stainless-steel grab bar complying with the following:
 - a. Stainless-Steel Nominal Thickness: Minimum 0.05 inch.
 - b. Mounting: Concealed with manufacturer's standard flanges and anchors.
 - c. Gripping Surfaces: Smooth, satin finish on ends and slip-resistant texture in grip area.
 - d. Outside Diameter: 1½ inches.

- e. Configuration and Length: As indicated on Drawings.
- 4. Warm-Air Dryer (where designated): Provide warm-air dryer complying with the following:
 - a. Automatic Hand Dryer: Surface-mounted, warm-air hand dryer with no-touch operation controlled by electronic sensor and with manufacturers' standard, white-painted metal cover.
- 5. Waste Receptacle:
 - a. Mounting: Freestanding
 - b. Minimum Capacity: 3 Gallon
- 6. Vendor:
 - a. Type: Sanitary napkin and tampon
 - b. Mounting: Surface mounted
 - c. Operation: No coin (free)
 - d. Exposed Material and Finish: Stainless steel, No. 4 finish
 - e. Lockset: Tumbler type with separate lock and key for coin box
- 7. Under Lavatory Guard:
 - a. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping, and allow service access without removing coverings.
 - b. Material and Finish: Antimicrobial, molded-plastic, white.

P. Surface Mounted Signage:

- 1. The base metal for all signs will be #16 gauge porcelain enameling grade steel conforming to ASTM A424.
- 2. Provide signage as indicated on drawings
- 3. Colors: Colors used for signage must be approved by the Commissioner prior to fabrication.

Q. Roof Mounted Signage Brackets:

1. Signage mounting brackets are to be furnished and installed by Prefabricated Control Booth Manufacturer to hold signage as specified or shown on the Drawings or as directed by the Commissioner.
2. Furnish and install signage mounting brackets designed to withstand the wind loads indicated in the "Performance Requirements" Article of this specification section.
3. Signs to be mounted in brackets are 60 inch by 69 inch by 1/8 inch in size.
4. Coordinate sign location with rooftop mechanical equipment.
5. Indicate signage mounting bracket locations on shop drawings.

R. Side Mounted Signage Brackets:

1. Signage mounting brackets are to be furnished and installed by Prefabricated Control Booth Manufacturer to hold signage as specified or shown on the Drawings or as directed by the Commissioner.
2. Furnish and install signage mounting brackets designed to withstand the wind loads indicated in the "Performance Requirements" Article of this specification section.
3. Signs to be mounted in brackets are 24 inch by 12 inch by 1/8 inch, 18 inch by 30 inch by 1/8 inch, and 36 inch by 28 inch by 1/8 in size or as specified in the Drawings.
4. Coordinate sign location with other structures/items in the islands. Signs must be located so that their visibility is not obstructed.
5. Indicate signage mounting bracket locations on shop drawings. Brackets must be mounted in such a way that the signage will not be bent or warped from a straight plane.

S. Fire Extinguisher: Provide 1 fire extinguisher per each booth as follows: Clean-Agent type in Steel Container: UL-rated 1-A:10-B:C, 10-lb nominal capacity, with HFC blend agent and inert material in enameled-steel container; with pressure-indicating gage.

T. Accessories: Provide the following for each control booth:

1. Ventilation fan

- 2. Ionization smoke detector, 120 V
- U. Rubber Floor Mat: Provide heavy-duty raised dot rubber mat (Flexi Tile PVC) where shown on the Drawings
- V. Other Accessories: As shown on the Drawings

2.04 PREFABRICATED STEEL CONTROL BOOTHS

- A. Available Manufacturers:
 - 1. B.I.G. Enterprises, Inc.
 - 2. Delta Scientific Corporation
 - 3. Intertex Companies
 - 4. Mardan Fabricators, Inc.
 - 5. Parking Booth Company, Inc.
 - 6. Par-Kut International, Inc.
 - 7. Porta-King Building Systems
- B. Structural Framework: Fabricated from 2-by-2-by-12 gauge steel structural or mechanical tubing. Connect framework by welding.
- C. Base/Floor Assembly: Height as indicated on the Drawings consisting of perimeter frame welded to structural framework of booth. Fabricate frame from 2-by-4-inch 10 gauge galvanized-steel structural tubing; C-shaped structural steel channels; or structural-steel angles. Include anchor clips fabricated from 3/8-inch thick stainless steel plate, predrilled and welded to base exterior.
 - 1. Subfloor and Finished Floor: 9 gauge, galvanized, rolled steel tread plate.
- D. Wall Panel Assembly: Assembly consisting of exterior face panel fabricated from 12 gauge minimum galvanized steel sheet; and interior face panel fabricated from 16 gauge minimum galvanized steel sheet; with 2-inch thick, rigid fiberglass or polystyrene board insulation in cavity between exterior and interior face panels.
 - 1. Thermal Resistance Value (R-Value): As indicated on the Drawings

2. Exterior wall panels to meet U. L. Level III Standards
- E. Flat Roof/Ceiling Assembly: Consisting of exterior roof panels, interior ceiling panels, and insulation (R-17 minimum) between exterior and interior panels; sloped to drain at booth perimeter.
1. Exterior Roof Panel: Fabricated from galvanized steel sheet to match exterior wall panel thickness; with EPDM membrane, continuously welded seams, and full-perimeter gutter.
 2. Interior Ceiling Panel: Fabricated from galvanized steel sheet to match interior wall panel thickness; with insulation in cavity between ceiling and roof.
 3. Canopy Fascia: Fabricated from galvanized steel sheet to match exterior wall panel thickness, of manufacturer's standard design.
 - a. Height: As indicated on the Drawings.
 - b. Overhang: As indicated on the Drawings.
 - c. 3' x 6' Canopy: As indicated on the Drawings. Braced as required.
 4. Downspouts: Integral, extending 3 inches beyond booth walls.
 5. Roof scuppers.
- F. Sliding Door: Top suspended from aluminum track with ball-bearing rollers; 1-3/4 inches thick; tubular-frame design fabricated from stainless steel; with top half of door glazed. Equip door with deadlock, lock support, guide hardware, and full weather stripping. Door and glazing to meet U. L. Level III Standards.
1. Glazing: Fixed unit with bullet resisting laminated glass, safety glazing meeting U. L. Bullet Resistance Level III Standards. The exterior glazing must be applied with a tinted sun glare control film that rejects 75% infrared light and ultra-violet rays.
 2. Deadlock: Mortised, laminated hook bolt type; with removable cylinder capable of being master keyed.
- G. Swinging Door: 1-3/4 inches thick; tubular-frame design fabricated from stainless steel. Equip door with deadlock, three butt hinges, and closer.
1. Glazing: Fixed unit with 6-mm-thick, clear tempered float glass.

2. Locksets: Mortised, with lever handle and removable cylinder capable of being master keyed.

- a. Bathroom door function: ANSI Type F02

- H. Finish: finish interior metal surfaces, including structural framework, walls, canopy, and ceiling with rust-inhibitive epoxy primer and one finish coat of industrial acrylic epoxy.

1. Color: As selected by the Commissioner from manufacturer's full range.

2.05 FABRICATION

- A. Fabricate control booths completely in factory.
- B. Preglaze windows and doors at factory.
- C. Prewire control booths at factory, ready for connection to service at Project site.
- D. Fabricate control booths with forklift pockets in base of booth.

2.06 PAINTS AND SEALANTS

- A. All paints and sealants will comply with the following requirements:
- B. For interior applications use adhesives and sealants that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 1. Wood Glues: 30 g/L
 2. Metal to Metal Adhesives: 30 g/L
 3. Adhesives for Porous Materials (Except Wood): 50 g/L
 4. Subfloor Adhesives: 50 g/L
 5. Plastic Foam Adhesives: 50 g/L
 6. VCT and Asphalt Tile Adhesives: 50 g/L
 7. Cove Base Adhesives: 50 g/L
 8. Multipurpose Construction Adhesives: 70 g/L
 9. Fiberglass Adhesives: 80 g/L
 10. Contact Adhesive: 250 g/L
 11. Plastic Cement Welding Compounds: 350 g/L
 12. ABS Welding Compounds: 400 g/L
 13. CPVC Welding Compounds: 490 g/L
 14. PVC Welding Compounds: 510 g/L
 15. Adhesive Primer for Plastic: 650 g/L
 16. Sealants: 250 g/L

17. Sealant Primers for Nonporous Substrates: 250 g/L
 18. Sealant primers for Porous Substrates: 775 g/L
- C. For interior applications use paints and coatings that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions:
1. Flat Paints and Coatings: VOC not more than 50 g/L
 2. Non-Flat Paints and Coatings: VOC not more than 150 g/L
 3. Anti-Corrosive Coatings: VOC not more than 250 g/L
 4. Varnishes and sanding Sealers: VOC not more than 350 g/L
 5. Stains: VOC not more than 250 g/L
 6. Aromatic Compounds: Paints and coatings will not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
 7. Restricted Components: Paints and coatings will not contain any of the following:
 - a. Acrolein
 - b. Acrylonitrile
 - c. Antimony
 - d. Benzene
 - e. Butyl benzyl phthalate
 - f. Cadmium
 - g. Di (2-ethylhexyl) phthalate
 - h. Di-n-butyl phthalate
 - i. Di-n-octyl phthalate
 - j. 1, 2-dichlorobenzene
 - k. Diethyl phthalate
 - l. Dimethyl phthalate
 - m. Ethylbenzene
 - n. Formaldehyde
 - o. Hexavalent chromium
 - p. Isophorone
 - q. Lead
 - r. Mercury
 - s. Methyl ethyl ketone
 - t. Methyl isobutyl ketone
 - u. Methylene chloride
 - v. Naphthalene
 - w. Toluene (methylbenzene)
 - x. 1, 1, 1-trichloroethane
 - y. Vinyl chloride

- D. Do not use composite wood and agrifiber products that contain urea-formaldehyde resin.

2.07 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearances of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Aluminum Finishes: Finish designations prefixed by AA comply with the system established by the aluminum Association for designating aluminum finishes.
 - 1. Class II, Clear anodic finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
- D. Galvanized Steel Sheet Finishes: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.
 - 1. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
 - 2. Acrylic Epoxy Finish: Apply manufacturer's standard Acrylic Epoxy finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.
- E. Stainless-Steel Finishes:
 - 1. Paint Finish:
 - a. Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating

to be applied over it. Clean welds, mechanical connections, and abraded areas.

- b. Acrylic Epoxy Finish: Apply manufacturer's standard Acrylic Epoxy finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.
2. Bright, Directional Satin Finish: No. 4
- a. Remove tool and die marks and stretch lines or blend into finish.
 - b. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
 - c. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

- A. Unless indicated otherwise in the structural drawings and details for the concrete island on which the booth will be mounted, at a minimum, install control booths on 6-inch thick concrete bases that are 12 inches larger than booths roof line dimensions in both width and length.
- B. Set control booths plumb and aligned. Level base plates true to plane with full bearing on concrete bases.
- C. Fasten control booths to concrete bases with expansion anchors.

- D. Connect electrical power service to power distribution system according to requirements specified in Division 16 and as shown on the contract documents.
- E. Install fire extinguisher at accessible location, as shown on the Drawings.
- F. Connect piping to all plumbing fixtures in compliance with the Chicago code requirements.

3.03 ADJUSTING AND CLEANING

- A. Adjust doors, operable windows, and hardware to operate smoothly, easily, properly, and without binding. Confirm that locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.
- C. After completing installation, inspect exposed finishes and repair damaged finishes.

3.04 UPS INSTALLATION

- A. The Contractor shall install the equipment in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.
- B. The equipment shall be installed on racks under the counter.
- C. The equipment shall be installed with clearances required by the Code.
- D. The equipment shall be installed to permit maintenance and replacement of components. The Contractor shall adjust the location of equipment to accommodate the installation in accordance with field conditions encountered.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. PREFABRICATED CONTROL BOOTHS will be measured per each unit furnished and installed in place complete and accepted by the Commissioner including concrete foundation (island), crash block, booth swing gate, traffic signal and other appurtenances as shown on the Drawings.

- B. Electrical field installation for prefabricated control booths will include all labor, material, and appurtenances necessary to extend all underground conduits, pipes, and wiring to the connection points inside the control booths, seal all conduit sleeves, and terminate all wiring and install appurtenances as indicated on the Contract Drawings and approved by the Commissioner. Electrical field installation will not be measured separately but will be included in the corresponding PREFABRICATED CONTROL BOOTH pay item.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. The PREFABRICATED CONTROL BOOTH will be paid for at the contract unit price for each type, size, and all specified amenities complete and in place including all electrical, plumbing, and mechanical equipment required to be fully operational.
- B. Electrical installation of prefabricated control booth will be included in the lump sum contract unit price for each control booth complete.
- C. Payment will be made under the following item:

ITEM NO.	DESCRIPTION	UOM
13128-01	PREFABRICATED CONTROL BOOTH W/ ADA ACCESSIBLE TOILET, COMPLETE	EA

END OF SECTION 13128

BASIC ELECTRICAL REQUIREMENTS

SECTION 16010

PART 1 DESCRIPTION

1.01 GENERAL:

- A. Work under this Section is subject to the requirements of the Contract Documents.
- B. Apparatus, appliance, material or work not shown on the Drawings, but mentioned in the Specifications, or vice versa, or any accessories necessary to make the work complete and ready for operation without additional expense to the City.
- C. The Contractor must furnish, erect, install, connect, clean, adjust, test and condition all manufactured articles, materials and equipment, and place in service in accordance with the manufacturer's directions and recommendations except as otherwise noted on the Drawing or specified herein.

1.02 RELATED WORK:

- A. As specified in the following and other sections as required:
 - 1. Section 16100 – Basic Materials and Methods
 - 2. Section 16123 – Building Wire and Cable
 - 3. Section 16195 – Electrical Identification
 - 4. Section 16452 – Grounding
 - 5. Section 16470 – Panelboards
 - 6. Section 16520 – Roadway/Parking Lot/Tunnel Lighting
 - 7. Section 16950 - Testing

1.03 REFERENCES:

- A. Materials and installation must comply with all codes, laws and ordinances of Federal, State and local governing bodies having jurisdiction.
- B. In every installation where regulations of electric and/or telephone companies apply, conformance with their regulations must be mandatory and any costs incurred must be included in the Contract.

- C. In case of differences between building codes, State and Federal laws, local ordinances and utility company regulations and the Contract Documents, the most stringent must apply.
- D. All design, equipment and materials specified must conform to all acts, laws, rules and regulation of the following organizations:
 - 1. City of Chicago Electrical Code (CEC) must take jurisdictional precedence over all other authoritative bodies.
 - 2. National Electrical Code (NEC) (ANSI/NFPA 70).
 - 3. National Electrical Safety Code (NESC-ANSI C2).
 - 4. American National Standards Institute (ANSI).
 - 5. National Fire Protection Association (NFPA).
 - 6. Institute of Electrical and Electronics Engineers (IEEE).
 - 7. Insulated Cable Engineers Association (ICEA).
 - 8. National Electrical Manufacturers Association (NECA).
 - 9. Illuminating Engineering Society (IES).
 - 10. Underwriters Laboratories, Inc. (UL)
 - 11. Canadian Standards Association (CSA).
 - 12. Occupational Safety and Health Administration (OSHA).
 - 13. Americans with Disabilities Act (ADA).
 - 14. International Association of Electrical Inspectors (IAEI)
SOARES – Book on Grounding.
 - 15. International Electrical Testing Association (NETA)
NETA – ATS- Acceptance Testing Specifications for
Electrical Power Distribution Equipment and Systems.
- E. Should Work be performed which does not comply with the requirements of the applicable building codes, State and Federal laws, local ordinances, industry standards, utility company regulations and the Contract Documents changes for compliance must be done by the Contractor at no cost to the City.
- F. The Contractor must secure and pay for all permits, governmental fees, taxes and licenses necessary for the proper execution and completion of the electrical work.
- G. The Contractor must submit to governmental agencies and utility companies Shop Drawings, which are required by these agencies, for

the approval.

- H. The Contractor will notify the Commissioner of any materials or apparatus believed to be inadequate, unsuitable, in violation of laws, ordinances, rules or regulations of authorities having jurisdiction.

1.04 SUBMITTALS:

- A. The Contractor must submit Project data to the Commissioner prior to purchasing and installation. The data must include, but not be limited to, the following:
 - 1. Installation design Drawings - schematic, wiring, and one line diagrams; lighting panel schedules; lighting; conduit; duct banks; conduit and cable schedules; grounding; symbols and legends; etc. must be included.
 - 2. Power system short circuit and coordination calculations. The calculations must be performed under the supervision of a Professional Engineer registered in the State of Illinois. The calculations must bear the stamp of the responsible Engineer.
 - 3. The equipment manufacturers' schematic diagrams must be "JIC" ladder type. Schematics must identify all devices, wire codes, and terminal numbers.
 - 4. The equipment manufacturers' wiring diagrams must show terminal blocks for external wiring. Wiring diagrams must identify all devices, wire codes, and terminal numbers.
 - 5. The equipment manufacturers' internal point to point and external wiring diagrams between cubicles, panels and components within the equipment line up must be provided.
 - 6. Catalog cuts and major electrical equipment manufacturers' Drawings must include, but are not limited to, relays, meters, current and potential transformers, disconnect switches, fuses, contactors, lighting and more.
 - 7. Complete descriptive literature, performance and test data and rating data for all equipment must be provided.
 - 8. Instruction books, Operation and Maintenance manuals with spare parts must be provided.
 - 9. Complete and accurate "As Built" Drawings must be provided by the Contractor to the Consulting Engineer for verification and drafting.

- B. Shop Drawings

1. The Contractor must submit Shop Drawings and Samples in accordance with the Contract Documents and supplementary requirements as stated under each Section of the Specifications.
2. The Contractor must make submittals in accordance with the approved CPM Schedule before any material or equipment is purchased. The submittals must be reviewed by the Commissioner for compliance with the Contract Documents.
3. Shop Drawings must include manufacturers' names, catalog numbers, cuts, diagrams, schedules and other such descriptive data specifically prepared for the Work by the Contractor, Sub-contractor and/or manufacturer to illustrate that the materials, equipment or system conform to the Contract requirements.
4. Additional submittal requirements are described in individual sections of the Specifications.
5. Any listed materials, fixtures, apparatus, or equipment that are not in accordance with the Contract Document requirements can and must be rejected for use in this Contract.
6. Any materials, fixtures, apparatus or equipment installed without reviewed and accepted submittals must be removed by the Contractor and replaced at the direction of the Commissioner and without cost to the City.
7. Substitutions to listed acceptable manufacturers equipment and material must not be accepted until the Contractor has complied with the requirements of Part Two, Article VI of the Contract Documents.

C. Installation Drawings

1. The initial copy of all installation Drawings must be submitted to the Commissioner for review.
2. The installation Drawings must be made under the direction and supervision of the Contractor and must show all electrical work including, but not limited to, conduit, wiring, electrical equipment and devices, lighting fixture locations and elevations, points where conduit enters or leaves structural slabs and walls, junction boxes, conduit supports and inserts. Symbol representation for home run circuits must not be acceptable. These Drawings must include all ductbank work, embedded conduit plans, electrical room layouts and elevations as well as all circuiting and locations of all electrical equipment.
3. In addition to the preparation and submittal of Shop Drawings

for manufactured electrical equipment and materials, the Contractor must prepare and maintain in current status, a complete set of detailed, completely circuited, and dimensioned electrical construction Drawings for all electrical work included under this Contract. These Drawings must be made at the Contractors expense.

4. Shop Drawings for manufactured electrical equipment and materials, the Contractor must prepare and maintain in current status, a complete set of detailed, completely circuited, and dimensioned electrical construction Drawings for all electrical work included under this Contract. These Drawings must be made at the Contractor's expense.
5. No electrical work will begin until these installation Drawings are so drawn, and thereafter finally accepted by the Commissioner.
6. The complete electrical distribution system from the sources, including each branch circuit panelboard, must be shown and dimensioned exactly as to be installed, with all feeders located on the installation Drawings. Major equipment, lighting controls and apparatus must be shown to scale and properly located.
7. The Contractor must provide a separate set of installation Drawings for the lighting system; a separate set of installation Drawings for the power and control; and a separate set of installation Drawings for the special systems.
8. The Contractor must provide a single line diagram describing the power distribution system. This diagram must include ratings for all equipment and cable sizes from the service connection to the 120 Volt lighting and distribution panels.
9. The installation Drawings must include floor plans and reflected ceiling plans with electrical layouts drawn at a scale (or scales) as required with a minimum scale of 1/8 inch equal 1'-0". It is intended that installation Drawings of each trade be the same scale(s) in order to permit respective plans to be superimposed upon all others of each trade.
10. In addition to the floor plans, the layouts of all congested areas such as mechanical and/or electrical equipment rooms, and all functionally critical areas must be drawn at a minimum scale of 1/4 inch equals 1'-0", and with all details of construction shown. Additional installation Drawings may be requested if in the opinion of the Commissioner they are required to properly coordinate the Project.
11. The installation Drawings must include schedules for all panelboards. Schedules must depict the bus arrangement of

the panelboard, the size of all circuit breakers, the connected load on each breaker, and a description of the load and its location.

12. The installation Drawings must indicate the electrical installation exactly as to be constructed and therefore must be periodically revised to reflect all changes inclusive of those required by the Commissioner, those which are or have been found necessary in the field, those which may be suggested by the Contractor and approved by the Commissioner, etc.
13. All installation Drawings must be made on 3 mil Mylar sheets of the same size and with the same border lines and title blocks as the Chicago Department of Aviation Drawings, with the Contractor's name added.
14. Revisions must be performed when considered necessary by the Commissioner or the Contractor in order to facilitate proper coordination.
15. The Contractor must be responsible for the coordination of electrical work with the work of all other trades and must, in preparing the installation Drawings, continually check the work of all other trades (inclusive of that indicated by Shop Drawings) in order to avoid possible installation conflicts arising therefrom. It must be understood that the work shown on the installation Drawings has been so coordinated. In the event of conflicts or interferences that cannot be resolved in the field, the Contractor must request a written clarification from the Commissioner.
16. Upon completion, the initial installation Drawings, and all revised installation Drawings thereafter, must be dated and certified as having been fully coordinated by the Contractor. It must then be understood that the work shown thereupon is ready for construction.
17. All installation Drawings must be made in accordance with an approved schedule, prepared by the Contractor, and arranged to coincide with actual construction in such a manner as to allow the latter work to proceed without delay.
18. If, in the opinion of the Commissioner, the installation Drawings are in acceptable condition after each has been finally revised and accepted, the Contractor may submit same as the field record Drawings called for elsewhere in the Specifications.
19. The Contractor must include wiring diagrams and schematic diagrams. Each schematic diagram must be "JIC" ladder type. Wire and terminal numbers must be shown on all schematic and wiring diagrams.

20. The minimum drafting letter size must be 1/8 inch in height and must be block type lettering.

D. The Contractor must submit test reports as described under this Contract.

1.05 QUALITY CONTROL:

- A. After all equipment, devices and raceways are installed and wires and cables are in place and connected to devices and equipment test the system for continuity, proper phase rotation, short circuit, improper grounds, and other defects. Testing must be in accordance manufacturers' recommendations, individual sections of this Specification, and Section 16950 - Testing of these Specifications.
- B. The Contractor must be responsible for protecting all equipment and systems against harmful exposures to, or accumulations of dust and moisture, flooding, corrosion or other forms of damage and must clean and restore damaged finishes as may be required to place installations in a "Like New" condition before acceptance by the Commissioner.

1.06 DELIVERY STORAGE AND HANDLING:

- A. Equipment and materials must be delivered to the site and stored in the original containers, suitably sheltered from the elements and mechanical injury, but readily accessible for inspection until installed.
 - 1. Items subject to moisture damage must be stored in dry, heated spaces.
 - 2. Manufacturer's directions must be followed in the delivery, handling, storage, protection, installation and operation of all equipment and materials.
- B. The Contractor must coordinate with the Commissioner the movement of heavy machinery, equipment and heavy parts thereof brought into or onto the building or premises.
- C. Conduit openings must be kept closed by means of plugs or caps to prevent the entrance of foreign matter.
- D. The Contractor must cover all fixtures, equipment and apparatus as required to protect them against dirt, water, chemical, solar, or mechanical damage. The Contractor must also provide any supplementary heating and cooling required to prevent moisture and thermal damage.
- E. Equipment must be inherently safe and moving parts must be covered

with guards.

- F. Equipment in storage having moving parts, which may be damaged or distorted by being idle, must be rotated or exercised periodically and all lubricants must be properly maintained.
- G. Additional requirements are described in individual sections of these Specifications.

1.07 WARRANTIES AND GUARANTEES:

- A. The following materials have special Manufacturer's Warranties for the periods listed with each item, which may originate, in part or in whole, with the manufacturer or the fabricator and such warranties must be passed through the Contractor to the Chicago Department of Aviation;
 - 1 The manufacturer must warrant every luminaire against defects due to design, workmanship, or material developing within a period of five (5) years after the luminaire has been placed in service. Any luminaire or part thereof developing defects within this period must be replaced by the manufacturer without expense to the City, and the Commissioner will be the sole judge in determining which replacements are to be made, and his decision will be final.
 - 2 The manufacturer must warranty the cable to be first class material throughout. If the cable is installed within one year of the date of shipment, the manufacturer must replace any cable failing during normal and proper use within two years of installation. The cable length to be replaced will be the entire unspliced length where the fault has been located. The Commissioner will be the sole judge in determining if a cable has failed and should be replaced.
- B. The Contractor must repair or replace defective materials and workmanship during the Contract Period and for one year from the date of Substantial Completion of the Project. Defective material and workmanship include, but are not limited to, the following:
 - 1. Luminaires
 - 2. Circuit breakers
 - 3. Junction boxes
 - 4. Conduits
 - 5. Cabinets and all of its components

1.08 EXTRA MATERIALS AND SPARE PARTS:

- A. Where spare parts or extra materials are called for in any Specification Section they must be supplied.
- B. The Contractor must turn over to the City all spare parts and extra materials in the original factory packaging.
- C. The Contractor must supply spare parts as recommended by the various equipment manufacturers. These must be of the types and quantities shown in the Operation and Maintenance Manuals. Spare parts will be counted per each part supplied.

1.09 ENVIRONMENTAL REQUIREMENTS:

- A. None required.

1.10 SPECIAL REQUIREMENTS:

- A. Field Measurements - Before proceeding with the fabrication of the Work, the Contractor must verify all dimensions and take such measurements as are required for proper fabrication and erection of the Work.
- B. Coordination - Coordinate work of this Section with adjacent work of other trades.

1.11 CONTRACT DRAWINGS:

- A. The Drawings are diagrammatic and/or home-run type which are intended to convey the scope of work and indicate the general arrangement and/or sizes of conduit, equipment, fixtures and other work included in the Contract.
- B. The location of items required by the Contract Documents are not definitely fixed by dimensions and are approximate only. The exact locations necessary to secure the best conditions and results must be determined at the site and will be subject to the review of the Commissioner.
- C. The Contractor must coordinate the location of the lighting fixtures, pull boxes, conduit racks, intercommunication speakers, etc. with the location of the mechanical equipment.
- D. The Contractor must lay out the Work, check Drawings of all trades to verify spaces in which Work must be installed, and maintain maximum headroom and space conditions at all points.

1. Where headroom or space conditions appear inadequate, the Contractor will notify the Commissioner, in writing, before proceeding with installation.
2. Any minor changes in the locations of equipment, fixtures, lighting fixtures, conduits, outlets, devices, etc., from those locations as shown on the Contract Drawings must be made without extra charge to the Contract. A minor change in location must be considered to be within 10 feet of the location as may be scaled from the Drawings for all interior work and within 25 feet for all exterior work.

1.12 EXECUTION, CORRELATION AND INTENT OF DOCUMENTS:

- A. Scaled measurements from Drawings will not be used to determine installation locations.

1.13 INSTRUCTIONS AND ADJUSTMENTS:

- A. Before Final Completion and before final Contract payment is made, the Contractor must demonstrate and explain to the Commissioner the function, operation and maintenance of all equipment and systems installed.
- B. The primary adjustments of the system(s) must be accomplished by the Contractor to the complete satisfaction of the Commissioner at the time of completion of the installation.
- C. Where required in individual sections of this Specification, the Contractor will arrange for training City personnel as specified.

1.14 OPERATING AND MAINTENANCE MANUAL:

- A. General - Assemble manuals to include definite and specific information and instructions on materials, apparatus, equipment and systems provided under the Contract. Include only the latest standard commercial data.
 1. Maintenance period to be represented by the manufacturers' maintenance data is five (5) years.
 2. Coordinate contents of manuals with the actual needs of the City's staff.
 3. Provide Five (5) copies of each manual, operating instructions, parts lists, and any other manufacturer supplies information. This requirement shall also apply to any other information the contractor is required to supply.

- B. Contents - Include for each item the following data, as applicable, edited to include items specific to this Contract. Make data, including notations, completely legible - typewritten or printed.
1. Manufacturer's operating instructions, maintenance and repair manuals which set forth the manner of operation, precautions, care to be followed and periodic preventive maintenance requirements.
 2. Final accepted Shop Drawings, Product Data and catalog cuts, including final comments and responses.
 3. Printed Data - Manufacturer's original catalog cuts, brochures, operating and maintenance data.
 4. Manufacturer's recommended maintenance and cleaning procedures, methods and materials for exposed finish.
 5. Manufacturer's Specifications, including performance curves, wiring diagrams, and tabulation of sizes and identifying numbers.
 6. Complete and detailed material list and parts list and assembly drawing.
 7. Recommended inventory of spare parts and emergency parts and sources of purchase.
 8. Governing agency and manufacturer test certificates, permits and inspection reports, including pressure test, insurance inspections and approvals, and shop or field performance tests.
 9. Certified factory and field performance report as required by the Contract Documents
 10. Final compliance certificates as required by the Contract Documents.
 11. Manufacturer's guarantee or warranty as normally provided and as specifically required by the Contract Documents.
 12. An index of volumes, in each volume of multiple volume systems.
 13. An index in and for each volume. List and combine the literature, for each system, in the sequence of operation.
 14. Name, address and telephone numbers of or, Subcontractors, suppliers, and installers.
 15. Name, address and telephone number of manufacturer's nearest service representative.

16. Name, address and telephone number of nearest parts vendor and service agency.
17. Anticipated date City assumes responsibility for maintenance.
18. Description of system and component parts.
19. Pre-operation check or inspection list.
20. Procedures for starting, operating and stopping equipment.
21. Post-operation check or shut down list.
22. Inspection and adjustment procedures.
23. Emergency operating instructions.
24. Accepted test data.
25. Maintenance schedules and procedures.
26. One (1) copy of each wiring diagram.
27. One (1) copy of each piping diagram.
28. One (1) copy of each duct diagram.
29. Manufacturer's parts list with catalog names, numbers and illustrations.
30. An exploded view of each piece of the equipment with part designations.
31. List of special tools and test equipment required for the operation, maintenance, adjustment, testings, and repair of the equipment, instructions and components. Include lubricants, fuels, identification systems, control sequences, hazards, start up, shut down, noise and vibration adjustments, safety procedures, economy and efficiency adjustments and effective energy utilization.
32. Scale and corrosion control procedures.
33. Dismantling and re-assembly instructions.
34. Trouble shooting, repair instructions.
35. Calibration procedures.
36. Ordering information.

C. Binding - Assemble each group of documents for materials, apparatus, equipment or systems in binders identified for the items covered. Organize the contents in binders as follows:

1. Group documents for each item in the order listed above for contents.

2. Index group of documents for each item in accordance with the filing system of the Contract Specification format.
3. Fold Drawings and other documents larger than 8-1/2" x 11" to properly fit in binders so that they can be fully unfolded without removal from the binder. Reinforce edges of large Drawings.
4. Provide each binder with a Table of Contents.

1.15 BINDERS:

- A. General - Hard-cover, three-hole, D-ring, loose leaf binders of size using standard 8-1/2" x 11" sheets. Binding is subject to the approval of the Commissioner.
- B. Quantity - As required for the amount of data to be contained.
- C. Flysheets - Separate each portion of the manual with colored, neatly prepared flysheets briefly describing contents of the ensuing portion.
- D. Cover - Clearly identify the manual on the cover with at least the following information:
 1. OPERATION AND MAINTENANCE INSTRUCTIONS
 2. Chicago O'Hare International Airport
 3. City of Chicago
 4. (Complete Project name and Project number)

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT:

- A. Materials and equipment must be new and must be labeled in accordance with CEC Section 14-64-010 and must bear the manufacturer's name, model number and other identification markings.
- B. Materials and equipment must be the standard product as may be modified by these Specifications, of a specified manufacturer regularly engaged in the production of the required type of material or equipment for at least five (5) years (unless specifically exempted by the Commissioner) and must be the manufacturer's latest design with published properties.
- C. Equipment and materials of the same general type must be of the same manufacturer throughout the Project to provide uniform appearance, operation and maintenance.

- D. Equipment and materials must be without blemish or defect and must not be used for temporary light or power purposes, including lamps, without the Commissioner's written authorization.
- E. Equipment and materials must comply with the requirements of the Contract Documents.

PART 3 EXECUTION

3.01 INSTALLATION OF WORK:

- A. The Contractor must perform all work with trained mechanics of the particular trade involved in a neat and workmanlike manner as accepted by the Commissioner.
- B. With the acceptance of the Commissioner and without additional cost to the City, the Contractor must make minor modifications in the Work as required by structural interferences, by interferences with work of other trades and for proper execution of the Work.
- C. Work installed before coordinating with other trades so as to cause interferences with the Work of such other trades will be changed as directed by the Commissioner to correct such condition without cost to the City.
- D. The equipment must be installed with ample space allowed for removal, repair or changes to equipment. Ready accessibility to removable parts of equipment and to wiring must be provided without moving other equipment which is to be installed or which is in place.
- E. The Contractor must compare the Drawings and Specifications, checking all measurements to determine the intent of the Contract Documents. Any discrepancies will be brought to the Commissioner's attention for interpretation.
- F. Locations of electrical outlets, lighting panels, cabinets, equipment, etc. are approximate and exact locations must be determined by the Contractor at the Project site.
- G. The Contractor must refer to Contract Documents for details, reflected ceiling plans, and large scale Drawings.

3.02 EQUIPMENT NOISE LIMITATION:

- A. Noise levels of electrical devices and equipment must be within acceptable limits as established by NEMA or other valid noise rating agencies. Commissioner's acceptance will be based on practical and

reasonable considerations of occupancy requirements.

- B. The Contractor must check and tighten the fastenings of sheet metal plates, covers, doors, and trims to prevent vibration and chatter under normal conditions of use.
- C. When located other than in high-noise-level equipment rooms, the enclosures or solenoid-operated switching devices and other noise-producing devices must have anti-vibration mountings and non-combustible sound-absorbing linings.
- D. Transformers, reactors, dimmers, lamp ballasts, and solenoids must be designed and rated for "quiet" operation.
- E. The Contractor must remove and replace any individual electrical item or device that is found to produce a sound energy output exceeding that of other identical devices installed on this Project or the requirements of the Contract Documents.

3.03 TRANSMISSION OF VIBRATION:

- A. Electrical equipment, conduit, and fittings must not be mounted to or supported by elements subject to vibration except by methods which must prevent transmission thereof.
- B. Where flexible conduit lengths are utilized as a means of isolating equipment and conduit systems vibration, care must be exercised to assure continuity of ground throughout.
- C. Per FAA-STD-1217f, stranded conductors smaller than 10 AWG are allowed in applications where vibration and flexing may be encountered.

3.04 PROTECTION:

- A. The Contractor must protect conduit and wireway openings against the entrance of foreign matter by means of plugs or caps. The use of such materials as tape, plastic bags, paper, rags, etc. is expressly forbidden. For conduits with threaded ends, as required by the Specifications, the Contractor must provide threaded caps for the protection of the conduit end.
- B. The Contractor must cover fixtures, materials, equipment and devices furnished or installed under this Contract or otherwise protect against damage, before, during, and after installation.
- C. Fixtures, materials, equipment, or devices damaged prior to final

acceptance of the Work must be restored to their original condition or replaced at no cost to the City.

- D. Equipment must be inherently safe and moving parts must be covered with guards.

3.05 NEMA RATINGS:

- A. NEMA 1 - materials and construction is limited to interior walls, finished rooms, electrical rooms, unless otherwise noted, and ceiling spaces except where the ceiling space is used as an air plenum.
- B. NEMA 12 - materials and construction must be employed in areas where air supply and/or return systems are located, i.e. fan rooms. NEMA 12 must also be used in enclosed garages above Code required limits, in areas such as baggage handling, mechanical rooms not wet rated, or as identified on the Drawings.
- C. NEMA 4X - materials and construction must be employed in all exterior areas, wet areas and in interior areas where wash down may occur, or as noted on the Drawings. When called for this material must be made of Grade 316 Stainless Steel.
- D. NEMA 7 & 9 - materials and construction must be employed in those areas so defined by either the Chicago Electrical Code or the National Electrical Code.

3.06 PROJECT SPECIFICS:

- A. Sections 16100, 16123, 16195, 16452, 16470, 16520, 16950, L-100, L-110 and L-115 are applicable to the work related to Tank Farm Road lighting.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Basic Electrical Requirements will not be measured separately for payment.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Basic Electrical Requirements will not be paid for separately, but will be considered incidental to respective pay items as specified elsewhere in the Contract documents.

END OF SECTION 16010

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BASIC MATERIALS AND METHODS

SECTION 16100

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Work under this Section is subject to the requirements of the Contract Documents.
- B. Furnish and install all electrical work, materials and accessories indicated schematically by Drawings, schedules and as specified herein including, but not limited to, the following:
 - 1. Rigid Galvanized Steel Conduit (RGSC)
 - 2. RGS conduit with PVC coating
 - 3. Electrical Metallic Tubing (EMT)
 - 4. Flexible Metal Conduit (FMC)
 - 5. Intermediate Metal Conduit (IMC)
 - 6. Liquid-tight Flexible Metal Conduit (LTFC)
 - 7. Underground PVC Conduit
 - 8. Bushings
 - 9. Fittings
 - 10. Boxes
 - 11. Wire and Cable

1.02 RELATED WORK:

- A. As specified in the following and other sections as required:
 - 1. Section 16123 – Building Wire and Cable
 - 2. Section 16195 – Electrical Identification
 - 3. Section 16452 – Grounding
 - 4. Section 16520 – Roadway/Parking Lot/Tunnel Lighting
 - 5. Section 16950 – Testing
 - 6. Section L-100 – Marker Light Bases, Lighting Fixtures and Guidance Signs
 - 7. Section L-110 – Installation of Airport Underground Electrical Duct

8. Section L-115 – Electrical Manholes and Handholes

1.03 REFERENCES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.03 References.

1.04 SUBMITTALS:

- A. See Specification Section 16010 Basic Electrical Requirements 1.04 Submittals.
- B. The Contractor must submit with the wire submittal a listing of the code numbers used by the Manufacturer of the wire/cable the Contractor is submitting.

1.05 QUALITY CONTROL:

- A. See Specification Section 16010 Basic Electrical Requirements 1.05 Quality Control.

1.06 DELIVERY STORAGE AND HANDLING:

- A. See Specification Section 16010 Basic Electrical Requirements 1.06 Delivery Storage and Handling.

1.07 WARRANTIES AND GUARANTEES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.07 Warranties and Guarantees.

1.08 EXTRA MATERIALS AND SPARE PARTS:

- A. None required

1.09 ENVIRONMENTAL REQUIREMENTS:

- A. None required

1.10 SPECIAL REQUIREMENTS:

- A. Field Measurements - Before proceeding with the fabrication of the Work, the Contractor must verify all dimensions and take such measurements as are required for proper fabrication and erection of the Work.
- B. Coordination - Coordinate Work of this section with related Work specified in the other divisions/sections of the Contract Documents.

PART 2 PRODUCTS

2.01 EQUIPMENT BASES:

- A. The Contractor must provide concrete pedestals, bases, pads, curbs, anchor blocks, anchor bolts, slab inserts, hangers, channels, cradles, saddles, etc., for installation of all electrical equipment and apparatus that is floor mounted.
- B. Concrete pads must be 6 inches high, unless shown otherwise on the Drawings, complete with steel reinforcing and necessary bolts, anchors, etc. Where the concrete pad is set directly on a concrete floor, drill and epoxy dowels into the floor after scarification. These pads must be extended at least 2 inches beyond the equipment outlined on all four (4) sides, unless otherwise indicated on the Drawings. The Contractor must chamfer the edges of the pad at a 45° angle.
- C. No direct-earth buried GRSC will be allowed without the PVC coating.

2.02 VIBRATION ISOLATION:

- A. Vibration producing equipment must have either spring elements in the hanger rods or isolation pads under the equipment.
- B. Conduit connections to vibration producing equipment must be made with flexible conduit, using either FMC or LTFC as required.
- C. Acceptable manufacturers must be Barry Division of Barry Wright Corp., Consolidated Kinetics Corp. or Mason Industries.

2.03 CONDUIT AND FITTINGS:

- A. Rigid Galvanized Steel Conduit (RGSC):
 - 1. Conduit and fittings must be rigid galvanized steel, heavy wall type, hot-dipped galvanized with zinc-coated threads and acceptable agency labeled.
 - 2. Rigid Galvanized Steel conduit and couplings must be threaded, rigid steel, hot-dipped galvanized after fabrication and must be in accordance with UL 6, Federal Specification WW-C-581d and ANSI Standard C80.1.
 - 3. RGSC must be used for all exposed work, unless permitted otherwise in these Specifications, outdoor conduit runs and for all conduit work installed in slabs.

4. Split, compression or setscrew couplings and connectors are not acceptable. All connections and fittings must be threaded.
- B. Intermediate Metal Conduit (IMC)- Minimum size 2 inches:
1. Conduit and fittings for intermediate metal conduit (IMC) must be heavy wall type, hot-dipped galvanized with zinc-coated threads and acceptable agency labeled.
 2. IMC and couplings must be threaded, rigid steel, hot-dipped galvanized after fabrication and must be in accordance with UL 6.
 3. IMC can be used for indoor exposed work in dry locations. It must not be installed below 8 feet with the exception of completing conduit runs to cabinets, panels and pull and junction boxes where the installation has been in IMC.
 4. The use of "Uni-swivel" type IMC is acceptable. The "Uni-swivel" system must employ a fully threaded connection. The use of set-screw type of connections are not acceptable.
 5. Splice, compression or setscrew couplings and connectors are not acceptable. All connections and fittings must be threaded.
- C. EMT Conduit
1. Electrical metallic tubing (EMT) "thin wall" conduit must be steel, electroplate galvanized after fabrication and acceptable agency labeled. The conduit must be in accordance with UL 6.
 2. EMT couplings and connections must be of the compression type with insulated throats. The insulated throats must be of flameproof and non-combustible composition materials.
 3. EMT must be used for indoor installations where the conduit is concealed in walls and above finished ceilings. EMT will not be installed in concrete.
 4. Set-screw, die cast, white or pot metal and indenter type fittings are not acceptable.
- D. PVC Coated RGS Conduit
1. PVC coated rigid steel conduit, including elbows and fittings must be made with RGS conduit, conforming to the RGSC Section of this Specification, to which is bonded a Polyvinyl chloride (PVC) coating for the protection of the conduit.
 2. The minimum thickness of the exterior coating must be 40 mils.

3. A Urethane chemical coating must be uniformly and consistently applied to the interior of the conduit and fittings. The internal coating must be applied at a minimum thickness of 2 mils.
 4. The PVC coated galvanized rigid conduit must be U.L. listed / labeled. The Manufacturer must submit certified test results from a recognized independent testing company validating that their product meets or exceeds the requirements of ASTM D870-02 Testing Water Resistance of PVC Coating Using Water Immersion and ASTM D2247-02 Testing Water Resistance of PVC Coating in 100% Relative Humidity, to signify compliance to the adhesion performance standards.
 5. PVC coated conduit must conform to NEMA Standard RN1-1986.
 6. All fittings and components for use with PVC coated conduits must be PVC coated as specified in this Specification. Each coupling must be furnished loose with each length of the conduit and must have a PVC sleeve extending one (1) pipe diameter, or 2 inches, whichever is greater, beyond the end of the coupling. The inside diameter of the sleeve must be the same as the outside diameter of the IPS conduit used with it. The wall thickness of the sleeve must be the same as the PVC coating in the conduit. All screws for fittings which are PVC Coated must be Stainless Steel.
 7. PVC coated conduit must be used in chemical environments, and for exterior work and underground ductbanks where so specified.
- E. Any portion of the conduit system that shows corrosion within the guarantee/warranty period must be replaced at no cost to the City.
- F. The minimum conduit size, unless specified otherwise, is 3/4 inch.
- G. All conduit fittings must be of the types specified, must be in accordance with UL 514 for normal application, and UL 886 for hazardous applications
- H. Acceptable conduit manufacturers must be Allied Tube and Conduit Corp., Wheatland Tube Company or Steel Duct Conduit Products.
- I. Acceptable conduit fitting manufacturers must be Appleton, Crouse-Hinds, OZ Gedney, Bridgeport, Regal or T&B.

2.04 FLEXIBLE CONDUIT AND FITTINGS:

- A. Liquid-Tite Flexible Conduit (LTFC) must be galvanized steel with a moisture and oil-proof plastic-coated jacket, listed and labeled by an acceptable agency. LTFC must be rated for the temperature environment in which it must be placed.
- B. LTFC must be in accordance with UL 360, with PVC outer jacket and integral ground conductor.
- C. Connectors must be malleable iron or steel with insulated throat, squeeze-type, with annular gripping rib. Particular attention must be given to maintaining ground bond and firm support through flexible connections. Liquid-tight connections must have insulated throats.
- D. Flexible metal conduit (FMC) must be in accordance with UL 1.
- E. Fittings for FMC must be specifically designed and manufactured for the use with FMC.
- F. Flexible metal conduit installed in air return ceilings and other plenums will be as approved by the City of Chicago Bureau of Electrical Inspection.
- G. Acceptable manufactures are Anamet, Electro-Flex or Ultra-Tite.

2.05 PVC CONDUIT:

- A. Non-metallic conduit must be PVC Schedule 40 with concrete encasement where shown on Drawings. Schedule 80 PVC shall be utilized when the only cables installed within them are for lightning protection / grounding / bonding.
- B. PVC conduit, including elbows and couplings, must meet the requirements of NEMA Standard TC2 (latest edition), UL Standard 641, Federal Specifications WC-1094A and must be UL rated and listed for use with 90 degrees C rated conductors in compliance with Article 347 of the NEC. Materials must have a minimum strength of 7,000 psi, flexural strength of 11,000 psi, and compressive strength of 8,600 psi, all at an ambient temperature of 23 degrees C.
- C. The conduit must be manufactured from virgin PVC compound that must meet the applicable requirements of ASTM D1784.
- D. PVC conduit fittings must meet with the requirements of NEMA Standard TC3 (latest edition), UL Standard 514 supplement and Federal Specification WC-1094A.

- E. Standard fittings and cement must be obtained from the conduit manufacturer. Assembly of the PVC conduit system must be in strict accordance with the manufacturers instructions.
- F. Acceptable PVC conduit manufacturers must be National Pipe, Carlon (Lamson and Sessions), Cantex, and IPEX.

2.06 BUSHINGS:

- A. Bushings for Rigid and IMC conduit must be malleable iron body with 105 degrees C and with 150 degrees C insulating ring. Insulator material must be molded in place and must be non-removable.
- B. Acceptable manufacturers must be Appleton, Catalog Series BU75I, OZ/Gedney Catalog Series IBC-125.
- C. Grounding bushings for RGSC and IMC must be Appleton Series GIB-75L or OZ/Gedney Series HBLG0722. Bushings must be hot-dipped galvanized or triple coated with an insulating ring molded into the bushing with a 150 degree C rating. Insulating ring must be non-removable.
- D. All bushings must be of the threaded type. Set screw or compression type bushings are not acceptable.

2.07 CONDUIT SEALS AND EXPLOSION-PROOF FITTINGS:

- A. Conduit seals must be Crouse-Hinds Type EYS or EZS, Appleton ESUF or ESUM or OZ Gedney and filled with compound after first damming with proper fiber per the manufacturers instructions. The fiber and compound must be from the same manufacturer as the fitting.
- B. Explosion-proof seal, drain and breather conduit fittings must be installed as required by Code.
- C. Fittings and sealing compound must be designed for application at the Class, Division and Group at locations indicated on the Drawings. Fittings must be of the malleable iron type.
- D. Combination seal and drain fittings may be used in lieu of two separate fittings.
- E. Acceptable explosion-proof manufacturers must be Appleton Electric Co., Crouse-Hinds Co. or OZ Gedney.

2.08 PULL AND JUNCTION BOXES:

- A. Pull and junction boxes in non-hazardous environment exterior of buildings, interior wet areas, and chemical environment where chemicals are stored or mixed with liquids and areas where subject to corrosive elements must be NEMA Type 4X, 316 stainless steel, with stainless steel hinged cover, stainless steel fasteners and stainless steel hardware. Minimum gauge must be 12 ga. for boxes with no dimension larger than 18 inches, and 10 ga. for all other boxes. The welds must be ground or polished to present a clean and neat finish.
- B. Pull and junction boxes in non-hazardous and dry environment must be NEMA Type 12 gasketed, 12-gauge, seam welded, galvanized, with a rust inhibitive primer, screwed type or hinged as required by job conditions. All screws must be stainless steel.
- C. Pull and junction boxes located in a hazardous environment must be explosion-proof type, rated for the environment into which they must be located.
- D. Covers for non-hazardous boxes must be secured with round or flat head machine screws. Where required screws must be of the tamper-proof type.
- E. Where required by building construction, special junction or pull boxes must be provided in sizes and shapes determined from field measurements as required to make a neat and workmanlike installation. Special size and/or shaped boxes must be sized in accordance with the Chicago Electrical Code.
- F. Where required, boxes with metal barriers or separators for grouping of dissimilar conductors for voltage or system must be provided in compliance with the City of Chicago Electrical Code.
- G. Where required by the Drawings or job site conditions special finishes must be provided. These may be hot-dipped galvanized, PVC coated, etc. The Contractor must take extreme precaution when working in these areas to insure that the proper finishes are provided.
- H. Acceptable manufacturers must be Appleton Electric, Crouse-Hinds, Hoffman, Keystone, A.W. Circle, Chicago Switchboard or IEC.

2.09 OUTLET BOXES:

- A. Outlet boxes for indoor, dry work must be of the galvanized, pressed steel, knockout type. Boxes must be suitable for the structural

conditions with the size determined by the number of conduits entering, and the devices or fixtures attached as required by the manufacturer. All outlet boxes must be in accordance with UL 514 for normal application and UL 886 for applications in hazardous locations.

B. Outlet boxes must generally be 4 inches square or octagonal except as follows:

1. In masonry walls, where conduit is installed concealed, each outlet box must be square cut masonry boxes.
2. For concrete installation boxes must be suitable and constructed for installation in concrete.
3. In exposed work, suitable boxes must be used for switches and receptacles. The NEMA type must be as described in this Specification.
4. Outlet boxes for use outdoors or in wet/damp locations must be of the threaded hub, cast malleable iron type, with malleable iron cast covers. Covers must be gasketed unless of the threaded type.
5. In finished plaster walls, drywall, etc., raised device covers on outlet boxes must be provided.
6. Where 1-1/4-inch conduit is required, the box size must be a minimum of 4-11/16 inches square.

C. Proper covers on flush mounted boxes must be provided.

D. Device Boxes

1. Recessed ceiling fixtures, unless otherwise specified by the light fixture manufacturer, must have 4 inch square sheet steel box with blank cover.
2. Surface mounted ceiling fixture and surface mounted wall bracket fixtures must have 4 inch sheet steel octagon box with round opening plaster ring.
3. Ceiling outlets and wall bracket outlets in dry locations must have 4 inch sheet steel octagon box with proper plaster ring.
4. Outlet boxes on exposed conduit run in wet or damp locations must be a cast iron box with threaded hubs and gasketed cover.
5. Wall switch and receptacle boxes installed in tiled or plastered walls must have 4 inch square sheet steel box or multigang box with proper tile or plaster ring as required. Two (2) gang utilization may be provided by means of 4 inch square box with two (2) gang tile or plaster ring.

6. Wall switch and receptacle boxes in dry locations in brick walls, unfinished walls, woodwork, etc. must be a 4 inch square sheet box, with single gang or two (2) gang plate ring of the proper depth.
 7. The use of single gang boxes is prohibited.
 8. Extra deep boxes must be provided for such devices as dimmers, G.F.I.C.'s or where there are more than 4 wires spliced together with a wiring device(s) also contained in the same box.
- E. Plaster covers must have threaded ears and must be of suitable depth for the application.
 - F. The Contractor must provide boxes with metal barriers, baffles or separators for grouping of dissimilar conductors or system separation.
 - G. Acceptable manufacturers must be Appleton, Racor, Steel City or Crouse-Hinds.

2.10 EXPANSION JOINTS:

- A. The Contractor must provide expansion couplings with 8 inch movement and with bonding jumpers in all conduit crossing building and structure expansion joints.
- B. Expansion fittings must be Appleton, XJ with XJB jumpers, Crouse-Hinds or OZ Gedney.

2.11 FLOOR BOXES AND FITTINGS:

- A. Concrete tight floor boxes must be pressed steel boxes with adjustment brass flange and covers. Acceptable manufacturers must be Bell F4052, Hubbell 2529 or Walker.
- B. Watertight floor boxes must be cast iron with adjustable brass flange and covers. Close up plugs and reducing bushings must be provided as required. Acceptable manufacturers must be Bell F122-NR, Hubbell 2537 or Walker

2.12 WIRE AND CABLE - 600 VOLT:

- A. Wire and cable must be soft copper, properly refined and must have minimum conductivity of 98 percent. Aluminum conductors are not acceptable.

1. Conductors for power and lighting must have 600-volt type insulation, must be not less than No. 12 AWG, must conform to the latest CEC and must bear acceptable agency label.
 2. Wire for signal and control systems must be No. 14 AWG stranded unless otherwise indicated on the Drawings, or elsewhere in the Specifications.
 3. Factory wired equipment of a manufacturers' standard product line must be wired with the manufacturers' standard wire size and type provided that the wiring meets all applicable Code requirements. This does not apply to custom-built equipment as specified elsewhere in the Specifications.
- B. Wire and cable must be delivered to the job site in original packaging or on factory reels. All wire and cable must bear tagging or marking on the finish at regular intervals and consisting of manufacturers' name or code number, as well as the insulation type, voltage rating and acceptable agency listing.
- C. Wire and cable must be factory color-coded insulation and must be installed and connected as follows:
1. Color coding for voltage system of 250 volts and less must be
 - a. "A" Phase - Black
 - b. "B" Phase - Red
 - c. "C" Phase - Blue
 - d. Neutral - White
 - e. Ground - Green
 2. Color coding for voltage system of over 250 volts and less than 600 volts must be
 - a. "A" Phase - Brown
 - b. "B" Phase - Orange
 - c. "C" Phase - Yellow
 - d. Neutral - Gray
 - e. Ground - Green
 3. Green must be used for grounding only.
 4. Three-way and four-way switch travelers must be of a different color from colors stated above and they must be of the same color.
- D. The insulation must be applied tightly to the conductor and must be free stripping.
- E. Branch circuit wiring must be solid copper No. 12 AWG unless otherwise specified. All conductors #10 and smaller shall be solid.

- F. Per FAA-E-2013, Paragraph 3.3.1.1.a, Solid conductors shall be furnished when conductors smaller than #8 are required.
- G. Type THHN/THWN thermo-plastic insulated, 90 degrees C dry and 75 degrees C wet rated must be used for light, power and other wiring not specifically defined for all sizes. Type THHN thermo-plastic insulated 90 degrees C rated must be used for continuous row fluorescent fixture wiring.
- H. Type SF-2 silicone insulated glass braid jacket, 200 degrees C< 600-volt rated must be used for fixture wiring and or recessed incandescent fixture wiring and must be No. 12 AWG minimum.
- I. Teflon insulated 200 degrees C rated must be used for use within 5 feet of boilers and 1 foot of heating pipes.
- J. Wire and cables 600-volt rated for installation in floor slabs, etc. and outdoor use in exposed conduit must be XHHW-2. All underground ductbank installation must be RHH/RHW/USE, either XLP-USE or EPR with a CPE jacket, insulated.
- K. If any of the cable types are modified by the Drawings, the Drawings must be followed.
- L. Wire types for the telephone, communications, public address, computer data, door security and fire alarm systems must be in accordance with recommendations of the equipment manufacturer. Acceptable manufacturers of this type of cable must be American Insulated Wire, Belden, Dekoron, Okonite, Pirelli or West Penn.
- M. The 600-volt insulated wires and cables must be factory tested prior to shipment in accordance with the latest ICEA standards for the insulation specified.
- N. Samples and reports on the results of shop tests for all wire and cables, descriptive literature for splices and terminations must be submitted and must be treated as a Shop Drawing submittal.
- O. Acceptable cable manufacturers for 600-volt rated cable must be American Insulated Wire Corp., Southwire, Cerro, Aetna,, Pirelli, and Draka Cableteq.

2.13 CONNECTORS:

- A. For connections to bus bars, use copper compression connectors. Connectors must be crimp type. All connectors must be copper. Copper compression connectors must be long barrel, tin plated, closed

end compression type. The barrel for each cable lug must be sized for the exact cable size specified. Copper-Aluminum connectors are not acceptable.

- B. Mechanical or set screw types are not acceptable. The cables must be terminated with the die type compression tools. The compression connection must be UL rated. Use only those tools which must provide a UL rated connection for the manufacturers product used.
- C. Conductors No. 2 AWG and larger must terminate in two-hole solderless lugs.
- D. Conductors No. 10 AWG and No. 4 AWG, inclusive, must terminate in one (1)-hole lug.
- E. Multiple-hole lugs must have NEMA spacing
- F. Acceptable connector manufacturers must be Burndy Type YA, Anderson Type VHCL, Thomas & Betts Co., Series 54800 and 54900 or Panduit Series LCB.

2.14 TAPE:

- A. Tape must be UL approved, black or colors as required, self-fusing jacketing tape, resistant to weather, oils, water and chemicals. Tape must met or exceed Scotch 33+.
- B. Acceptable manufacturers must be Amazon, Plymouth or 3-M.

2.15 WIRE-PULLING LUBRICANT:

- A. Where necessary to use a lubricant for pulling wires, the compound must be listed by Underwriters Laboratories. Cable pulling lubricant must be biodegradable, non-flammable, non-toxic compound with a solid residue of not more than 1.5 percent and a viscosity of at least 50,000 C.P.S.
- B. Cleaning agents or lubricants that have a deteriorous effect on conductors covering must not be used. Cable lubricant must contain no waxes, greases, silicones or polyalkylene glycol oils.
- C. Lubricant must be rated to match temperature conditions at the time of installation.
- D. Acceptable manufacturers must be Polywater J, High Performance Cable Lubricant, Ideal or Aqua-Jel 2.

2.16 SUPPORTS:

- A. Where conduits are supported with one-hole straps, spacers must be used to provide 1/4 inch minimum clearance between the conduits and supporting surfaces. All hangers, racks and straps must be galvanized steel.
- B. Perforated strap hangers are not acceptable. The use of tie wire is not acceptable.
- C. Hanger rods for trapeze-type hangers must be made from high tensile strength carbon steel not less than 3/8 inch diameter. The rods must have free-running, burr-free Unified National Coarse threads, with an electro-galvanized finish. Threaded rods used outdoors, in wet areas or in corrosive areas must be Grade 316 stainless steel.
- D. Conduit supports for trapeze hangers must be made from U-shaped steel components which are galvanized. Minimum material thickness must be 12 gauge. Supports must be hot-dipped galvanized or stainless steel for exterior use. For areas of corrosive nature, or where PVC Coated strut is used, PVC coated components must be provided. The use of painted components is prohibited. The miscellaneous components which are required to complete the support materials, except the threaded rod, must have the same finish as the U-shaped channel. Conduit supports must be as manufactured by Unistrut Corp., Kindorf, Powerstrut or B-line.
- E. When conditions exceed the structural capabilities of U-shaped strut the Contractor must submit for review detailed Drawings indicating the proposed method of support. The submittal must contain complete details of fabrication, calculations, materials and finishes.
- F. All field cut ends must be treated in a manner which must insure the integrity of the support system immediately after cutting and before installation. The repair must be done with materials which are compatible with the factory finish. In no case must spray on galvanizing be acceptable for PVC or other special finishes.
- G. Supports must be held to concrete walls and ceilings by power-driven fasteners or electro-galvanized steel or stainless steel inserts as manufactured by Ramset, Unistrut Corp. or Hilti. The support type must be determined by the area conditions.
- H. Where single conduits are supported in ceilings, products such as "minis", must be used. The hanger rod size must be as required by the hanger manufacturer.

- I. In metal stud walls, products such as "Caddy clips" must be used to support conduits. These supports must be of the locking type which have an overstrap to lock the conduit into place. These supports must be held in place with screws which must attach them to the metal stud construction.
- J. For 4 inch and 4-11/16 inch boxes, 1/4 inch rods must be the minimum size. Larger size boxes must have hanger rods sized in accordance with the load, but must not be smaller than 1/4 inch.
- K. Boxes installed in stud walls must be secured to the studs by attaching to the stud with mounting brackets specifically designed for this purpose. No box will be installed with support supplied on only one side of the box. Acceptable manufacturers are Appleton, Raco, Steel City or Caddy.

2.17 SPLICES:

- A. No splicing will be permitted except in junction boxes, handholes and manholes. Splices and terminations in wire/cable larger than 8 AWG must be made with compression type connectors and lugs. The tools used must provide a UL certified connection. Indenter type compression fittings must not be acceptable. Lugs must be one (1) or two (2)-hole, color keyed. Lug bolting must include a flat washer, Belleville washer and a locknut.
- B. Outdoor splices of conductors must be made using heat shrink products which, when properly installed, must produce a completely sealed covering over the connectors or lugs. The tube or jacket must be completely coated with mastic to insure a 100 percent seal to the conductor jacket. The splice, when completed, must be watertight. An acceptable manufacturer of this type product is Raychem Inc.
- C. All splices and pigtail connections in lighting and receptacles wiring No. 8 AWG and smaller must be made up with the pre-insulated spring connectors. Acceptable products are Buchanan, Ideal Wingnut or Scotch Lock 2.

2.18 TERMINAL BOXES:

- A. Terminal boxes must be UL 508 Listed for Type 12 and Type 13 or Type 4X. They must conform to NEMA Standards for Types 12 and 13 or Type 4X and they must conform to JIC Standard EGP-1-1967.
- B. Each box must have provisions for the mounting of terminals, either on an internally mounted panel, or on metal strips which are provided by

the manufacturer expressly for the purpose of attaching terminal strips. Wherever a panel or strips are provided they must be mounted on studs using lockwashers and nuts.

- C. Terminal boxes in non-hazardous environments which are exterior of buildings, in interior wet areas, in chemical environment where chemicals are stored or mixed with liquids and in corrosive areas must be NEMA Type 4X, 10-gauge minimum for boxes with a dimension over 18 inches, 12 - gauge minimum for smaller boxes, 316 stainless steel with stainless steel hinged door, stainless steel fasteners and stainless steel hardware. Boxes must have provisions for external locks. The welds must be ground or polished to present a neat and clean appearance.
- D. Terminal boxes in non-hazardous and dry environment must be NEMA Type 12 gasketed, 12-gauge, seam welded, galvanized, with a rust inhibitive primer, hinged door, and must have provisions for external locking. The interior must be painted with white enamel. The exterior will be painted, color as required by the Commissioner.
- E. Acceptable manufacturers of enclosures are Hoffman, A. W. Circle and IEC.
- F. The terminals must be 30 ampere, 600 volt rated, barriered, with pressure plate lugs for termination of control wiring. The terminals must be of modular design and must be held in place in such a manner as to prevent them from becoming loose when adding or removing terminals. Terminal blocks will be acceptable agency listed. Acceptable manufacturers are Buchanan, Allen Bradley, Eaton/Cutler-Hammer/Westinghouse, G. E., and Square D.
- G. The terminal box assembly must be acceptable agency labeled. Identification of terminals and wiring must be per Specification 16195 Electrical Identification.
- H. Acceptable suppliers of the assembled terminal box are Panatrol, Chicago Switchboard, and Gus Berthold.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL:

- A. Interferences:
 - 1. Locations of conduits, fixtures and equipment must be adjusted and supported to accommodate the work in accordance with

field conditions encountered, anticipating potential interferences.

2. The Contractor must determine the exact route and location of each pipe, duct and electrical raceway prior to fabrication.

B. Accessibility

1. The work must be installed to permit removal (without damage to or removal of other parts) of parts requiring periodic replacement or maintenance and as defined by the Chicago Electrical Code.
2. Conduits and equipment must be arranged to permit ready access to components and to clear the openings of swinging and overhead doors and of access panels.
3. The Contractor must provide necessary access panels in equipment as required for inspection of interior and for proper maintenance. Access panels must be as specified in other parts of the Contract Documents.

C. Exterior Wall Openings

1. Openings in exterior walls, particularly at or below grade, must be kept properly plugged and caulked at all times, except when being worked on, to prevent the possibility of flooding due to storms or other causes.
2. After completion of work, openings must be permanently sealed and caulked so as to provide leakproof and/or to maintain the fire-rated conditions of the structure penetrated.

3.02 CONDUIT INSTALLATION:

- A. All conduits must be installed as required. The conduit system must be installed complete with all accessories, fittings, boxes and supports in an approved and workmanlike manner to provide proper raceways for electrical conductors.
1. All conduit runs shown in the Drawings are shown diagrammatically for the purpose of outlining the general method of routing the conduits to avoid interferences.
 2. Conduit systems must be run concealed or exposed as shown or as dictated by job-site conditions.
 3. Exposed conduit runs must be installed true, plumb, parallel with or at right angles to adjacent building members, and must present an orderly, neat and workmanlike appearance.

4. Field bends must be carefully made to prevent conduit damage or reduction in internal areas. All bends must be made with equipment specifically made for the purpose of bending conduit. The bending radius must not be less than six (6) times the nominal diameters of the conduit, with carefully matched bends on parallel runs to present a neat appearance. The number of crossovers must be kept to a minimum. Where larger radii are required to meet utility company requirements, etc., they must be provided. Hickey bends are not acceptable.
5. For PVC conduit bends which exceed the radii available the Contractor must field bend the conduit using equipment and methods as directed by the conduit manufacturer. Extreme care must be taken not to deform the conduit.
6. Conduits which are crushed or deformed in any way will not be installed.
7. All conduits cut on the job must be carefully reamed inside and out to remove burrs. All field cut ends of conduits must be cut square and must be done with the proper tools. The use of tubing cutters is strictly prohibited. Conduits not properly cut will be replaced at no cost to the City.
8. For PVC coated conduits all field bends must be made using tools specifically designed for the purpose of bending PVC coated conduits. If the Contractor does not have these tools he must bend the PVC coated conduit using a bend radius one size larger than would normally be used for that size conduit.
9. All threads must be tapered. No running threads will be permitted. Threads on steel conduit must be given a coat of zinc duct in oil, or other approved compound. All joints must be properly tightened and must be watertight and insure a low resistance ground path in the conduit system.
10. For PVC coated conduits field cut threads must be done with tools as specified by the manufacturer of the PVC coated conduit. Extreme care must be taken to prevent damage to the PVC coating. The manufacturers' instructions must be followed for this operation. After the threads have been cut any damage to the coating must be immediately repaired using materials and methods as recommended by the manufacturer. The material thickness of any field repair must be equal to the factory finish which has been damaged. Repairs must be done immediately.
11. The Contractor must exercise extreme care in the assembly of PVC coated conduits. Metal jawed tools will not be used for this assembly. Conduits which are damaged as a result of using

improper tools must be removed and replaced by the Contractor at no cost to the City.

12. All conduits must be carefully cleaned before and after installation and all inside surfaces must be free of imperfections likely to injure the cable. After installation of complete runs, all conduit must be snaked with an approved tube cleaner equipped with an approved cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Any conduits through which the mandrel will not pass must be removed and replaced. All conduits installed in interior areas 1 inch and smaller must be cleaned by pulling clean rags thru the conduits. After cleaning, the ends of the conduits must be protected as specified to prevent the entrance of water and other foreign matter. The use of such items as plastic bags, tape, paper, rags, etc. will not be used under any circumstances. Failure to properly protect conduit ends must result in the Contractor having to again mandrel the conduits immediately before installing the wires.
13. Lines of nylon, polyolefin or polypropylene, propelled by carbon dioxide, vacuum or compressed air, must be used to snake or pull wire and cable into conduits. Flat steel tapes or "sparks" type tapes can only be used in conduit runs of 50 feet or less. They will not be used in PVC or PVC coated conduits. Metal cables are expressly forbidden for pulling wire/cable. Non-metallic pull tapes can be used for all types of conduits.
14. Where conduits are connected to boxes or equipment enclosures, drilled holes or full size knockout openings must provide electrical continuity for grounding and must be assured by the use of bonding type locknuts. Where connections are at slightly eccentric openings, jumper type grounding bushings and wire jumpers must be installed. Should the openings become excessively eccentric, as determined by the Commissioner, the box or equipment must be replaced at no cost to the City. The use of reducers will not be found acceptable under any circumstances.
15. Telephone conduit radius must not be less than 10 conduit diameters. The Contractor must verify with the company providing phone service as to their actual requirements for installation.
16. Conduit systems must be installed, with fittings, couplings, connectors, double locknuts, bushings, etc., and made up tight to insure ground continuity throughout the system.

- B. As far as practicable, conduit must be pitched slightly to drain to the outlet boxes, or otherwise installed to avoid trapping of condensate. Where necessary to secure drainage, a breather-drain fitting must be installed in the boxes at low points. Each breather drain fitting must be manufactured by Crouse-Hinds Co., Appleton Electric Co., or O.Z. Gedney. Conduit must not run through columns or beams unless so specifically detailed, submitted and accepted by the Commissioner.
- C. Each building expansion joint, each straight uninterrupted run of surface mounted conduit, and vertical risers in excess of 100 feet must be provided with appropriate expansion fitting. The distance between fittings as installed must not exceed 200 linear feet.
- D. The Contractor must furnish and install expansion couplings and bonding jumpers for metallic conduit system where conduits cross building expansion joints or where conduits transfer between structurally independent pipes, poles or supports.
- E. Conduits crossing building-expansion joints must be provided with expansion fittings and flexible grounding bonds bypassing the fittings to insure ground continuity.
- F. Conduit Installed in Concrete Slab
 - 1. Where conduit is to be installed in concrete slab, conduit must be placed in the center of slab and no closer than 3 diameters from adjacent conduits. The maximum outside diameter of conduits in the slab must be no greater than $\frac{1}{4}$ of the slab thickness. The minimum slab thickness must be 6 inches for embedded conduit installation. In no case must conduits be installed in the bedding material of the finish floor covering.
 - 2. Conduit openings must be temporarily plugged to exclude water, concrete, plaster and other foreign material. For smaller conduits push pennies may be acceptable, as determined by the Commissioner.
 - 3. Conduits run in or below any floor slab must be entirely encased in reinforced steel concrete. In no case must conduit be laid in the fill below slab.
 - 4. Conduits embedded in concrete must be blocked and braced in place by use of adequate conduit separators to prevent displacement during the placing of concrete. The Contractor must be held responsible for proper position of conduits and must rearrange any conduit that may be displaced, when concrete is placed, at his own expense.

5. Conduits run in floor slabs or underground must be a minimum of 1 inch in size, rigid galvanized steel conduit unless noted otherwise on the Drawings.
 6. All concealed conduits must be placed in walls and ceilings at the proper time, in accordance with the progress of the structural work.
 7. Concrete-encased conduit runs extending through structural expansion joints must have fittings permitting longitudinal movement of the conduit ends without damaging the contained wires. The fittings must be watertight and include a grounding bond.
- G. Conduits installed in dry locations requiring a flexible connection for adjustment or vibration isolation must be provided with an 18 inch minimum length of either FMC or LTFC, as required by the area conditions.
- H. Flexible conduit installed in wet locations, exterior locations, air return ceilings and at motors must be liquid-tight type except for lighting in air return ceilings which must be of a type acceptable to the Bureau of Electrical Inspection, City of Chicago.
- I. Flexible conduit in ½ inch trade size may be used for connections with a maximum length of 18 inches for such devices as limit switches, for which the use of ¾ inch flexible conduit may not be practical due to the manufacturer providing only threaded hubs of the ½ inch size. In the case of such installations as electric door locks, where only ½ inch provisions are available, the Contractor can install ½ inch conduit from the device to a box located as close as possible.
- J. The number of 90 degree bends must be limited to four or a total of 360 degrees including all off sets, sweeps, kicks, etc. This must be between any pull points.
- K. The Contractor must be aware that the conduits are sized for cables routed in exposed rigid steel conduits, as denoted on the Contract Drawings. The same cables may be partly routed in ductbanks. The ductbanks are sized on the Drawings.
- L. Conduits entering motor control center conduit compartments, switchboards, switchgear, unit substations, etc. must be fitted with jumper type insulated grounding bushings, bonded together and to the structure of the enclosure by a continuous bonding wire.

- M. Conduit runs entering the building from outdoors are subject to moisture accumulation due to condensation. After the wires and cables are installed, the end of the conduit continuing into the warmer area must be packed with a non-setting sealing compound.
- N. All communication, telephone, data and computer conduits must have a minimum separation of 12 inches from any AC power and control conduits.
- O. The Contractor must orient outlet boxes for duplex receptacles or multiple gang switches for horizontal mounting.
- P. An outlet box must be provided at each location requiring one
 - 1. Outlet box locations as shown on the Drawings must be considered as approximate only, unless noted otherwise on the Drawings.
 - 2. Exact locations must be determined from the Drawings and/or from field instructions and coordination with the work of all other trades.
 - 3. Boxes must be installed true and plumb, so that the covers or plates must be level, and at uniform elevations for the type of wiring devices contained.
 - 4. Boxes for toggle switches and pilot lights at doorways must be located at the strike side of the door.
 - 5. Fixtures which weigh more than 5 pounds must be supported independently of the box.
- Q. There must be no more openings made in any box than are required for the conduits entering same. Depths of boxes must be as to allow for easy wire pulling and proper installation of wiring devices.
- R. All boxes must be supported independent of the conduit system. The boxes must be supported from the building structure. Conduits must not be supported from the boxes.
- S. Switches and receptacles must be ganged in a common box only when directed or indicated on the Drawings.
- T. All ceiling outlets must have adequate supports and must be equipped with adequate devices to carry and mount the light fixtures. They must not be supported from the ceiling structure.
- U. Conduit connections to NEMA 12 equipment must be made up with sealing locknuts. Conduit connections to NEMA 4 and NEMA 4X

equipment must be made with Myer's type hubs. In no case must the Contractor terminate conduit to a NEMA 4 or 4X component by providing knock-outs and locknuts.

3.03 CONDUIT CONNECTIONS TO EQUIPMENT:

- A. The conduit system must terminate at the terminal box or at the conduit connection points of electric motors, devices and equipment. Terminations of conduit at such locations will permit direct wire connections to the motors, electrical devices or other equipment.
- B. Conduit connections must be made with rigid conduit if the equipment is fixed and not subject to adjustment, mechanical movement or vibration. A union type fitting must be provided when GRS or IMC is terminated at each enclosure or piece of equipment which contains a threaded termination for the conduit. This may be a threaded hub or through a fitting such as a Myers type hub. Conduit terminations using double locknuts do not require union type fitting.

3.04 PULL BOX INSTALLATION:

- A. Pull boxes must be installed where shown and where necessary to insure that the installed cable will not be damaged.
- B. The Contractor must add pull boxes where needed even though not shown on the Drawings.
- C. Junction boxes and pull boxes of the proper size and shape must be provided. Where suitable, standard outlet boxes must be used as junction boxes and pull boxes.
- D. Pull boxes and junction boxes must be supported from the building structure and must not be supported by the conduit. Pull/junction box supports must comply with the applicable requirements for supports as contained in these Specifications.

3.05 HAZARDOUS AREAS:

- A. The conduit system installed in hazardous locations must be provided as shown, specified and required. The installation must conform to the requirements of the CEC for Class, Division and Group as shown on the Drawings or required by Project conditions.
- B. Explosion proof fittings must be provided for all conduits, within hazardous areas, leaving the hazardous areas, and where they enter the non-hazardous areas, as required.

- C. Explosion-proof seal, drain and breather conduit fittings must be installed as required by Code.

3.06 WIRING INSTALLATION:

- A. All cable and wire must be installed in conduit.
- B. No splices will be permitted between terminals, except at approved junction or terminal box points. Cable and wire runs must be looped through pull boxes without cutting and splicing where possible. Boxes must be sized to allow cable and wire installation without splices.
- C. All hardware, such as cable stanchions, racks, insulators, brackets, structural supports, wall inserts, cable and junction boxes, bolts, connectors, clamps, fittings and other accessories for the installation of wires and cables in buildings, manholes and outdoors must be furnished and installed complete to provide a satisfactory operating installation.
- D. All wiring systems must be "pullable" and use of "BX" is prohibited.
- E. Branch Wiring
 - 1. Branch circuit wiring for lighting and other single phase applications must be sized for a voltage drop in accordance with the City of Chicago Electrical Code.
 - 2. The maximum voltage drop for each circuit must be 3 percent for power and 1 percent for lighting circuits.
 - 3. The Contractor must use multi-wire circuits utilizing separate neutrals and must follow the color coding established. The Contractor must size the wire in accordance with the following:
 - a. Under no circumstances must any switch break a neutral conductor.
 - b. Where farthest wiring device or light is no more than 75 feet from the panel, No. 12 AWG wire must be used between all wiring devices and for home runs.
 - c. Where the farthest wiring device or light is more than 75 feet from the panel, the Contractor will submit voltage drop calculation to the Commissioner, prior to sizing the wire. These calculations must show the wire size to be installed by the Contractor.
 - d. The minimum wire size must be No. 10 AWG between the panel and the first wiring device or fixture when located more than 75 feet from the panel, with a

minimum No. 12 AWG wire being used between all other wiring devices or fixtures.

- e. In office areas, each circuit must have its own neutral. Networking of circuits is not permissible in these areas. This does not apply to lighting circuits with the exception of fixtures which employ electronic ballasts.
- F. Wiring systems in plenum spaces must be installed in accordance with the Chicago Electrical Code and the Chicago Fire Code.
- G. Feeders must be installed with the sizes as indicated on the Drawings and must be connected as required for the proper operation of the equipment they serve.
- H. Building utility motors must be provided under other sections of the Specifications.
 - 1. The Contractor must make all connections necessary to leave motor driven equipment in satisfactory operating condition.
 - 2. The Contractor must provide power branch circuit wiring for all motors and starting equipment.
 - 3. The Contractor must verify the actual motor sizes to be installed, and the actual locations, and provide wiring and equipment of proper sizes as required.
 - 4. At the time when each motor is first operated, the Contractor must check the motor terminal voltages and the amperes in each motor lead to ascertain that, under normal load conditions, the currents do not exceed the nameplate rating on the motor.
 - 5. If the ampere reading in any leads exceeds the nameplate rating of the motor, or if the motor terminal voltages vary more than 5 percent from the nameplate rating of the motor, the Contractor must disconnect the motor and request further instructions from the Commissioner.
- I. Proper termination of conduits and wires at motors, control panels or other equipment items must be provided.
- J. In the event that conduit and wire sizes increase beyond the motor or equipment manufacturer's normal provisions for conduit and wire terminations, due to voltage-drop or other considerations in motor branch-circuit designs, the Contractor must provide auxiliary termination facilities, with adequate boxes, lugs, terminals, knock-outs, etc., as may be required.

- K. Equipment having safety devices such as limit switches, overload relays, high-low water cut-outs, high-low pressure switches, solenoids, pilot devices, flow switches, freeze protection thermostats, etc., must be so wired that they must always be in the control circuits of selector switches regardless of switch position.
- L. The only devices that may be shunted out in the manual position of a selector switch are remote pushbutton stations, clocks, timers and room thermostats and ductstats of the non-limit type.

3.07 SPLICES AND TERMINATIONS - 600-VOLT CABLE:

- A. All splices and terminations must be carefully taped and covered using material recommended by the cable manufacturers, to provide insulation equal to that of the conductors.
- B. All splices must be made in proper splice or junction boxes. Splices must not be made in power or control panels. Splices must not be pulled into any conduit. Splices must not be made in any fitting.
- C. Shielded Cable Grounding
 - 1. Shielded control cables must have the shields grounded at one (1) end. The shield must be insulated from ground, equal to that of the original cable instructions, at each splice.
 - 2. Coaxial cable shields must be insulated from ground throughout the length of the cable run. The shields must be grounded at, and only at, the coaxial connector terminating in the equipment on each end of the cable run.
- D. Splices
 - 1. Splices must be performed only by experienced and qualified cable splicers regularly engaged in this type of work.
 - 2. Shielded cables must have the ends of the shielding bonded together across splices to provide a continuous electrical path. Splice will be made with a terminal block and only when approved by the Commissioner.
 - 3. All cable runs must be given an insulation resistance test and continuity check at the completion of each splice throughout the length of the cable run.
 - 4. Where a cable is cut preparatory to splicing, the work must proceed without delay. When an unavoidable delay is encountered in completing a splice, the opened cable must be

protected to prevent the entrance of moisture and foreign matter with a heat shrink cap.

5. The Contractor must splice control cables with the splice kits and materials manufactured for the purpose of splicing control wiring and in accordance with manufacturer's instructions. A power cable splice kit or resin must not be used to make a control cable splice, and vice versa, under any conditions.
6. No splices are allowed except after approval from the Commissioner and the FAA.

3.08 WIRING METHODS:

- A. All remote mounted devices such as control stations limit switches or pressure switches in a common circuit must have their wires brought back to the terminals on one (1) panel.
- B. When multi-conductor cables are used the number of conductors to be provided in each cable to be such that at least 1 spare conductor must be available for up to 5 conductors in use, 2 spare conductors must be available for 6 to 10 conductors in use, and 20 percent must be available for more than 10 conductors in use. The spare conductors are only required between major electrical equipment.
- C. Multi-conductor cable jacket must be pulled back and neatly trimmed to allow conductors to be separated, so they can be terminated to more than one (1) device. The cable must be supported in the panel where it enters the enclosure.
- D. Spare conductors must have the ends taped and they must be neatly coiled and tied and left in the bottom of the enclosure. They must be marked as spare conductors.

3.09 ELECTRICAL HARDWARE INSTALLATION:

- A. Locations
 1. Anchor bolts, sleeves, inserts, hangers and supports required for the work must be furnished and installed by the Contractor.
 2. Any expense resulting from improper location or installation must be paid for by the Contractor at no cost to the Commissioner.
 3. Where conduit and equipment is to be suspended from poured concrete construction, the Contractor must provide approved concrete inserts in the form work. Expansion shells may be used on precast concrete members but not closer than three (3)

inches from the edge. The Contractor must verify the acceptable depth of anchors before beginning work on any pre or post tensioned members.

B. Hangers

1. The Contractor must provide adequate supports for all conduits and equipment, either suspended from the construction above, or by means of struts to the construction below. Where metal deck pan is used for the concrete floor above, anchors must only be placed in the rib. When the weight of the support system, including the completed electrical assembly, exceeds 100 pounds per hanger the Contractor will submit his design for review to the Commissioner.
2. Hangers for support of conduit must be fabricated type, but not of the perforated iron type, and must conform to the requirements of the Contract Documents.
3. Hangers must be suitable for the weight of the material / equipment being supported. This must include any and all pulling loads, as well as the load of the conductors, which the support may be subject to.
4. Trapeze type hangers may be used where several conduits are to be installed at the same elevation.
5. The Contractor must provide straps, clamps, threaded rods, turnbuckles and anchors and all miscellaneous specialties for the attachment of hangers and supports to the structure.
6. Vertical conduits must be supported by heavy metal clamps or collars anchored in or to the construction at each floor.

C. Conduit Supports

1. Exposed conduits must be supported in an approved manner. Conduits must not be fastened to or come in contact with any mechanical system pipes, ducts or equipment of other trades, except as approved by the Commissioner. In all conduit work, acceptable hangers, racks or a combination thereof must be used as supports.
2. Conduit trapeze supports must be located at intervals not exceeding 5 feet. Single conduits must be supported as required by the Chicago Electrical Code.
3. Conduits must be securely fastened to each trapeze with U-bolts, straps or clamps.

4. Whenever possible conduits must be supported from the building structural steel. Beam clamps must be used to attach to the steel. When the conduit supports must be attached to the structural concrete proper anchors must be installed. Anchors must not be closer than 3 inches from the edge of the concrete. The use of anchors containing lead, plastic or wood is strictly prohibited.

D. Sleeves

1. The Contractor must provide sleeves in fire rated walls and floors, and when penetrating CMU walls.
2. Wall sleeves must be minimum 18-gauge galvanized sheet metal, as approved by Code, of sufficient length to finish flush with finished surfaces at both ends of the sleeves.
3. Sleeves must be not less than 1 inch larger than outside diameter of the conduit.
4. Floor sleeves must be galvanized steel pipe, as approved by Code, 3 inches above floor, and must be watertight.
5. Where conduit passes through floors or exterior walls, the Contractor must caulk sleeves with an appropriate system to insure the complete sealing of the opening to prevent passage of water, dirt or air and to insure the fire rating of the structure penetrated.
6. Sleeves must be set true to line plumb and position and must be so maintained during construction. Where sleeves are provided in poured concrete, the Contractor must inspect same during and after concrete is poured to insure proper position and to correct any deviation at the Contractors expense.

3.10 PAINTING:

A. Prime Coat

1. Shop fabricated and factory built equipment without a primer must be galvanized or protected by plating. Before delivery to the site, the equipment must be cleaned and given one (1) shop coat of zinc-chromate primer.
2. Any portions of the shop coat damaged in delivery or during construction must be recoated.
3. Nameplates, labels, tags, stainless steel or chromium-plated items such as motor shafts, levers, handles, trim strips, etc. must not be painted.

B. Finish Coat

1. Conduit and equipment must be left cleaned and primed, ready for finish painting provided under the Painting Section of the Specifications.
2. All equipment, panelboards, switchboards, etc. must be factory finished in baked enamel or lacquer, or as specified. Standard finishes must be as approved. All scratches must be neatly touched-up by the Contractor.
3. All metal work installed by this Contractor exposed to weather and not factory finished must be painted with one coat of rust inhibitive primer and two coats of oil based paint of color selected by the Commissioner.

3.11 PATCHING:

- A. The Contractor must provide all cutting and patching of building materials required for the installation of the work herein specified:
 1. No structural members must be cut without the approval of the Commissioner.
 2. Roof deck is considered a structural member.
 3. Approved cutting must be done with concrete saws or core drills.
- B. Patching must be provided by mechanics of the particular trade involved and done in a neat and workmanlike manner.
- C. Slots, chases, openings and recesses through floors, walls, ceilings and roofs must be cut by the Contractor. The Contractor must see that they are properly located.
- D. Slots, chases, openings and recesses in the structure must be cut by a qualified Contractor. The Contractor must patch and repair as required. Where patching or repair becomes excessive at a location, as determined by the Commissioner, the Contractor must use skilled craftsmen of the appropriate trade to make the repairs or patching.

3.12 CLEANING:

- A. Open ends of conduit and equipment must be properly capped or plugged to keep dirt and other foreign matter from entering.
- B. Each length of conduit must remain capped until the conduit connections are required.

- C. Trenches must be kept free from water. Conduits for ductbanks must not be laid when conditions of the trench are unsuitable for such work, or the weather must prevent quality work.
- D. When work is not in progress, open ends of conduit and fittings must be securely closed so that no water, earth or other substance must enter.
- E. When so directed by the Commissioner all material being removed must become the property of the Contractor, must be removed from the Airport and must be legally disposed of off City property by the Contractor.
- F. The Contractor must be responsible to keep the areas where work is occurring broom clean at all times.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. All conduit, couplings, bushings, conduit bodies, boxes, PVC glue, wire pulling lubricant, and supports will be not be measured separately and will be considered incidental to the corresponding underground duct item.
- B. Underground duct bank for roadway lighting will be measured per specification L-110 Installation of Airport Underground Electrical Duct.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment for conduits, inner ducts, roadway lighting ducts and all associated materials will be incidental to the underground duct item it is associated with and listed in specification L-110 Installation of Airport Underground Electrical Duct.

END OF SECTION 16100

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BUILDING WIRE AND CABLE

SECTION 16123

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Work under this section is subject to the requirements of the Contract Documents.
- B. Furnish and install all electrical work, materials and accessories indicated schematically by Drawings, scheduler and specified herein which include, but is not limited to, the following:
 - 1. Building wire and cable
 - 2. Metallic-sheathed cable
 - 3. Direct burial cable
 - 4. Service entrance cable
 - 5. Armored cable
 - 6. Metal clad cable
 - 7. Wiring connectors and connections

1.02 RELATED WORK:

- A. As specified in the following and other sections as required:
 - 1. Section 16010 – Basic Electrical Requirements
 - 2. Section 16100 – Basic Materials and Methods
 - 3. Section 16195 – Electrical Identification
 - 4. Section 16452 – Grounding
 - 5. Section 16950 - Testing

1.03 REFERENCES

- A. See Specification Section 16010 Basic Electrical Requirements 1.03 References.

1.04 SUBMITTALS

- A. See Specification Section 16010 Basic Electrical Requirements 1.04 Submittals.
- B. The Contractor must submit Project data to the Commissioner prior to purchasing and installation. The data must include, but not be limited to, the following:
 - 1. Catalog cuts and major electrical equipment manufacturers' Drawings must include, but are not limited to, relays, meters, current and potential transformers, disconnect switches, fuses, contactors, lighting and more.
 - 2. Complete descriptive literature, performance and test data and rating data for all equipment must be provided.
 - 3. Instruction books, Operation and Maintenance manuals with spare parts must be provided.
- C. Submit certified copies for all factory tests

1.05 SYSTEM DESCRIPTION

- A. Product Requirements: Provide products as follows:
 - 1. Per FAA-E-2013, paragraph 3.3.1.1.a, solid conductors shall be furnished when conductors smaller than #8 are required.
 - 2. Stranded conductors for control circuits.
 - 3. Conductor not smaller than 12 AWG for power and lighting circuits.
 - 4. Conductor not smaller than 14 AWG for control circuits.
 - 5. 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.
 - 6. 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.
- B. Wiring Methods: Provide the following wiring methods:
 - 1. Concealed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.

2. Exposed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
3. Above Accessible Ceilings: Use only building wire, Type THHN/THWN insulation, in raceway.
4. Wet or Damp Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
5. Exterior Locations: Use only building wire, Type XHHW-2 insulation, armored cable with jacket.
6. Underground Locations: Use only Type RHH/RHW/USE, either XLP-USE or EPR with a CPE pocket insulation, in raceway.

1.06 DESIGN REQUIREMENTS

- A. Conductor sizes are based on copper.
- B. Aluminum conductors are not acceptable and will not be allowed.

1.07 QUALITY CONTROL

- A. See Specification Section 16010 Basic Electrical Requirements 1.05 Quality Control.

1.08 DELIVERY STORAGE AND HANDLING:

- A. See Specification Section 16010 Basic Electrical Requirements 1.06 Delivery Storage and Handling.

1.09 WARRANTIES AND GUARANTEES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.07 Warranties and Guarantees.

1.10 EXTRA MATERIALS AND SPARE PARTS:

- A. None required.

1.11 ENVIRONMENTAL REQUIREMENTS:

- A. None required.

1.12 SPECIAL REQUIREMENTS:

- A. Field Measurements – Before proceeding with the fabrication of the Work, the Contractor must verify all dimensions and take such

measurements as are required for proper fabrication and erection of the Work.

- B. Coordination – Coordinate Work of this section with related Work specified in the other divisions/sections of the Contract Documents.

PART 2 PRODUCTS

2.01 BUILDING WIRE

- A. Manufacturers:
 - 1. Diamond Wire & Cable Co.
 - 2. American Insulated Wire Corp.
 - 3. Southwire
 - 4. Cerro
 - 5. Aetna
 - 6. Pirelli
 - 7. Draka Cableteq
- B. Product Description: Single conductor insulated wire.
- C. Conductor: Copper.
- D. Insulation Voltage Rating: 600 volts.

2.02 SERVICE ENTRANCE CABLE

- A. Manufacturers:
 - 1. Diamond Wire & Cable Co.
 - 2. American Insulated Wire
 - 3. Southwire
 - 4. Cerro

5. Aetna
 6. Pirelli
 7. Draka Cableteq
- B. Wire and cable must be soft copper, properly refined and must have minimum conductivity of 98 percent. Aluminum conductors are not acceptable.
1. Conductors for power and lighting must have 600-volt type insulation, must be not less than No. 12 AWG, must conform to the latest CEC and must bear Underwriters' Laboratory label.
 2. Wire for signal and control systems must be No. 14 AWG stranded unless otherwise indicated on the Drawings, or elsewhere in the Specifications.
 3. Factory wired equipment of a manufacturers' standard product line must be wired with the manufacturers' standard wire size and type provided that the wiring meets all applicable Code requirements. This does not apply to custom-built equipment as specified elsewhere in the Specifications.
- C. Wire and cable must be delivered to the job site in original packing or on factory reels. All wire and cable must bear tagging or marking on the finish at regular intervals and consisting of manufacturers' name or code number, as well as the insulation type, voltage rating and UL listing.
- D. Wire and cable must be factory color-coded insulation and must be installed and connected as follows:
1. Color coding for voltage system of 250 volts and less must be
 - a. "A" Phase Black
 - b. "B" Phase Red
 - c. "C" Phase Blue
 - d. Neutral White
 - e. Ground Green
 2. Color coding for voltage system of over 250 volts and less than 600 volts must be
 - a. "A" Phase Brown
 - b. "B" Phase Orange
 - c. "C" Phase Yellow

- d. Neutral - Gray
 - e. Ground - Green
- 3. Green must be used for grounding only.
- 4. Three-way and four-way switch travelers must be of a different color from colors stated above and they must be of the same color. Yellow must not be used for anything except interlock wiring.
- E. The insulation must be applied tightly to the conductor and must be free stripping.
- F. Per FAA-E-2013, paragraph 3.3.1.1.a, solid conductors shall be furnished when conductors smaller than #8 are required.
- G. Type THHN/THWN thermo-plastic insulated, 90 degrees C dry and 75 degrees C wet rated must be used for light, power and other wiring not specifically defined for all sizes. Type THHN thermo-plastic insulated 90 degrees C rated must be used for continuous row fluorescent fixture wiring.
- H. Type SF-2 silicone insulated glass braid jacket, 200 degrees C < 600-volt rated must be used for fixture wiring and or recessed incandescent fixture wiring and must be No. 12 AWG minimum.
- I. Teflon insulated 200 degrees C rated must be used for use within 5 feet of boilers and 1 foot of heating pipes.
- J. Wire and cables 600-volt rated for installation in floor slabs, etc. and outdoor use in exposed conduit must be XHHW-2. All underground ductbank installation must be RHH/RHW/USE, either XLP-USE or EPR with a Hypalon jacket, insulated.
- K. If any of the cable types are modified by the Drawings, the Drawings must be followed.
- L. Wire types for the telephone, communications, public address, computer data, door security and fire alarm systems must be in accordance with recommendations of the equipment manufacturer. Acceptable manufacturers of this type of cable must be American Insulated Wire, Belden, Dekoron, Okonite, Pirelli or West Penn.
- M. The 600-volt insulated wires and cables must be factory tested prior to shipment in accordance with the latest ICEA standards for the insulation specified.

- N. Samples and reports on the results of shop tests for all wire and cables, descriptive literature for splices and terminations must be submitted and must be treated as a Shop Drawing submittal.
- O. Acceptable cable manufacturers for 600-volt rated cable must be Diamond Wire and Cable, American Insulated Wire Corp., Southwire, Cerro, Aetna, Pirelli, and Draka Cableteq.
- P. Conductor: Copper for sizes 4AWG and larger.
- Q. Insulation Voltage Rating: 600 volts.

2.03 WIRING CONNECTORS

- A. Manufacturers:
 - 1. Burndy Model YA.
 - 2. Anderson Model VHCL.
 - 3. Thomas & Betts Model Series 54800 & 54900.
 - 4. Panduit Model Services LCB.
- B. For connections to bus bars, use copper compression connectors. Connectors must be crimp type. All connectors must be copper. Copper compression connectors must be long barrel, tin plated, closed end compression type. The barrel for each cable lug must be sized for the exact cable size specified. Copper-Aluminum connectors are not acceptable.
- C. Mechanical or set screw types are not acceptable. The cables must be terminated with the die type compression tools. The compression connection must be UL rated. Use only those tools which must provide a UL rated connection for the manufacturers product used.
- D. Conductors No. 2 AWG and larger must terminate in two-hole solderless lugs.
- E. Conductors No. 10 AWG and No. 4 AWG, inclusive, must terminate in one (1)-hole lug.
- F. Multiple-hole lugs must have NEMA spacing
- G. Acceptable connector manufacturers must be Burndy Type YA, Anderson Type VHCL, Thomas & Betts Co., Series 54800 and 54900 or Panduit Series LCB.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify interior of building has been protected from weather.
- B. Verify mechanical work likely to damage wire and cable has been completed.
- C. Verify raceway installation is complete and supported.

3.02 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.03 EXISTING WORK

- A. Remove exposed abandoned wire and cable [including abandoned wire and cable above accessible ceiling finishes]. Patch surfaces where removed cables pass through building finishes.
- B. Disconnect abandoned circuits and remove circuit wire and cable. Remove abandoned boxes when wire and cable servicing boxes is abandoned and removed. Install blank cover for abandoned boxes not removed.
- C. Provide access to existing wiring connections remaining active and requiring access. Modify installation or install access panel.
- D. Extend existing circuits using materials and methods [compatible with existing electrical installations, or] as specified.
- E. Clean and repair existing wire and cable remaining or is wire and cable to be reinstalled.

3.04 INSTALLATION

- A. Route wire and cable to meet Project conditions.
- B. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- C. Identify [and color code] wire and cable under provisions of Section 16195 Electrical Identification. Identify each conductor with its circuit number or other designation indicated.
- D. Special Techniques--Building Wire in Raceway:
 - 1. Pull conductors into raceway at same time.

2. Install building wire 4 AWG and larger with pulling equipment.

E. Special Techniques - Cable:

1. Protect exposed cable from damage.
2. Support cables above accessible ceiling, using spring metal clips or [metal] [plastic] cable ties to support cables from structure [or ceiling suspension system]. Do not rest cable on ceiling panels.
3. Use suitable cable fittings and connectors.

F. Special Techniques - Wiring Connections:

1. Clean conductor surfaces before installing lugs and connectors.
2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
4. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
7. Install solid conductor for feeders and branch circuits 10 AWG and smaller.
8. Install stranded conductors for branch circuits 10 AWG and smaller. However, when stranded conductors are used in lieu of solid, then install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.

3.05 WIRE COLOR

A. General

1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:

- a. Black and red for single phase circuits at 120/240 volts.
 - b. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - c. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.
- 2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
 - a. Black and red for single phase circuits at 120/240 volts.
 - b. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - c. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.
- B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.
- C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.
- D. Feeder Circuit Conductors: Uniquely color code each phase.
- E. Ground Conductors:
 - 1. For 6 AWG and smaller: Green.
 - 2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

3.06 FIELD QUALITY CONTROL

- A. Section 16010 Basic Electrical Requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Building wire and cable will not be measured separately for payment, except for roadway lighting cable.
- B. Underground cable for roadway lighting installed must be measured by the number of lineal feet installed in place, completed, ready for operation, and accepted as satisfactory. Measurements will be made in straight lines between changes in direction and to the centers of

equipment and boxes access points. 10 feet of extra cable will be allowed when terminating at a controller. 5 feet of extra cable will be allowed at light pole, handholes, junction boxes, and similar locations. Changes in direction shall assume perfect straight line runs, ignoring actual raceway sweeps.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment for roadway lighting cable will be made at the Contract unit price for wire and cable installed by the Contractor and accepted by the Director. This price includes full compensation for furnishing all materials and for all preparation and installation of these materials, and for all labor, equipment, tools, and all work necessary to complete this item.
- B. Payment will be made under the following item:

ITEM NO.	DESCRIPTION	UOM
16123-01	4-1/C #2, 1-1/C #4GRD, CABLE	LF

END OF SECTION 16123

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FIBER OPTIC CABLE AND EQUIPMENT

SECTION 16125

PART 1 DESCRIPTION

1.01 GENERAL

- A. Work under this section is subject to the requirements of the Contract Documents and is to be used for FAA and other fiber optic cable applications.
- B. The Contractor must furnish and install all wall or rack mounted fiber optic cable, patch panels and ST type connectors as shown on the Contract documents. Where space permits, all wall mounted fiber optic patch panels must be installed in enclosures.
- C. Furnish and install fiber optic cable suitable for outside or inside buildings, risers, ducts, plenum and air handling spaces and cable accessories required of the type and size shown on the drawings and specified herein, including but not limited to, the following:
 - 1. Single mode fiber optic cable must be type-B, indoor/outdoor, 24 strand tight buffered distribution type OFNP, , P/N OC 051108-04 for 24 strand; Rev. A, Laser Ultra-Fox. Acceptable manufacturers are Optical Cable Corp., Alcoa, General Cable, and Draka Cableteq.
 - 2. Patch panels and NEMA 1 and NEMA 4 enclosures and splicing kits, terminal connectors and accessories for termination in Hub building facility and/or indoor/outdoor enclosures for a complete installation.

1.02 REFERENCES

- A. Specification Section 16010 Basic Electrical Requirements 1.03 References.
- B. FAA Specification FAA-E-2761c, November 19, 1998, Cable, Fiber Optic, Multi-mode and Single-mode, Multi-fiber, with exceptions documented in this specification.
- C. FAA Order 1830.7, Fiber Optic Transmission Systems and Equipment Policy.
- D. FAA-STD-061, 10/15/2003. Fiber Optics Standard for Telecommunications Systems and Equipment, with exceptions

documented in this specification.

- E. ANSI / TIA / EIA-STD-RS-455, Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices.
- F. ANSI/TIA/EIA-STD-RS-359, Standard Colors for Color Identification and Coding.
- G. ANSI/TIA/EIA-598A, Fiber Optic Cable Color Coding.
- H. MIL-STD-202, Test Methods for Electronic and Electrical Component Parts.
- I. MIL-HDBK-454, Standard General Requirements for Electronic Equipment.
- J. MIL-STD-810, Environmental Test Methods and Engineering Guidelines.
- K. NFPA 262, Test for Flame-travel and Smoke of Wire and Cables Used in Air-handling Spaces.
- L. Underwriters Laboratories, Inc. (UL):
 - 1. U.L. 910: Flame Retardancy.
 - 2. U.L. 1581 VW-1: Vertical Tray Cable Flame Test.
 - 3. U.L. 1666: Riser Cable.
- M. American National Standards Institute (ANSI)
 - 1. ANSI/TIA-568, 569 and 607.
 - 2. ANSI/TSB-36, 40 and 50.
 - 3. ANSI X3 T9.5.
- N. NETA: The International Testing Association Acceptance Testing Specification.
- O. Specification Section L-118 CED/FAA Communication MH/HH As-Built Checklist

1.03 CONTRACTOR QUALIFICATIONS

- A. The fiber optic cable installation must be installed and supervised by trained and experienced personnel. The cable terminations and splices must be made by qualified technicians. The Contractor must submit to

the Commissioner documentation on the qualifications and experience for fiber optic equipment installations of all personnel involved in the installation, supervision, termination and testing of any fiber optic cable. The Commissioner will determine if the Contractor is qualified to perform the Work.

- B. Prior to starting any Work under this Section, the Contractor and Sub Contractors must submit to the satisfaction of the Commissioner, evidence demonstrating a minimum of 5 years experience in Projects similar in size and scope. The Contractor must show that its Fiber Optic Personnel are qualified in Fiber Optic Transmission System Cable Installation and have worked on similar projects, including any required licenses of the person(s) doing the Work. Submit copies of all state and local licenses, registrations and permits necessary to carry out the Work of this Contract. The Contractor must also submit to the Commissioner, a list of its Fiber Optic Transmission System projects completed, indicating each project name, location, cost, name and telephone number of contact person for verification of any information, upon request by the Commissioner.

1.04 QUALITY CONTROL

- A. The contractor is responsible for protecting all equipment and systems against harmful exposure to, or accumulations of dust, moisture, flooding, corrosion or other forms of damage and must clean and restore damaged finishes.

1.05 SUBMITTALS AND DELIVERABLES

- A. Submit all Contractor qualification documentation as described in Paragraph 1.03 above.
- B. The following deliverables will be required from the Contractor as requirements for the formal acceptance of the fiber optic cable by CDA and subsequent Contractor Acceptance Inspection of fiber optic cable installation:
 - 1. O & M Manuals/Product data and catalogs
 - 2. Fiber Optic Test Reports
 - 3. Manhole/Handholes As-built Checklists or Reports (Section L-118 CED/FAA Communication MH/HH As-Built Checklist)
 - 4. FAA Form 4650-12 *Material Requisition/Issue/Receipt*
 - 5. Fiber Optic Cable As-builts/Red-Lined Drawings
 - 6. Approved Submittals

7. Warranties/Guaranties

- C. All of the above deliverables must be compiled in five (5) sets of 3-ring binders for submittal to the Commissioner, who will forward them to the FAA.

PART 2 EQUIPMENT AND MATERIALS

2.01 GENERAL

- A. The fiber optic cable must be according to FAA-STD-061, the ANSI, Electronics Industries Association (EIA), and Telecommunications Industries Association (TIA) for the single-mode cable.
- B. Single-mode fiber. The fiber must be dual spectral-window, matched-clad, of all silica based composition. The tight buffered fiber optic cable must be color coded according to the following industry standard color coding scheme:

Color Coding Scheme per Industry Standards:

Fiber Position	Color	Fiber Position	Color (with black dash)
1	Blue	13	Blue
2	Orange	14	Orange
3	Green	15	Green
4	Brown	16	Brown
5	Gray	17	Gray
6	White	18	White
7	Red	19	Red
8	Black	20	Black (with yellow dash)
9	Yellow	21	Yellow
10	Purple	22	Purple
11	Rose	23	Rose
12	Aqua	24	Aqua

- C. Multi-mode fiber. The fiber must be suitable for FAA applications, provide fiber cables of loose tube construction, with water swellable aramid yarn water blocking for indoor/outdoor applications, comprised of 62.5 µm multi-mode fibers.
- D. Outdoor and Indoor/Outdoor rated cables must include an outer jacket to provide protection from hydrocarbon fuels.
- E. Potassium acetate is used as a de-icing agent. Outdoor and Indoor/Outdoor rated cables must have outer jackets that provide proper protection from this agent.

- F. The fiber optic patch panels as manufactured by Corning Cable Systems, with ST type connectors must meet FAA requirements. For multi-mode applications the patch panels would be equipped with ST connector panels for 62.5 μ m multi-mode cables.
- Acceptable Fiber Optic Patch Panel Housings (Project Dependent)
Corning Part #PCH-02U (Rack Mount)
Corning Part # PCH-04U (Rack Mount)
Corning Part # WCH-06P (Wall Mount)
 - Acceptable Fiber Optic Connector Panels (Project Dependent)
Corning Part # CCH-CP-12-19T (Single Mode)
Corning Part # CCH-CP-12-15T (62.5 μ m Multi Mode)

2.02 REQUIREMENTS

- A. Introduction. The fiber optic cable specified herein will be an integral part of a CDA communication system. The requirements defined herein are intended to result in a cable with reliability appropriate to the critical nature of the application.
- B. Materials. If material for a cable component is stipulated, it must be as specified herein. If the material for a cable component is not stipulated, it must be entirely suitable for the application. The manufacturer must certify that all synthetic substances were produced from virgin compounds.
- C. Workmanship. The cable must be free of any imperfections that may affect its performance or survivability in the environment.
- D. Fiber and cable.
1. The fiber optic cable must consist of, but not be limited to, the following components:
 - a. Tight buffered or loose tube optical fibers, as specified
 - b. Rod fillers
 - c. Synthetic yarn strength member
 - d. Protective outer jacket
 - e. Optical fiber
 2. The tight buffered optical fiber must consist of a central glass optical fiber surrounded by a primary polymer buffer and an optical tight fitting secondary, thermoplastic polymer buffer. The

primary diameter of the protective coating must be $250 \pm 15 \mu\text{m}$ and the secondary buffer must be $900 \mu\text{m}$ as determined by FOTP 173. The protective coating must be easily removed by common chemical or mechanical means.

3. Tight buffered cable must be assembled by heliacally stranding 12 or 24 tight buffered optical fibers and rod fillers around a central rod filler.
4. For loose-tube optical cable applications requiring 6 or fewer fibers, the cable shall consist of individual sub-cables in a filled buffer tube and a ripcord covered by an outer jacket. Each sub-cable shall consist of the main fiber strand with a $250 \mu\text{m}$ fiber coating. The cable shall have a water swellable aramid yarn water blocking system to fill all voids and indices to prevent the intrusion of moisture.
5. For loose-tube optical cable applications requiring more than 6 fibers, the fiber cable shall be organized in subgroups of 6 individual fibers. The cable shall consist of dielectric central member, color-coated subgroup cables, additional dielectric strength members, and a ripcord covered by an outer jacket. Each subgroup cable consists of 6 individual sub-cables with a filled color-coded buffer tube. Each sub-cable shall consist of the main fiber strand with $250 \mu\text{m}$ fiber coating. The cable shall have a water swellable aramid yarn water blocking system to fill all avoids and indices to prevent the intrusion of moisture.
6. Rod fillers; each rod filler must consist of a central dielectric strength member surrounded by an extruded elastomeric polymer coating.
7. Synthetic yarn strength member. The synthetic yarn strength member must be heliacally laid directly over the stranded cable core. The strength member must be composed of individually and precisely tensioned elements such that the tensile load is equally shared by each element.
8. Outer jacket. The outer jacket must consist of an extrusion of flexible Fluor polymer plenum material having a nominal wall thickness of 0.6 millimeters and a minimum wall thickness of 0.48 millimeters at any point. The outer jacket must be extruded directly over the strength member layer. Tape or other materials between the jacket and core are specifically not allowed. The outer jacket must be smooth and free from holes, splits, blisters or other surface flaws
9. Ripcord. The cable must contain a non-wicking aramid yarn beneath the cable jacket to serve as a ripcord for jacket removal.

10. Cable marking. The outer jacket must be surface printed with the manufacturer's identification and required UL markings. The marking must include the date of manufacture, manufacturer's part number and sequential numerical meter or foot marks.
11. Colors. The buffered coatings must be color coded in accordance with ANSI/TIA/EIA-598A. The color of the outer jacket must be yellow for single-mode fiber cable only. Multi-mode fiber jacket to match FAA existing multi-mode cables - black. The color of the markings on the cable must contrast with the cable jacket color. Primary colors must be in accordance with ANSI/TIA/EIA-STD-RS-359.
12. Single Mode Fiber Optic Cable Diameter. The overall cable diameter must be $7.5 \pm 2.0\text{mm}$.
13. Loose tube multi-mode fiber optic cable only. Indoor/outdoor fiber optic cable will be an all-dielectric, loose tube, with water swellable aramid yarn water blocking construction, fiber optic cable. Each fiber will be multi-mode, graded index, $62.5/125\text{ }\mu\text{m}$ diameter (core/clad).
14. Single-mode optical fiber. The single-mode optical fiber must be dual spectral-window, matched-clad, of all silica based composition.
 - a. Core-cladding concentricity (offset). The core-cladding offset as determined by the method described in FOTP 176, must not exceed $0.8\text{ }\mu\text{m}$.
 - b. Core diameter. Each single-mode optical fiber must have a core diameter of $8.3\mu\text{m}$.
 - c. Cut-off wavelength of cabled fiber. The cut-off wavelength of cabled fiber must be less than 1260 nm as determined by FOTP 170, Test Procedure, method A or B.
 - d. Zero-dispersion wavelength. The zero-dispersion wavelength must be within the range 1300 nm to 1324 nm as determined by FOTP 168A. The median zero-dispersion wavelength must be $1310 \pm 3\text{ nm}$.
 - e. Zero-dispersion slope. The maximum for the zero-dispersion slope must not exceed $00.93\text{ ps/nm}^2\text{-km}$ as determined by FOTP 168A.
 - f. Attenuation. The attenuation of the cabled fiber, as determined by FOTP 78A must not exceed 0.5dB/km at

1310 nm nor must it exceed 0.3dB/km at 1550 nm at 68 degrees F.

The attenuation profile as measured using an Optical Time Domain Reflectometer (OTDR) must be substantially uniform. Localized variations/discontinuities in the OTDR profile must not exceed 0.1dB as determined by FOTP 59. The attenuation resulting from the hydroxyl ion absorption must not exceed the attenuation at the nominal zero dispersion wavelength by more than 2.1dB as determined by FOTP 78A.

- g. Temperature dependence of attenuation. The temperature dependence of attenuation, as determined by FOTP 3, must not exceed 0.2 dB/km over the temperature range -40 degrees F + 140 degrees F.
 - h. Cladding diameter. The cladding diameter must be $125 \pm 1 \mu\text{m}$ as determined by FOTP 176.
 - i. Non-circularity. The non-circularity of the cladding must not exceed 1.0% as determined by FOTP 176.
 - j. Tensile strength. The tensile strength of the fiber as measured by FOTP 31 must not be less than 0.69 GN/m^2 .
15. Multi-mode optical fiber. The multi-mode optical fiber must be a fully graded refractive index profile with a transmission window at 1300 nm, of all silica based composition.
- a. Core-cladding concentricity (offset). The core-cladding offset as determined by the method described in FOTP 176, must not exceed $3 \mu\text{m}$.
 - b. Core diameter. Each multi-mode optical fiber must have a core diameter of $62.5 \pm 3 \mu\text{m}$, as determined by FOTP 58A.
 - c. Numerical aperture. The numerical aperture of the fiber shall be 0.275 ± 0.015 as determined by FOTP 177 with FOTP 47 Method A or B.
 - d. Zero-dispersion wavelength. The zero-dispersion wavelength must be within the range 1320 nm to 1365 nm as determined by FOTP 168A.

- e. Zero-dispersion slope. The zero dispersion slope of the fiber shall not exceed 0.110 ps/nm²-km within the range 1320 nm to 1348 nm nor shall it exceed (1458 - λ) / 1000 ps/nm²-km within the range 1348 nm to 1365 nm as determined by FOTP 168A.
- f. Attenuation. The attenuation of the cabled fiber, as determined by FOTP 61 must not exceed 1.0 dB/km at 1300 nm at 20 degrees C, and bandwidth will be a minimum of 500 MHz - km at 1300 nm.

The attenuation profile as measured using an Optical Time Domain Reflectometer (OTDR) must be substantially uniform. Localized variations/discontinuities in the OTDR profile must not exceed 0.2 dB as determined by FOTP 59. The attenuation resulting from the hydroxyl ion absorption must not exceed the attenuation at the nominal zero dispersion wavelength by more than 3 dB as determined by FOTP 61A.

Each fiber attenuation will not exceed 3.5 dB/km nominal, measured at room temperature at 850 nm and bandwidth will be a minimum of 500 MHz/km at 850 nm.

- (1) Tensile Load. The cable will withstand a maximum pulling tension of 400 lb. during installation, short term and 100 lb. upon installation, long term.
 - (2) Temperature Range. The shipping, storage and installing range of the cable will be 14 degrees F to 140 degrees F, (-10 degrees C to 60 degrees C).
 - (3) Cable Performance Tests. The cable will meet or exceed all ANSI or EIA minimum performance measures for Fiber Optic Test Procedures (FOTP) requirements, such as fluid penetration, compound drip, compressive loading resistance, cyclic flexing, impact, tensile loading and bending.
- g. Temperature dependence of attenuation. The temperature dependence of attenuation, as determined by FOTP 3A, must not exceed 0.5 dB/km over the temperature range -40 degrees F to + 140 degrees F.
 - h. Cladding diameter. The cladding diameter must be 125 \pm 2.0 μ m as determined by FOTP 176.
 - i. Non-circularity. The non-circularity of the core must not

exceed 5.0% as determined by FOTP 176.

- j. Tensile strength. The tensile strength of the fiber as measured by FOTP 31B, must not be less than 0.69 GN/m².

E. Mechanical Performance

Single-mode Fiber:

1. Un-spliced length. The un-spliced length on each delivered reel must be 3.0 km minimum unless otherwise specified.
2. Central strength member. The central strength member of the cable must be totally dielectric and fully compatible with other cable components. Reference ICEA S 87-640-1992, Section 9.1.6.
3. Fiber proof test. All fibers must be subjected to a minimum proof stress of 0.7 Gpa (100 kpsi).
4. Fiber strippability. Both the primary and secondary fiber buffer layers and outer jacket must be easily removed with commercially available mechanical stripping tools.
5. Installation bending radius. The manufacturer's allowable installation minimum bending radius shall be not greater than 20 times the cable diameter.
6. Minimum tensile strength. The cable must withstand a minimum installation tensile load not less than 1801 Newtons (N) and not less than 450 N continuous tensile load.
7. Impact resistance. The cable must withstand an impact force 1000 times, per the requirements of ANSI/TIA/EIA-RS-455 (FOTP-25A).
8. Crush resistance. The cable must withstand a compression load of 1500 N/cm, per the requirements of ANSI/TIA/EIA-RS-455 (FOTP-41A).
9. Cyclic flex resistance. The cable must withstand cyclic flexing 1000 times per the requirements of ANSI/TIA/EIA-RS-455 (FOTP-104).

Multi-Mode fiber:

1. Un-spliced length. The un-spliced length on each delivered reel must be 3.0 km minimum unless otherwise specified.
2. Central strength member. The central strength member of the cable must be totally dielectric and fully compatible with other

cable components. Reference ICEA S 87-640-1992, Section 9.1.6.

3. Fiber proof test. All fibers must be subjected to a minimum proof stress of 0.7 Gpa (100 kpsi).
4. Fiber strip ability. Both the primary and secondary fiber buffer layers and outer jacket must be easily removed with commercially available mechanical stripping tools.
5. Installation bending radius. Bending radius of 20 times cable diameter. The installation bending radius should be specified as a maximum allowable value. Cables with a manufacturer recommended smaller installation bending radius are acceptable.
6. Minimum tensile strength. The cable must withstand a minimum installation tensile load not less than 1801 Newtons (N) and not less than 450 N continuous tensile load.
7. Impact resistance. The cable must withstand an impact force 2000 times with 1.6 N-m, per the requirements of ANSI/TIA/EIA-RS-455 (FOTP-25A).
8. Crush resistance. The cable must withstand a compression load of 2000 N/cm, per the requirements of ANSI/TIA/EIA-RS-455 (FOTP-41A).
9. Cyclic flex resistance. The cable must withstand cyclic flexing 2000 times per the requirements of ANSI/TIA/EIA-RS-455 (FOTP-104).

F. Environmental Performance

Single-mode Fiber:

1. Cable storage. There must be no deterioration of the cable, fiber integrity or optical performance due to outdoor storage of the cable on the shipping reel.
2. Temperature. The cable must comply with the optical cable and mechanical performance requirements over the operating temperature range of -40 degrees Celsius to +70 degrees Celsius. The cable must not be damaged in any way when exposed to the storage temperature range of -40 degrees Celsius to +80 degrees Celsius. The actual temperature of the cable for installation will be -10 degrees Celsius to +60 degrees Celsius.
3. Humidity. The cable must comply with the optical and mechanical performance requirements of up to 95% relative humidity (non-condensing) when subjected to moisture

resistance conditioning according to method 106B of MIL-STD-202 except that the specimen must not be vibrated.

4. Moisture resistance. Optical and mechanical performance must not be degraded and the cable must not be damaged in any way by immersion in ground water.
5. Fungus resistance. The outer jacket material used in construction of this cable must be fungus inert as described in requirement 4 of MIL-HDBK-454.
6. Sunlight / UV resistance. The outdoor outer jacket material must be as determined in accordance with MIL-STD-810, method 505.
7. Flame retardancy. The cable must be UL listed type OFNR or OFNP as per the requirements of UL standard 910.
8. Chemical resistance. The outer jacket material must exhibit chemical resistance to most de-icing fluids used at airports such as potassium acetate, hydrocarbons and halogenated solvents. This material must be resistant to such chemicals as crude oil, diesel fuel, gasoline, jet fuel, kerosene, oils or Skydrol 500.
9. Quality standard. The manufacturer must provide proof of ISO 9001 certification.

Multi-Mode fiber:

1. Cable storage. There must be no deterioration of the cable, fiber integrity or optical performance due to outdoor storage of the cable on the shipping reel.
2. Temperature. The cable must comply with the optical cable and mechanical performance requirements over the operating temperature range of -40 degrees Celsius to +70 degrees Celsius. The cable must not be damaged in any way when exposed to the storage temperature range of -40 degrees Celsius to +80 degrees Celsius. The actual temperature of the cable for installation will be -10 degrees Celsius to +60 degrees Celsius.
3. Humidity. The cable must comply with the optical and mechanical performance requirements of up to 95% relative humidity (non-condensing) when subjected to moisture resistance conditioning according to method 106B of MIL-STD-202 except that the specimen must not be vibrated.
4. Moisture resistance. Optical and mechanical performance must not be degraded and the cable must not be damaged in any way by immersion in ground water.
5. Fungus resistance. The outer jacket material used in

construction of this cable must be fungus inert as described in requirement 4 of MIL-HDBK-454.

6. Sunlight / UV resistance. The outdoor outer jacket material must be as determined in accordance with MIL-STD-810, method 505.
7. Flame retardancy. The cable must be UL listed type OFNR or OFNP as per the requirements of UL standard 910.
8. Chemical resistance. The outer jacket material must exhibit chemical resistance to most de-icing fluids used at airports such as potassium acetate, hydrocarbons and halogenated solvents. This material must be resistant to such chemicals as crude oil, diesel fuel, gasoline, jet fuel, kerosene, oils or Skydrol 500.
9. Quality standard. The manufacturer must provide proof of ISO 9001 certification.

G. The 62.5 μ m Multi-mode Indoor/Outdoor Riser Rated Loose Tube Fiber Optic Cable

1. The fiber shall use a carefully controlled refractive index profile to achieve low attenuation and high bandwidth at both operating wavelengths, the fiber bandwidth shall meet the standards for FDDI and support Ethernet, Fast Ethernet, Token Ring, ATM and FDDI applications.
2. The buffer tubes shall be compatible with standard hardware, cable routing and fan-out kits.
3. The cable shall be designed for point-to-point applications as well as midspan access, provide a high-level of protection for fiber installed in the outside plant environment.
4. This cable is designed to connect equipment or facilities that are separated by an outdoor type environment.
5. It shall be suitable for indoor/outdoor conduit or tray installations.
6. Individual fiber strands and or groupings shall be color coded per ANSI/TIA/EIA guidelines.

H. Rack Mountable Combination Fiber Optic Shelves with Integral Splice Tray

1. Low profile Combination Modular shelf:
 - a. The fiber optic shelf must be used for a combination of splicing and termination of fiber optic building cable or outside plant (OSP) cables.
 - b. The shelf must be used for a combination of splicing and

termination of up to a minimum of 24 fibers strands with SC or ST connectors and 48 fiber strands with LC connections.

- c. The modular shelf must be a 2U-height fully enclosed shelf, with integrated front cable management trough included.
 - d. The shelf must have slide-out tray for easy access.
 - e. The modular shelf system must have interchangeable modules, available in SC, ST and LC for 62.5 and 8.3 solutions. The modules must be offered with or without pre-assembled and factory-terminated pigtails.
 - f. A splice tray must provide easy access and administration of a minimum of two individual splice trays.
 - g. Provide factory terminated pigtails for connection to fiber shelves. Pigtails must be fusion spliced.
 - h. Each modular shelf must be equipped with the following:
 - (1) Hinged front doors for easy access.
 - (2) Front cable management trough.
 - (3) Top cover panel.
 - (4) Standard water-tight cable entry conduit connectors for OSP cable.
 - (5) Blank labels for identifying fiber splices and terminations.
 - i. Provide dust caps for all terminated, spare fiber strands.
 - j. Provide blank modules, as applicable.
2. 4U Combination Modular Shelf:
- a. The fiber optic shelf must be used for a combination of splicing and termination of fiber optic building cable or outside plant (OSP) cables.
 - b. The shelf must be used for a combination of splicing and termination of up to a minimum of 72 fibers strands with SC or ST connectors.
 - c. The modular shelf must be a 4U-height fully enclosed shelf, with integrated front cable management trough included.
 - d. It must be designed to combine both splicing and

termination in a sliding format, which in turn provides both rear and full front access.

- e. A single shelf must be provided for splicing, termination and fiber management.
- f. The modular shelf system must have interchangeable modules, available in SC, ST and LC for 62.5 and 8.3 solutions. The modules must be offered with or without pre-assembled and factory-terminated pigtails.
- g. A splice tray must provide easy access and administration of a minimum of six individual splice trays.
- h. Provide factory terminated pigtails for connection to fiber shelves. Pigtails must be fusion spliced.
- i. Each modular shelf must be equipped with the following:
 - (1) Hinged front and rear doors constructed of black polycarbonate and equipped (rear door) with knockouts for optional lock mechanism.
 - (2) Cable entry protectors for incoming building fibers.
 - (3) Fiber jumper bend limiters.
 - (4) Top cover panel.
 - (5) Blank labels for identifying fiber splices and terminations.
- j. Provide dust caps for all terminated, spare fiber strands.
- k. Provide blank modules, as applicable.

I. Fiber Optic Connectors

1. ST Fiber Optic Connectors:

- a. Provide field-terminated fuse on connectors (AFL fuse connect, suggested vendor).
- b. The connector must be available for multi-mode and single mode fiber optic cables.
- c. The connector must utilize a zirconia ferrule for fiber alignment.
- d. The connector must be Bellcore, TIA/EIA and IEC compliant.
- e. The connectors must meet the following requirements:
 - (1) Average loss for multi-mode fiber; 0.3 dB.

- (2) Average loss for single-mode fiber; 0.2 dB (tuned) and 0.3 dB (untuned).

2. SC Fiber Optic Connectors:

- a. Provide factory-terminated connectors with pigtails.
- b. The connector must be available for multi-mode and single mode fiber optic cables.
- c. The connector must utilize a zirconia ferrule for fiber alignment.
- d. The connector must have push-pull hardware for easier connections, as well as high optical stability.
- e. The connectors must be crimped to the outer hardware, to prevent momentary disconnect when axial load is placed on the cable.
- f. The connectors must meet the following requirements:
 - (1) Length; 2 inch (5.08 cm).
 - (2) Operating temperature; -40 to +85 degrees Celsius.
 - (3) Average loss for multi-mode fiber; 0.3 dB
 - (4) Average loss for single-mode fiber; 0.2 dB (tuned) and 0.3 dB (untuned).

3. LC Fiber Optic Connectors:

- a. Provide factory-terminated connectors with pigtails.
- b. The fiber optic connector must be one half the size (double density) of conventional ST and SC connectors.
- c. The connector must have an insertion release mechanism similar to the RJ-45 intuitive push/pull-style housing.
- d. The connector must be pull-proof to prevent momentary disconnect from axial loads.
- e. The connectors must be crimped to the outer hardware, to prevent momentary disconnect when axial loads.
- f. The connectors possess an anti-snag latch which facilitates routing of patch cords.
- g. The connectors must be field-mountable with minimal polish.
- h. The connectors must be polarized.

- i. The connector must be Bellcore, TIA/EIA and IEC compliant.
 - j. The connectors must meet the following requirements:
 - (1) Nominal Fiber outside diameter (OD) for multi-mode fiber; 125 μ m, for single-mode fiber; 125 μ m
 - (2) Cable outside diameter (OD) for multi-mode fiber; 0.9 mm, for single-mode fiber; 0.9 mm
 - (3) Typical Insertion Loss μ , σ) for multi-mode fiber; 0.10, 0.10 dB, for single-mode fiber; 0.10, 0.15 dB
 - (4) Return loss maximum for multi-mode fiber; -20.0 dB, for single-mode fiber; -40 dB
 - (5) Cable Retention for multi-mode fiber; 2 lbs, for single-mode fiber; 2 lbs
 - (6) Mating durability for 500 Reconnects Insertion Loss Change for multi-mode fiber; less than 0.2 dB, for single-mode fiber; less than 0.2 dB.
 - (7) Temperature stability (-40 degrees Celsius to +75 degrees Celsius) Insertion Loss Change for multi-mode fiber; less than 0.3 dB, for single-mode fiber; less than 0.3 dB.
 - (8) Tip Material shall be Ceramic for multi-mode and single-mode fibers.
4. Patch Cords:
- a. Provide factory-terminated connectors fiber patch cords consisting of buffered, graded index fiber with 125 micron cladding. Core size to match application requirements. The 900 micron fiber coating must be covered by aramid yarn and a jacket of flame retardant PVC. Provide factory-terminated connectors with ceramic ferrules. Provide the connector type (SC, ST, LC) as called for in this specification or on the drawings.
 - b. Provide two-strand riser rated zipcord style cords for all duplex patch through and equipment connections. Provide single strand cords for single equipment connections.
 - c. Provide the quantities and length of patch cords required to make orderly, manageable connections between all patch panels and equipment being cross connected.
 - d. Mated connectors loss; 0.2 dB typical, guaranteed maximum of 0.5 dB, for 500 insertions.
 - e. Operation temperature; -40 degrees Celsius to +80

degrees Celsius and less than 0.3 dB change.

- f. Cable retention; 20 lb. minimum for less than 0.2 dB change.

5. Fiber Cable Splicing:

- a. Fiber optic splices are not allowed except where factory terminated pigtails are used for fiber terminations in fiber shelves. If field conditions warrant additional splices, submit a written request to the Commissioner and obtain approval prior to splicing cables.
- b. Fiber optic splices must be fusion splices performed in the field by a qualified splicer. Mechanical splices are not allowed.
- c. Splicing equipment must provide 3-axis alignment for fiber coating of 250 to 900 micrometers and a splice loss of less than 0.05 dB.
- d. Provide heat shrink splice protection for all fiber optic splices.
- e. Provide adequate number of splice trays to fully transition all installed fibers to factory-terminated pigtails.

6. Grounding System and Conductors:

a. Bounding and Grounding

- (1) Communication bonding and grounding must be in accordance with the Chicago Electric Code, NFPA and FAA Specification FAA-019e.
- (2) Horizontal cables and equipment must be grounded in compliance with ANSI/NFPA 70 and local requirements and practices.
- (3) Horizontal equipment includes cross connect frames, patch panels and racks, active telecommunication equipment and test apparatus and equipment.

7. Splice Closures:

- a. Fiber optic splices are not allowed except where factory terminated pigtails are used for fiber terminations in fiber shelves. If field conditions warrant additional splices, submit a written request to the Commissioner and obtain approval prior to splicing cables.

- b. When approved, provide splice closures constructed of thermoplastic, suitable for “butt” or “through” cable entry moisture tight sealing arrangement, removable splice tray organizer, and splice trays for mechanical splices, suitable for multi-mode system operation at 800, 1300, 1310 and 1550 nanometers, grounding lugs or equivalent for grounding cable armor.
- (1) The optical fiber splice closure must meet all requirements stated in this specification.
 - (2) The splice closure must be resistant to solvents, stress cracking, and creep. The housing materials must also be compatible with chemicals and other materials to which they might be exposed in normal applications. For splice closures installed in manholes the housing material must be compatible with hydrocarbon fuels and potassium acetate.
 - (3) The optical fiber closure must be capable of accepting any optical fiber cable used in interoffice, outside plant, and building entrance facilities.
 - (4) The optical fiber closure must be available in distinct sizes to accommodate a variety of cable entries as specified in the table below:

Table - Cable Capacity

Canister (Butt) Configuration		Branch (In-Line) Configuration	
Express Entries/Max. Cable Diameter (mm)	Drop Port Entries/max. cable Diameter (mm)	Express Entries/Max. Cable Diameter (mm)	Drop Port Entries/max. cable Diameter (mm)
2/32	6/25	4/32	12/25
2/25	4/18	4/25	8/18
2/20	3/15	4/20	6/15

- (5) As an option, the ability to double the cable capacity of an installed canister splice closure by use of a kit must be available. Such a conversion must not disturb existing cables or splices.
- (6) Encapsulation must not be required to resist water

penetration.

- (7) The splice closure must be re-enterable. The enclosure end cap must be capable of accepting additional cables without removal of the sheath retention or strength member clamping hardware on previously installed cables or disturbing existing splices. The optical fiber splice closure must provide a clamping mechanism to prevent positioning of the central member or strength members and to prevent cable sheath slip or pullout.
- (8) The splice enclosure must have appropriate hardware and installation procedures to facilitate the bonding and grounding of metal components in the closure and the armored cable sheath. The cable bonding hardware must be able to accommodate a copper conductor equal to larger than a #6 AWG.
- (9) Aerial splice closures must have available the necessary hardware to attach and secure the closure to an aerial strand.
- (10) The closure must accommodate splice trays suitable for single fiber, single fiber heat shrink, mechanical, or ribbon heat shrink splices.
- (11) Spliced fibers must not be subjected to a bend radius smaller than 30 mm (1.2 inches). Buffer tubes must not be subjected to a bend radius smaller than 38 mm (1.5 inches).
- (12) The installation of the splice closure must not require specialized tools or equipment, other than those normally carried by installation crews.

2.03 QUALITY ASSURANCE

- A. The fiber optic cable must meet or exceed the requirements of this specification when measured in accordance with the methods of the individual requirements or the following methods are defined in EIA-STD-RS-455:

1. Fiber dimensions
 2. Attenuation
 3. Bandwidth
 4. Numerical aperture
 5. Fiber proof test
 6. Cable bending
 7. Tensile load
 8. Impact resistance
 9. Crush resistance
 10. Attenuation vs. temperature
- B. Quality control provisions. The manufacturer must comply with the requirements of ANSI/ISO/ASQC 9003. All tests must be performed by the Contractor and must be witnessed by the Commissioner. If the Commissioner's witnessing is waived, the Contractor must furnish three copies of certified test data. The cable will not be accepted by the Commissioner until the test data, certified by a properly authorized official of the Contractor to be true, correct, and complete and satisfying the specification requirements, has been submitted to and approved by the Commissioner. All tests must be performed at the time of manufacture. Any reel of cable or specimen offered for inspection but failing to meet the requirements of the test may not be re-offered for a retest without approval of the Commissioner.
- C. Inspector's Samples. One 25 meter length of cable must be cut from the end of reels to be selected randomly, with a maximum sampling of one sample per each 15 km. A minimum sample for orders less than 15 km is one sample. A sample must be taken at random from each lot of five reels, for a total of ten samples. Each sample will be identified by reel number, Contract/order number and specification number. The reels must be numbered sequentially for this purpose in the order of manufacture.
- D. Cable Testing:
1. Testing must be in accordance with Standard FAA-E-2761c on all fiber optic cables.
 2. Fiber. All fibers in the finished cable must be tested at the factory, after delivery to the site, on the reel prior to installation, during and after installation and in accordance with the definitions and procedures specified in the EIA/TIA-455 Fiber Optic Test Procedures (FOTP's) to determine if the fiber

complies with the specifications. Each optical fiber will be proof tested by the fiber manufacturer at a minimum stress of 350,000 kPa. The fiber manufacturer must provide a certificate of compliance for the following properties where indicated by a “yes”:

	Multi-mode	Single-mode
a. Core Diameter	Yes	---
b. Cladding Diameter	Yes	Yes
c. Protective Coating Diameter	Yes	Yes
d. Core-Cladding Concentricity	Yes	Yes
e. Core Non-Circularity	Yes	---
f. Cladding Non-Circularity	Yes	Yes
g. Tensile Strength	Yes	Yes
h. Numerical Aperture	Yes	---
i. Zero-Dispersion Wavelength	Yes	Yes
j. Zero-Dispersion Slope	Yes	Yes
k. Bandwidth	Yes	---
l. Mode-Field Diameter	---	Yes
m. Cut-Off Wavelength	---	Yes
n. Sheath Material Properties	Yes	Yes
o. Specification 16125		
Mechanical Performance	Yes	Yes
Environmental Performance	Yes	Yes

3. Cable assembly test. The tests described elsewhere in these specifications and FAA-E-2761c, and must be performed on all fibers of every reel.

- a. Optical attenuation at manufacturer. The optical attenuation of the cable must be validated in accordance

with the requirements of this specification and fiber optic cable specification FAA-E-2761c on all fibers of every reel of finished cable. The test results for each reel must be provided upon delivery in a sealed waterproofed envelope. All optical fibers in cables must be 100 percent attenuation tested. The attenuation must be measured at 1310 nm and 1550nm for single-mode fiber optic cables. The attenuation must be measured at 850 nm and 1300 nm for multi-mode fiber optic cables. The contractor must submit manufacturer's shop test report.

- b. Optical bandwidth. The -3dB end-to-end optical bandwidth of all fibers in all multi-mode cables shall be determined by FOTP 30B or FOTP 51A. For lengths greater than 1 km, the required -3dB end-to-end bandwidth shall be calculated from:

$$BW_{-3dB} \geq 500 \text{ Mhz}/(\text{length in kilometers})^{.85}, \\ (62.5/125\mu\text{m})$$

- c. Temperature dependence of attenuation. The temperature dependence of attenuation must be determined by FOTP 3 (for 48 hours or when it is ensured that the cable has uniformly reached the test temperature) on all fibers of one reel of cable selected at random. Measurements must be made at -40 degrees F and + 140 degrees F \pm 3.5 degrees F.
- d. Sheath thickness. The thickness of the interior and/or the exterior sheath must be as specified in section 3.4.5.6, 3.4.5.7, and 3.4.5.8 of specification FAA-E-2761C when measured in accordance with ASTM D4565, section 7.
- e. Cable flexing. The specimen(s) selected from the sample specified in 2.03,C must be prepared in accordance with FOTP 37A, except that a mandrel having a diameter up to 20 times the cable diameter will be permitted. Test condition D 32 degrees F and 104 degrees F of Table I of FOTP 37A will suffice, as will Test Level 2 (10 mandrel turns) of Table III. The test mass must be in accordance with Table II.
- f. Water intercepts tests. Test specimens selected randomly from the sample specified in 2.03,C must be tested per FOTP 82B. There must be no evidence of water leakage.

- g. Cable pulling capacity test. This test must be performed in accordance with FOTP 33A. This test must be a type acceptance test on a production run basis.
 - h. Sheath material properties certification. The manufacturer must certify that the extrusion process used for application of the sheathing compound complies with the recommendations of the compound supplier.
 - i. Crush resistance test. Test specimens taken at random must be subjected to the crush force specified. The optical attenuation must not change from before the test to after the test in the tested sample.
 - j. Impact resistance test. Test specimens taken at random must be subjected to the impact force specified. The optical attenuation must not change from before the test to after the test in the tested sample.
- 4. The fiber optic cables and related equipment must be the products of approved manufacturers. Fabrication of the fiber optic cables and related equipment must utilize the most advanced commercial materials and manufacturing process. Manufacturer must be ISO 9001 and TL-9000 certified.
 - 5. Fiber optic cable installation must be performed by experienced fiber optic cable installers who must have been regularly engaged in the installation of fiber optic cables for the last five (5) years at the minimum.
 - 6. Fiber optic cable splicing and terminations must be performed by experienced fiber optic cable installers who must have been regularly engaged in splicing and termination of fiber optic cables for the last five (5) years at the minimum.
 - 7. The contractor must retain the services of the fiber optic cable manufacturers technical representative to certify that the fiber optic cable installation is in accordance with the manufacturer's installation requirements.
 - 8. The contractor must retain the services of an independent testing firm who must perform acceptance testing of the fiber optic cable installation. The test firm must have experience in the inspection and testing of cables of the specified type and must be a member company of NETA.

2.04 Preparation for Delivery

- A. Cable length per reel. The specified length of cable must be delivered

on a non-returnable reel in one continuous length within a tolerance of 0%, +10%, unless otherwise specified.

- B. Top and bottom ends of the cable must be available for testing.
- C. Cable protective wrap. The outer layer of cable must be completely covered with a reflective and water resistant wrap such as white water-resistant paper, white plastic, or aluminum foil.
- D. Reel construction. Reels must have been constructed from previously-unused wood and in accordance with NEMA WC-26, Wire and Cable Packaging. Plywood reels are not acceptable. The reel must protect the cable from all shipping hazards and must provide long-term outdoor-storage protection from wind, sand, rain, snow and sunlight. The cable reels must also comply with the requirements stipulated in ICEA S-87-640 paragraph 7.4.4, subparagraphs 7.4.4.1 through 7.4.4.4 inclusive, and paragraph 7.4.7. If access to the inner end of the cable is via a slot in the reel flange, the slot must be covered with a rust-resistant metal plate. The plate must not be less than 18-gauge. Each reel must have a weather resistant reel tag attached identifying the reel and cable.
- E. Reel lagging. The reel must be lagged with nominal two-inch by four inch #2 common lumber from edge-to-edge around the full circumference of the reel. The lagging must be strapped with two or more equally spaced steel bands.
- F. Reel marking. The Contractor's name, Contract number under which the cable was purchased, NSN, actual length and type of cable, and cable installation temperature range (prominently marked), must be embossed or printed with indelible ink onto aluminum plates and securely fastened to each outer reel-flange with nails or screws. The minimum font size for reel markings must be 28.

PART 3 CONSTRUCTION METHODS

3.01 CABLE INSTALLATION

- A. No work will be undertaken without verification of approved and qualified personnel on site performing the actual work tasks. This is specific and critical during the pulling and handling of fiber optic transmission system cables, terminations, racking cables in manholes, hand holes, junction boxes, and testing of the cables.
- B. General. The fiber optic cable must be installed in continuous runs between Hub building and/or indoor/outdoor enclosures as shown on

the plans. Splices will not be allowed. The cable must be terminated at locations as shown on the plans and as directed by the FAA and/or the Commissioner.

1. Cable Minimum Bend Radius. For static storage, the cable must not be bent at any location to less than 20 times the diameter of the cable outside diameter or as recommended by the manufacturer. During installation, the cable must not be bent at any location to less than 20 times the diameter of the cable outside diameter or as recommended by the manufacturer.
2. Cable Slack. Loops of single-mode and multi-mode fiber optic cable must be provided in each handhole and manhole as shown on the plans, at the top of each conduit riser, and at each enclosure according to the following requirements. The minimum slack amounts must be as follows:

Slack Location	Slack Cable Length (Feet)	
	Multi-Mode Fiber	Single-Mode Fiber
Junction Box (24"x24")	15.0	15.0
Handhole	24.0 horizontal coil	20.0 vertical coil
Conduit Riser	13.0	13.0
Manhole	42.0 horizontal coil	20.0 vertical coil

- a. The slack cable length for each multi-mode fiber optic transmission system loop must be coiled one and one half times around the inside perimeter of the manhole or handhole, laid and supported on the rack arms of the manhole or handhole.
- b. The slack cable length for single-mode fiber optic transmission system loop must be hanged and coiled in accordance to the CDA/OMP Standard Detail 6-16-18 *Handhole FAA Single-Mode Fiber Coiling Detail*. The slack must be coiled to (3) – 2 ft. diameter coils per fiber cable and the coils must be bound at two points and supported in their static storage positions as shown in the Drawings and standard details.
3. Cable Termination. Field cable must terminate in the distribution enclosure as directed by the FAA and/or the Commissioner.

- C. Installation in Conduits. All single mode fiber optic cables shall be installed in yellow 1" inner duct; all multi mode fiber optic cables shall be installed in orange 1" inner duct. The Contractor must compensate for inner duct elongation due to installation as described in Section L-110

Installation of Airport Underground Electrical Duct. The fiber optic inner duct must be installed in a 4" conduit as shown on the Plan Set. Use only (1) 12 or (1) 24 strand fiber optic cable per 1" inner duct. A suitable cable feeder guide must be used between the cable reel and the face of the conduit to protect the cable and to guide it into the conduit off the reel. The cable must be carefully inspected for jacket defects. If defects are noticed, the pulling operation must be stopped immediately and the Commissioner must be notified. The fiber optic cable minimum bend radius must not be exceeded during installation. After installation, no fiber optic cable shall be under tension in the manholes and handholes nor within the ductbank between manholes and handholes.

Precautions must be taken during installation to prevent the cable from being kinked or crushed. A pulling eye must be attached to the cable and used to pull the cable through the conduit. A pulling swivel must be used to eliminate twisting of the cable. As the cable is played off the reel into the cable feeder guide, it must be lubricated with a type of lubricant recommended by the cable manufacturer. The lubricant used must be of water based type and approved by the cable manufacturer. Dynamometers of break away pulling swing must be used to ensure that the pulling line tension does not exceed the installation tension specified by the cable manufacturer. Maximum length of cable pulling tensions must not exceed the cable manufacturer's recommendations. The mechanical stress placed on a cable during installation must not be such that the cable is twisted or stretched. The pulling of the cable must be hand assisted at each enclosure. The cable must not be crushed, kinked or forced around a sharp corner. Sufficient slack must be left at each end of the cable to allow proper cable termination. At each enclosure, manhole or handhole the cable must be visibly marked/tagged as directed by the Commissioner.

- D. The Contractor must test the fiber optic cable on the reel at the construction site as specified in 2.03(D) in the presence of the Commissioner prior to installation.
- E. The Contractor must test the fiber optic cable for each segment after installation and must certify and demonstrate to the FAA and/or the Commissioner that it meets all the performance requirements. The cable strand readings must not exceed a 0.5 dB difference from the least to the highest reading per cable. Contractor must test the performance of each strand on every fiber optic cable segment in both directions of transmission and provide (3) three copies of the test results to the Commissioner in both electronic and loose leaf hard copy formats. The following tests shall be performed and the associated documentation provided:

1. Factory tests – optical attenuation, cable assembly test (refer to checklist).
 2. On-site pre-installation reel tests – Optical Time Domain Reflectometer (OTDR).
 3. Installed cable tests – OTDR and optical attenuation
- F. The fiber optic cable must be tagged at every manhole, junction box, enclosure and facility with the named designations identified on the drawings. Within the lower level concourse tunnels, fiber cables not routed within conduit must be tagged every 50' minimum. The tagging identification must meet CDA/OMP Design Criteria Section 2, Airside for Single-Mode Fiber. Tags for multi-mode are similar except for orange color and as directed by the Commissioner.
- G. Installation Temperature. No fiber optic cable shall be installed in a 12 hour period during which the National Weather Service forecasts temperatures at or below the cable's minimum installation temperature at O'Hare International Airport.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Fiber optic patch panels will not be measured for payment separately but will be incidental to the specified fiber optic cable. The patch panel will be complete, connected, tested, ready for operation and accepted as part of a completed system by the Commissioner.
- B. The fiber optic cable will be measured for payment per linear foot in place. Cable will be measured horizontally and vertically between the changes in direction, including slack cables and the cable in the vertical conduit riser and inside the Hub building facility and other indoor/outdoor enclosures. Splicing will be incidental to the fiber optic cable installation.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Fiber optic connectors will not be paid for separately but will include all connectors of the type and size specified and shown on the Plans, and will be considered incidental to the cost of the specified fiber optic cable.
- B. Patch panels of the type specified and/or shown on the Plans will not be paid separately, but will be considered incidental to the cost of the

specified fiber optic cable.

- C. Fiber optic cable will be paid for at the Contract unit price per linear foot for Fiber optic cable of the type, size and number of fibers specified.

The lengths of slack cable allowed and the vertical cable in the Hub building facility and/or other indoor/outdoor enclosures and the cable in the vertical conduit riser will be paid for at the Contract unit price per linear foot for Fiber optic cable of the type, size and number of fibers specified.

The cable warning tags and termination will be included in the cost of the fiber optic cable.

- D. Payment will be made under the following item:

ITEM NO.	DESCRIPTION	UOM
16125-01	1- 24 STRAND, TYPE B, SINGLE-MODE FIBER OPTIC CABLE	LF

FAA FOTS Single-Mode Fiber Optic Cable Specification Test Requirement Checklist

01.	<p>Manufacturer to provide Certificate of Specification 16125 Compliance for:</p> <ul style="list-style-type: none"> Core Diameter Cladding Diameter Protective Coating Diameter Core-cladding Concentricity Core Non-circularity Cladding Non-circularity Tensile Strength Numerical Aperture Zero-dispersion Wavelength Zero-dispersion Slope Bandwidth Mode-field Diameter Cut-off Wavelength Sheath Material Properties Specification 16125 Mechanical Performance Specification 16125 Environmental Performance
02.	Manufacturer must validate the optical attenuation on all fibers of every reel of finished cable by power measurement per FAA-E-2761C at the factory prior to shipment at 1310nm and 1550nm wavelengths (16125, 2.03, d, 3.a).
03.	Manufacturer to test all fibers of one reel of cable selected at random for temperature dependence of attenuation (16125, 2.03, d, 3.c).
04.	Manufacturer to test specimen selected from sample for cable flexing (16125, 2.03, d, 3.e).
05.	Manufacturer to test specimen selected randomly from sample for water intercept tests (16125, 2.03, d, 3.g).
06.	Manufacturer to test on a production run basis cable pulling capacity test (16125, 2.03, d, 3.h).
07.	Manufacturer to test specimen selected randomly from sample for crush resistance test (16125, 2.03, d, 3.j).
08.	Manufacturer to test specimen selected randomly from sample for impact resistance tests (16125, 2.03, d, 3.k).
09.	Contractor must validate the optical attenuation on all fibers of every reel of finished cable by OTDR test trace per FAA-E-2761C at the site prior to installation in the presence of the Commissioner/FAA at 1310nm and 1550nm wavelengths.
10.	The Contractor must test the fiber optic cable for each segment after installation and must certify and demonstrate to the FAA and the Commissioner that it meets all the performance requirements of specification 16125 and FAA-e-2761c. The Contractor must validate the optical attenuation on all fibers of every segment of installed cable by OTDR test trace per FAA-e-2761c at the site, in the presence of the Commissioner/FAA at 1310nm and 1550nm wavelengths. OTDR measurements to be made bi-directionally with the results averaged where splices occur in a segment between nodes.
11.	Contractor must perform a power attenuation test bi-directionally on each fiber for each segment of cable.
12.	The cable strand reading must not exceed a 0.5 db difference from the least to the highest strand reading per cable.

FAA FOTS Multi-Mode Fiber Optic Cable Specification Test Requirement Checklist

01.	<p>Manufacturer to provide certificate of Specification 16125 compliance for:</p> <ul style="list-style-type: none"> Core Diameter Cladding Diameter Protective Coating Diameter Core-cladding Concentricity Core Non-circularity Cladding Non-circularity Tensile Strength Numerical Aperture Zero-Dispersion Wavelength Zero-Dispersion Slope Bandwidth Sheath Material Properties Specification 16125 Mechanical Performance Specification 16125 Environmental Performance
02.	Manufacturer must validate the optical attenuation on all fibers of every reel of finished cable by power measurement per FAA-E-2761C at the factory prior to shipment at 850 nm and 1300nm wavelength (16125, 2.03, d, 3.a)
03.	Manufacturer to test all fibers of every reel for optical bandwidth (16125, 2.03, d, 3.b).
04.	Manufacturer to test all fibers of one reel of cable selected at random for temperature dependence of attenuation (16125, 2.03, d, 3.c.).
05.	Manufacturer to test specimen selected from sample for cable sheath thickness (16125, 2.03, d, 3.d)
06.	Manufacturer to test specimen selected from sample for cable flexing (16125, 2.03, d, 3.e).
07.	Manufacturer to test specimen selected randomly from sample for water intercept tests (16125, 2.03, d, 3.f).
08.	Manufacturer to test on a production run basis cable pulling capacity test (16125, 2.03, d, 3.g).
09.	Manufacturer to test specimen selected from sample for cable sheath material properties certification (16125, 2.03, d, 3.h).
10.	Manufacturer to test specimen selected randomly from sample for crush resistance test (16125, 2.03, d, 3.i).
11.	Manufacturer to test specimen selected randomly from sample for impact resistance tests (16125, 2.03, d, 3.j).
12.	Contractor must validate the optical attenuation on all fibers of every reel of finished cable by OTDR Test trace per FAA-E-2761C at the site prior to installation in the presence of the Commissioner/FAA at 850nm and 1300nm wavelength.
13.	The Contractor must test the fiber optic cable for each segment after installation and must certify and demonstrate to the FAA and the Commissioner that it meets all the performance requirements of Specification 16125 and FAA-E-2761C. Contractor must validate the optical attenuation on all fibers of every segment of installed cable by OTDR Test trace per FAA-E-2761C at the site in the presence of the Commissioner/FAA at 850nm and 1300nm wavelength. OTDR measurements to be made bidirectional with the results averaged where splices occur in a segment between nodes.
14.	Contractor must perform a power attenuation test on each fiber bi-directionally for each segment of cable.
15.	The cable strand reading must not exceed a 0.5 db difference from the least to the highest strand reading per cable.

END OF SECTION 16125

CHICAGO DEPARTMENT OF AVIATION/
O'HARE MODERNIZATION PROGRAM
TAXIWAY Z/JJ AND TANK FARM ROAD – PACKAGE B
OH6143.710.372.50
ISSUED FOR BID, 3/21/18

16125-32

FIBER OPTIC CABLE AND EQUIPMENT

CABINETS AND ENCLOSURES

SECTION 16131

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes hinged cover enclosures, cabinets, terminal blocks, and accessories, as shown on drawings and as specified herein.

1.02 RELATED WORK

- A. As specified in the following divisions:
 - 1. 13128- Prefabricated Modular Control Booths.

1.03 REFERENCES:

National Electrical Manufacturers Association:

- 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- 2. NEMA ICS 4 - Industrial Control and Systems: Terminal Blocks.

1.04 SUBMITTALS:

- A. The Contractor shall submit project data to the Commissioner prior to purchasing and installation. The data shall include, but not be limited to, the following:
 - 1. Installation design drawings - schematic, wiring, and one line diagrams; conduit; conduit and cable schedules; grounding; symbols and legends; etc. shall be included.
 - 2. The equipment manufacturers' schematic diagrams shall be "JIC" ladder type. Schematics shall identify all devices, wire codes, and terminal numbers.
 - 3. The equipment manufacturers' wiring diagrams shall show terminal blocks for external wiring. Wiring diagrams shall identify all devices, wire codes, and terminal numbers.
 - 4. The equipment manufacturers' internal point to point and external wiring diagrams between cubicles, panels and components within the equipment line up shall be provided.
 - 5. Catalog cuts and major electrical equipment manufacturers'

drawings shall include, but are not limited to, relays, meters, current and potential transformers, disconnect switches, lighting and more.

6. Complete descriptive literature, performance and test data and rating data for all equipment shall be provided.
7. Instruction books, Operation and Maintenance manuals with spare parts shall be provided.
8. Complete and accurate "As Built" drawings shall be provided by the Contractor to the Consulting Engineer for verification and drafting.

B. Shop Drawings

1. The Contractor shall submit Shop Drawings and Samples in accordance with the Contract Documents and supplementary requirements as stated under each section of the specifications.
2. The Contractor shall make submittals in accordance with the approved CPM Schedule before any material or equipment is purchased. The submittals shall be reviewed by the Commissioner for compliance with the Contract Documents.
3. Shop Drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, schedules and other such descriptive data specifically prepared for the Work by the Contractor, Sub-contractor and/or manufacturer to illustrate that the materials, equipment or system conform to the Contract requirements.
4. Additional submittal requirements are described in individual sections of the specifications.
5. Any listed materials, fixtures, apparatus, or equipment that are not in accordance with the Contract Document requirements can and shall be rejected for use in this Contract.
6. Any materials, apparatus or equipment installed without reviewed and accepted submittals shall be removed by the Contractor and replaced at the direction of the Commissioner and without cost to the City.
7. Substitutions to listed acceptable manufacturers equipment and material shall not be accepted until the Contractor has complied with the requirements of Part Two, Article VI of the Contract Documents.

C. Installation Drawings

1. The initial copy of all installation drawings shall be submitted to the Commissioner for review.

2. The installation drawings shall be made under the direction and supervision of the Contractor and shall show all electrical work including, but not limited to, conduit, wiring, electrical equipment and devices junction boxes, conduit supports and inserts. Symbol representation for home run circuits shall not be acceptable. These drawings shall include all ductbank work, embedded conduit plans, electrical room layouts and elevations as well as all circuiting and locations of all electrical equipment.
3. Shop Drawings for manufactured electrical equipment and materials, the Contractor shall prepare and maintain in current status, a complete set of detailed, completely circuited, and dimensioned electrical construction drawings for all electrical work included under this Contract. These drawings shall be made at the Contractor's expense.
4. No electrical work shall begin until these installation drawings are so drawn, and thereafter finally accepted by the Commissioner.
5. The complete electrical distribution system from the sources, including each branch circuit panelboard, shall be shown and dimensioned exactly as to be installed, with all feeders located on the installation drawings. Major equipment, lighting controls and apparatus shall be shown to scale and properly located.
6. The Contractor shall provide a separate set of installation drawings for the power and control.
7. The Contractor shall provide a single line diagram describing the power distribution system. This diagram shall include ratings for all equipment and cable sizes from the service connection to the 120 Volt lighting and distribution panels.
8. The installation drawings shall include schedules for all panelboards. Schedules shall depict the bus arrangement of the panelboard, the size of all circuit breakers, the connected load on each breaker, and a description of the load and its location.
9. The installation drawings shall indicate the electrical installation exactly as to be constructed and therefore shall be periodically revised to reflect all changes inclusive of those required by the Commissioner, those which are or have been found necessary in the field, those which may be suggested by the Contractor and approved by the Commissioner, etc.
10. Revisions shall be performed when considered necessary by the Commissioner or the Contractor in order to facilitate proper coordination.

11. The Contractor shall be responsible for the coordination of electrical work with the work of all other trades and shall, in preparing the installation drawings, continually check the work of all other trades (inclusive of that indicated by Shop Drawings) in order to avoid possible installation conflicts arising therefrom. It shall be understood that the work shown on the installation drawings has been so coordinated. In the event of conflicts or interferences that cannot be resolved in the field, the Contractor shall request a written clarification from the Commissioner.
12. Upon completion, the initial installation drawings, and all revised installation drawings thereafter, shall be dated and certified as having been fully coordinated by the Contractor. It shall then be understood that the work shown thereupon is ready for construction.
13. All installation drawings shall be made in accordance with an approved schedule, prepared by the Contractor, and arranged to coincide with actual construction in such a manner as to allow the latter work to proceed without delay.
14. If, in the opinion of the Commissioner, the installation drawings are in acceptable condition after each has been finally revised and accepted, the Contractor may submit same as the field record drawings called for elsewhere in the specifications.
15. The Contractor shall include wiring diagrams and schematic diagrams. Each schematic diagram shall be "JIC" ladder type. Wire and terminal numbers shall be shown on all schematic and wiring diagrams.
16. The minimum drafting letter size shall be 1/8 inch in height and shall be block type lettering.

- D. The Contractor shall submit test reports as described under this Contract.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five (5) years experience.

1.06 EXTRA MATERIALS

- A. Furnish five (5) of each key.

PART 2 PRODUCTS

2.01 HINGED COVER ENCLOSURES

- A. Manufacturers:
 - 1. Carlon Electrical Products
 - 2. Hubbell Wiring Devices
 - 3. Reliance Electric
 - 4. Hoffman Enclosures
- B. Construction: NEMA 250, Type 1 type 3R steel enclosure.
- C. Covers: Continuous hinge, held closed by key.
- D. Furnish interior metal panel for mounting terminal blocks and electrical components; finish with white enamel.
- E. Enclosure Finish: Manufacturer's standard enamel.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner.
- B. Install cabinet fronts plumb.

3.02 CLEANING

- A. Clean electrical parts to remove conductive and harmful materials.
- B. Remove dirt and debris from enclosure.
- C. Clean finishes and touch up damage.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Cabinet and enclosures will not be measured separately for payment.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Cabinet and enclosures will not be paid for separately but will be included in the lump sum price for the PREFABRICATED MODULAR CONTROL BOOTH.

END OF SECTION 16131

WIRING DEVICES

SECTION 16140

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Work under this section is subject to the requirements of the Contract Documents.
- B. Furnish and install Wiring Devices and materials as specified herein and as shown on the Contract Drawings, including but not limited to the following:
 - 1. Receptacles
 - 2. Light Switches
 - 3. Cover plates

1.02 RELATED WORK:

- A. As specified in the following sections:
 - 1. Section 13128 – Prefabricated Modular Control Booths
 - 2. Section 16010 – Basic Electrical Requirements
 - 3. Section 16100 – Basic Materials and Methods
 - 4. Section 16123 – Building Wire and Cable
 - 5. Section 16195 – Electrical Identification
 - 6. Section 16452 – Grounding
 - 7. Section 16950 – Testing

1.03 REFERENCES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.03 References.

1.04 SUBMITTALS:

- A. The Contractor shall submit data to the Commissioner prior to purchasing and installation. The data shall include, but not be limited to, the following:

1. Catalog cuts and major electrical equipment manufacturers' Drawings shall include, but is not limited to, relays, meters, current and potential transformers, disconnect switches, fuses, contactors, lighting and more.
 2. Complete rating data for all equipment shall be provided.
- B. Submit samples of devices and wall plates.
- C. See Specification Section 16010 Basic Electrical Requirements 1.04 Submittals - B Shop Drawings.

1.05 QUALITY CONTROL:

- A. See Specification Section 16010 Basic Electrical Requirements 1.05 Quality Control.

1.06 DELIVERY STORAGE AND HANDLING:

- A. See Specification Section 16010 Basic Electrical Requirements 1.06 Delivery Storage and Handling.

1.07 WARRANTIES AND GUARANTEES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.07 Warranties and Guarantees.

1.08 EXTRA MATERIALS AND SPARE PARTS:

- A. None required.

1.09 ENVIRONMENTAL REQUIREMENTS:

- A. None required.

1.10 SPECIAL REQUIREMENTS:

- A. Field Measurements - Before proceeding with the fabrication of the Work, the Contractor shall verify all dimensions and take such measurements as are required for proper fabrication and erection of the Work.
- B. Coordination - Coordinate Work of this section with related Work specified in the other divisions/sections of the Contract Documents.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Products of one of the following Manufacturers shall be acceptable:
 - 1. Harvey Hubbell Inc.
 - 2. Leviton
 - 3. Pass & Seymour
 - 4. Lutron
 - 5. Arrow Hart Wiring Devices
 - 6. Eagle Electronic
 - 7. Siemens Co.
 - 8. Square D
- B. All wiring devices shall be the product of a single manufacturer. The Contractor shall not provide devices from more than one (1) manufacturer for any Project.
- C. Wiring device colors shall be as follows:
 - 1. Brown in mechanical areas, outdoors and in unfinished areas, i.e., areas where they are not exposed to the public.
 - 2. In finished areas, i.e., areas such as offices, reception areas, ticketing, waiting rooms, bathrooms, gate areas, etc. the colors shall be as directed by the Commissioner.
 - 3. Special devices, i.e. surge protector or isolated ground devices shall have colors as specified elsewhere in this Specification.

2.02 RECEPTACLES:

- A. Provide duplex Specification grade receptacles incorporating nylon thermoplastic faces, thermoset heat resistant base, brass mounting strap and assured pretensioned grounding features. Receptacles shall comply with NEMA Std's publication number WD 1, shall be UL listed and approved under Federal Specification WC 596 latest revision. Receptacles shall be 20 ampere, 125 volt, 3 wire, NEMA 5-20R, grounding type. Receptacles shall be Hubbell # 5352, Leviton # 5362 or Pass & Seymour # 5362.
- B. Provide Ground Fault Circuit Interrupters of the feed through type with heavy duty duplex receptacles capable of protecting downstream receptacles on a single circuit, grounding type, UL rated Class A, Group 1, rated 20 amperes, 125 volt 60 Hz., with a 5 milliamperes

ground fault trip level, NEMA configuration 5-20R. Color shall be as directed by the Commission.

2.03 SWITCHES:

- A. Provide, as indicated on the Drawings, Specification grade, meeting Federal Specification WS896E and UL listed under UL 20, flush single pole toggle switches, 20 ampere, 120-277 volt AC, with mounting yoke insulated from mechanism, equipped with plaster ears, grounding terminal and switch handle. Switches shall have brass side wired screw terminals. Single pole switches shall be Hubbell No. 1221 Brown or approved equal.

2.04 COVER PLATES:

- A. Cover plates shall be provided for each wiring device in single gang or multi-gang configurations as required by the installation. The cover plates shall be smooth nylon and shall be by the same manufacturer as the wiring device for finished areas and of the same color. The screw heads shall also be of the same color as the cover plate.
- B. In unfinished indoor areas the cover plates shall be, for surface mounted devices, Garvin type covers of the correct configuration for the device(s). For flush mounted devices the cover plate shall be smooth nylon, brown in color.
- C. For outdoor and wet location installations the cover plate shall be cast aluminum, gasketed with cover(s) which are normally closed and held in place under spring tension. For devices installed where they are subject to direct spray the cover plate shall be of the type whose integrity is not compromised when the device is in use.
- D. Where required provide oversized cover plates which shall conceal the entire opening in the wall.

PART 3 EXECUTION

3.01 INSTALLATION:

- A. Install wiring device where indicated on the Drawings. Ground Fault Sensing receptacles shall be installed where required by Code and where shown on the Drawings.
- B. Install wiring devices only in electrical boxes which are clean and free of debris such as dirt, drywall, taping compound, etc.

- C. All wiring devices shall be properly centered, level and plumb. Each wiring device shall be properly installed in the plaster ring provided. In no case shall any device be installed more than 1/4 of an inch past the face of the plaster ring. The Contractor shall not "build out" the device from the plaster ring by inserting shims, washers, etc.
- D. Outdoor receptacles shall be installed in weatherproof enclosures with the proper cover and gasketing. Where required or necessary, as determined by the Commissioner, the Contractor shall caulk around the assembly to insure that it is weather tight.
- E. The wire connections to each wiring device shall be neatly and properly trimmed avoiding excess exposed conductor. The Contractor shall not center strip the wiring for the purposes of connecting to the wiring device and then continuing on to the next device. Each wiring device shall have the grounding terminal connected to the grounding conductor. Upon completion of the wiring the Contractor shall apply a tape wrapping, consisting of at least two (2) layers of tape, over the terminals of the wiring device.
- F. Upon completion of the finish surface the cover plates may be installed. Do not install cover plates before the finish surface is completed and is ready for acceptance of the cover plate. In unfinished areas where there are surface mounted devices the Contractor shall properly protect the cover plates and devices from any painting, waterproofing, etc.
- G. Switches shall be installed with the "OFF" position down.
- H. Mounting heights shall be as follows, unless noted otherwise
 - 1. Indoor receptacles horizontally mounted 1' - 6" centerline minimum
 - 2. Switch vertically mounted 3' - 6" centerline
 - 3. Telephone outlet horizontally mounted 1' - 6" centerline
 - 4. Telephone outlet vertically mounted 3' - 6" centerline
 - 5. Receptacles at counters, sinks, etc. As shown on the Drawings.
- I. Upon completion of the installation the Contractor shall test all wiring devices. All switches shall be operated several times to show proper operation. Voltage drop shall be checked per Specification Section 16950 - Testing. All GFCI devices shall be tested to insure proper operation.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

Wiring devices will not be measured separately for payment.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Wiring devices will not be paid for separately, but will be included in the lump sum price for PREFABRICATED MODULAR CONTROL BOOTH.

END OF SECTION 16140

ELECTRICAL IDENTIFICATION

SECTION 16195

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Work under this section is subject to the requirements of the Contract Documents.
- B. Furnish and install Electrical Identification as shown on the Drawings and as specified herein, including but not limited to the following:
 - 1. Conduit markers
 - 2. Wire / Cable Markers.
 - 3. Warning Tape.
 - 4. Danger Signs.
 - 5. Equipment Identification.
- C. For the purposes of this Specification the term "Cable" must apply to any type of conductor mentioned in the Contract Documents.

1.02 RELATED WORK:

- A. As specified in the following divisions:
 - 1. Section 16010 – Basic Electrical Requirements
 - 2. Section 16100 – Basic Materials and Methods

1.03 REFERENCES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.03 References.

1.04 SUBMITTALS:

- A. The Contractor must submit data to the Commissioner prior to purchasing and installation. The data must include but not be limited to the following:
 - 1. Catalog cuts and major electrical equipment manufacturers' Drawings must include, but is not limited to, relays, meters, current and potential transformers, disconnect switches, fuses, contractors, lighting and more.

2. Complete rating data for all equipment must be provided.
 3. Instruction books, operation and maintenance manuals with spare parts must be provided.
- B. Submit samples of Conduit markers, cable markers and Phenolic Tags.
 - C. Submit a nameplate log which must clearly indicate the exact wording for each nameplate.
 - D. Shop Drawings - See Specification Section 16010 Basic Electrical Requirements 10.4 Submittals – B. Shop Drawings.

1.05 QUALITY CONTROL:

- A. See Specification Section 16010 Basic Electrical Requirements 1.05 Quality Control.

1.06 DELIVERY STORAGE AND HANDLING:

- A. See Specification Section 16010 Basic Electrical Requirements 1.06 Delivery Storage and Handling.

1.07 WARRANTIES AND GUARANTEES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.07 Warranties and Guarantees.

1.08 EXTRA MATERIALS AND SPARE PARTS:

- A. None required

1.09 ENVIRONMENTAL REQUIREMENTS:

- A. None required

1.10 SPECIAL REQUIREMENTS:

- A. Field Measurements - Before proceeding with the fabrication of the Work, the Contractor must verify all dimensions and take such measurements as are required for proper fabrication and erection of the Work.
- B. Coordination - Coordinate Work of this section with related Work specified in the other divisions/sections of the Contract Documents.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Products of one of the following Manufacturers will be acceptable (for each type marker):
 - 1. Alarm Supply Co., Inc.
 - 2. Brady, W.H. Co.
 - 3. Calpico Inc.
 - 4. Cole-Flex Corp.
 - 5. Direct Safety Co.
 - 6. George-Ingraham Corp.
 - 7. Griffolyn Company
 - 8. Ideal Industries, Inc.
 - 9. LEM Products, Inc.
 - 10. Markal Company
 - 11. National Band and Tag Co.
 - 12. Panduit Corp.
 - 13. Garfoplast.

2.02 UNDERGROUND CABLE MARKERS:

- A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than one (1) type is specified for an application, selection is installer's option, but provide only one selection for each application.
- B. Cable markers for all underground cables must be vinyl tags, with the lettering etched through the outer layer. Tags must have the lettering engraved through the outer layer exposing the second layer. The edges of each tag must be beveled. Markers must be held in place with Nylon, self-locking cable ties. Each marker must be provided with a hole at each end of the marker for the purposes of attaching the marker to the cable.
 - 1. The cable markers must be white vinyl with black letters. Letters must be a minimum of 3/8 inch in height.
- C. Cable identification must be the circuit number and the panel designation it is powered from. Where the cable originates from a piece of equipment, which is not a panel, the marking must be the item being fed and the source, i.e. "EF-1 MCC-1".

2.03 UNDERGROUND LINE MARKERS:

- A. Manufacturer's standard permanent, bright-red, continuous-printed plastic tape, intended for direct-burial service, not less than 6 inches wide x 4 mils thick. Provide tape with printing which most accurately indicates type of buried electrical service. Tape must be of the Aluminum Foil Polyethylene Laminate type which must be detectable when buried.

2.04 INTERIOR CABLE MARKERS:

- A. Cable markers must be installed on both ends of all conductors. Self-adhesive, self-laminating, or heat shrink tubing or plastic bead type must be used. All markers must be mechanically printed. Cable markers must be rated for the environment in which they are placed. Acceptable manufacturers will be Brady, 3M, Panduit or Garfoplast.
- B. Circuit identification must be per the Contract Drawings. Should the Drawings not specify the circuit identification the following system must be used:
 - 1. For branch circuit wiring from receptacle/lighting panels the circuit identification must be the panel number and the circuit number.
 - 2. For circuiting from distribution panels the circuit identification must be the panel number and the circuit number.
 - 3. For power conductors from MCC's the identification must be the MCC designation, the item being supplied and the phase designation. Control wiring must be per the wiring diagrams.
- C. Conductor color coding must be done using tape as specified elsewhere in the Contract Documents. Provide color coding for all conductors which do not come with factory applied colors.

2.05 CONDUIT MARKERS:

- A. Conduit tags must be either stainless steel, grade 316 minimum, or brass. Tags must have the identification either stamped in or embossed in the material. Tags must be fastened to the conduit with either stainless steel wire or with nylon, self-locking cable ties. For interior, dry locations nylon tags which are mechanically printed may be used.
- B. Conduit tags for underground use must be as described above. Where it is not practical to attach the tag to the conduit, i.e., in handholes and manholes, the tags must be fastened to the structure at

the point where the conduit enters the structure. The Contractor may use a single large plate type marker for this purpose. The marker must accurately depict the conduits and their identification. The identification must be attached using anchors as described in other parts of the Contract Documents.

2.06 WARNING/DANGER SIGNS:

- A. Provide manufacturer's standard "DANGER" signs of rigid Polyethylene; of standard, red, black and white graphics; 14" x 10" size except where 10" x 7" is the largest size which can be applied where needed, and except where larger size is needed for adequate vision, with recognized standard explanation wording, e.g., HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH, etc.
- B. Provide "Warning" signs, as required, of rigid Polyethylene, colors as required by OSHA.
- C. Signs must be attached with Stainless Steel screws. Warning/Danger signs must not be of the adhesive type for attachment to doors or walls.

2.07 EQUIPMENT IDENTIFICATION:

- A. After finish painting is completed, the Contractor must provide white with black core laminated phenolic nameplates with 1/4 inch minimum lettering etched through the outer covering. Inscription must be made with all upper case letters and must be the same inscriptions as shown on the Drawings or as directed by the Commissioner.
 - 1. All major electrical equipment must be so identified, including motor starters, disconnect switches, panels, switches, etc.
 - 2. Disconnect switches serving feeders and overcurrent protective devices mounted in a switchboard must be so identified.
 - 3. Embossed self-adhering plastic tape labels will not be accepted.
 - 4. Use stainless steel screws, except where contact-type permanent adhesive may be required when screws cannot or should not penetrate substrate.
 - 5. For Fire Alarm Systems provide white with red core laminated phenolic name plates.
 - 6. For Emergency Power equipment provide red with white letters.
 - 7. The Contractor must take care when attaching the identification so that the NEMA rating of the equipment is not violated.

2.08 LETTERING AND GRAPHICS:

- A. Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.
- B. Identification markings on signs and markers must not be done with pens, pencils, crayons, magic markers, paint, dymo-labels, etc.
- C. Identification on small boxes, i.e., 4 inch square and 4-11/16 inch boxes may be done with a permanent marker in neat and legible block printing. Black markers must be used for this purpose. The Contractor must identify the circuits contained and the panel(s) of origin.

2.09 TERMINAL IDENTIFICATION:

- A. Terminal strips must be identified by using markers supplied by the terminal manufacturer. Whenever possible they must be mechanically printed. When this is not possible the strips must be marked in neat and legible block lettering using a permanent marking system acceptable to the terminal strip manufacturer. The terminal marking must be the wire number attached to that terminal.

2.10 PULL BOX IDENTIFICATION:

- A. Identification markers for pull boxes, junction boxes, etc. must be of the polyester film type, self adhesive and pre-printed. The marker must contain the highest voltage level contained within that box. The marker must be yellow with black letters and the lettering must be visible from the floor.
- B. The box must have a phenolic nameplate, white with black letters, affixed to the box with stainless steel screws with the box identification. Each box must have an identifying designation that must be shown on the Drawings.

2.11 CABLE TIES:

- A. Cable ties must be fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18 inch minimum width, 50 lb. minimum tensile strength, and suitable for a temperature range from minus 50

degrees F to 350 degrees F. Provide ties in specified colors when used for color coding.

- B. Acceptable manufacturers will be Thomas & Betts Co., Brady Co. and Panduit.

2.12 WIRE IDENTIFICATION IN EQUIPMENT:

- A. The wire identification for manufactured equipment must match the wire identification shown on the manufacturers wiring diagrams. All wires must be identified. The manufacturer must use product as specified in the Contract Documents.
- B. For custom built equipment the wire identification must match the wire identification shown on the assemblers approved Shop Drawings. All wires must be identified.
- C. In no case must a wire number change designations as a result of termination at a terminal.
- D. Where multi-conductor cables are used the cable must be identified as well as each conductor contained within that cable.

PART 3 EXECUTION

3.01 APPLICATION AND INSTALLATION:

- A. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, requirements of Chicago Electrical Code and the Contract Documents.
 - 1. Where identification is to be applied to surfaces which require a specific finish, install identification after completion of the finish. The Contractor must take all precautions to avoid damaging the finish. Any damage must be repaired in a manner acceptable to the Commissioner.
 - 2. Comply with governing regulations and requests of governing authorities for identification of electrical work.
- B. The Contractor must provide a typewritten directory of circuits in lighting and power panels. The Contractor must clearly indicate the purpose of each circuit, i.e., lighting, receptacles, water cooler, etc. and must indicate the location of the supplied equipment.

3.02 CONDUIT, WIRE, CABLE AND BUS IDENTIFICATION:

- A. When not shown on the Contract Drawings the Contractor must indicate on his/her field marked set of Drawings, as required by the Contract Documents, the conduit identification.
- B. Each cable must be labeled at all terminals and at all accessible points in equipment, panelboards, manholes, handholes and pull boxes, etc. Labels must be as specified herein.
- C. All wires and feeder cables must be labeled in all junction boxes pull boxes, control panels, motor control centers, panelboards, switchboards, etc. All conductors must be tagged in cabinets at the time wires are pulled in and tested and markers must not be removed for any reason.
- D. Markers approved by the Commissioner must be attached to all cables where entering or leaving from conduit runs. The cable designation and circuit use must appear on the tag.
- E. Apply colored, pressure sensitive tape in half-lapped turns for a distance of 2 inches from the cable marker and in all boxes. Provide color coding at all splices and taps to each side of the splice or tap. Apply the last two laps of tape with no tension to prevent possible unwinding. Do not obliterate cable tag with the tape.
- F. All conduit runs must be identified by means of non-corrosive metal tag with stamped identification thereon, as shown on Contractor's installation Drawings and attached at all conduit terminations, including junction boxes. For interior work a nylon tag, mechanically printed may be used in lieu of metal.
- G. Conduit identification tags must be fastened to the conduit near the point of termination where conduits enter motor control centers, switchboards, switchgear, terminal cabinets, outlet boxes, junction boxes, pull boxes and other items. The tag must be held in place by a nylon, self-locking cable tie.
- H. Conduits in miscellaneous pull boxes in runs where the system identity cannot be clearly seen must have identifying tags indicating the name of the system. Such tags must be installed as described above. Miscellaneous systems must include, but not be limited to, telephones, lighting, etc.
- I. Conduits terminating at lighting fixtures, wall switches, telephones, terminal cabinets, lighting panelboards, receptacle outlets and similar

items need not be tagged where their system identification is obvious, except as noted above for clarity.

- J. Exterior installed conduits, except branch lighting circuit conduits, must be tagged at the ends and in intermediate boxes, chambers, manholes, handholes and other enclosures in accordance with the same inscriptions as shown on the Drawings.
- K. Tags must be fastened as specified except that where this method is not practicable they must be fastened to the adjacent masonry by means of expansion bolts.
- L. Phase identification letters must be 1 inch high in readily visible locations, and must be stamped into the main bus bars of switchboards and panelboards.
- M. For conduits in duct banks and embedded in structural slabs, etc. the conduit identification must be installed at the point where the conduit exits the slab.

3.03 OPERATIONAL IDENTIFICATION AND WARNING:

- A. Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.
- B. In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations indicated, either by the Contract Documents or as directed by the Commissioner, and at locations subsequently identified by installer of electrical work as constituting similar dangers for persons in or about the facility.
 - 1. Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110-120 volts.
 - 2. Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, damage to or loss of property.

3.04 EQUIPMENT/SYSTEM IDENTIFICATION:

- A. Install engraved plastic-laminate signs on each unit of electrical equipment; including central or master unit of each electrical system including communication/control/ signal systems, unless unit is specified with its own self-explanatory identification or signal system. Provide text matching terminology and numbering from the Contract Documents and Shop Drawings. Provide signs for each unit, but not limited to, the following categories of electrical work:
1. Panelboards, electrical cabinets and enclosures.
 2. Access panel/doors to electrical facilities.
 3. Major electrical switchgear.
 4. Electrical substations.
 5. Motor control centers.
 6. Power transfer equipment.
 7. Transformers.
 8. Inverters.
 9. Disconnect Switches.
 10. Motor Starters.
 11. Time Clocks, Contactors, etc.
 12. Rectifiers.
 13. Frequency converters.
 14. Battery racks.
 15. Power generating units.
 16. Telephone switching equipment.
 17. Clock/program master equipment.
 18. Call system master station.
 19. TV/audit monitoring master station.
 20. Fire alarm master station.
 21. Security monitoring master station.
- B. Install signs at locations indicated or, where not otherwise indicated, at the location which provides the best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use a permanent adhesive where fasteners should not or cannot penetrate substrate.

- C. Provide Identification on all pull, junction, splice or terminal boxes. Identification must consist of the voltage contained within the enclosure and the enclosure identification.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Electrical Identification will not be measured separately for payment.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Electrical Identification will not be paid for separately, but will be considered incidental to the electrical work specified elsewhere in the contract documents.

END OF SECTION 16195

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GROUNDING

SECTION 16452

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Work under this section is subject to the requirements of the Contract Documents. This section applies to building and general electrical grounding. Airfield lighting and FAA grounding must be in accordance with current FAA Advisory Circulars and FAA Standards.
- B. Furnish and install all electrical Grounding work, materials and accessories as shown on the Drawings and as specified herein, including but not limited to the following:
 - 1. Metal building frames
 - 2. Electrical power systems
 - 3. Ground electrodes
 - 4. Counterpoise loops
 - 5. Separately derived systems
 - 6. Raceways
 - 7. Service equipment
 - 8. Enclosures
 - 9. Equipment
 - 10. Lighting standards
 - 11. Landscape lighting
 - 12. Signs
 - 13. Ground Wire.
 - 14. Conduits.
 - 15. Ground Rods.
 - 16. Grounding Triad.
 - 17. Ground Test Stations.
 - 18. Exothermic Welds
 - 19. Grounding and Bonding jumpers.

- C. Install products and materials (furnished in other sections) as shown on the Drawings and as specified herein, including but not limited to the following:
 - 1. Section 16520 – Roadway/Parking Lot/Tunnel Lighting
 - 2. Section D-751 – Manholes, Catch Basins, Inspection Holes and Manhole Adjustments
 - 3. Sections L-100 – Marker Light Bases, Lighting Fixtures and Guidance Signs
 - 4. Section L-110 – Installation of Airport Underground Electrical Duct
- D. Requirements of this section apply to electrical grounding and bonding work specified elsewhere in these Specifications.

1.02 RELATED WORK:

- A. As specified in the following divisions:
 - 1. Section 16010 – Basic Electrical Requirements
 - 2. Section 16100 – Basic Materials and Methods

1.03 REFERENCES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.03 References.

1.04 SUBMITTALS:

- A. See Specification Section 16010 Basic Electrical Requirements 1.04 Submittals – B. Shop Drawings.

1.05 QUALITY CONTROL:

- A. See Specification Section 16010 Basic Electrical Requirements 1.05 Quality Control.

1.06 DELIVERY STORAGE AND HANDLING:

- A. See Specification Section 16010 Basic Electrical Requirements 1.06 Delivery Storage and Handling.

1.07 WARRANTIES AND GUARANTEES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.07 Warranties and Guarantees.

1.08 EXTRA MATERIALS AND SPARE PARTS:

- A. None required.

1.09 ENVIRONMENTAL REQUIREMENTS:

- A. None required.

1.10 SPECIAL REQUIREMENTS:

- A. Field Measurements - Before proceeding with the fabrication of the Work, the Contractor must verify all dimensions and take such measurements as are required for proper fabrication and erection of the Work.
- B. Coordination - Coordinate Work of this Section with related Work specified in the other divisions/sections of the Contract Documents.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Products of one of the following Manufacturers will be acceptable (for each type of product):
 - 1. Adalet-PLM Div.; Scott Fetzer Co.
 - 2. Burndy Corporation
 - 3. Cadweld Div.; Erico Products Inc.
 - 4. Crouse-Hinds Div.; Cooper Industries
 - 5. Eagle Electric Mfg. Co.
 - 6. Ideal Industries, Inc.
 - 7. Joslyn Corporation
 - 8. Okonite Company
 - 9. OZ Gedney Div. General Signal Corp.
 - 10. Thomas and Betts Corp.
 - 11. Harger

2.02 GROUNDING WELL COMPONENTS

- A. Per FAA-STD-019e, the access well shall be 24" in diameter.
- B. Well Cover: Cast iron
- C. Acceptable manufacturers are Harger, East Coast Lighting Equipment, Antenna Systems and Solutions, and Neenah (7506-F).
- D. Test each and every ground rod prior to backfill. Provide those individual test results in tabulated form to FAA Resident Engineer.

2.03 MECHANICAL CONNECTORS

- A. Manufacturers:
 - 1. Erico Inc.; Electrical Products Group
 - 2. ILSCO Corporation
 - 3. Crouse-Hinds Division; Cooper Industries
 - 4. Thomas & Betts, Electrical
 - 5. Burndy Corporation
 - 6. O-Z Gedney Co.
 - 7. Apache Grounding
 - 8. Adalet-PLM Div.
 - 9. Eagle Electric Manufacturing, Co.
 - 10. Ideal Industries, Inc.
 - 11. Joslyn Corporation
 - 12. Okonite Co.
 - 13. Harger
- B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.04 EXOTHERMIC CONNECTORS

- A. Manufacturers:
 - 1. Erico Inc.; Electrical Products Group
 - 2. ILSCO Corporation
 - 3. Crouse-Hinds Division; Cooper Industries
 - 4. Thomas & Betts, Electrical

5. Burndy Corporation
 6. O-Z Gedney Co.
 7. Apache Grounding
 8. Adalet-PLM Div.
 9. Eagle Electric Manufacturing, Co.
 10. Ideal Industries, Inc.
 11. Joslyn Corporation
 12. Okonite Co.
 13. Harger
- B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

2.05 GROUNDING AND BONDING:

- A. Except as otherwise indicated, provide electrical grounding and bonding systems indicated, with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters and additional accessories needed for a complete installation. Where more than one (1) type component product meets indicated requirements, selection is installer's option.
- B. Unless otherwise indicated, provide electrical grounding conductors for grounding system connections per Section 16100 - Basic Materials and Methods and which are sized according to the Chicago Electrical Code. In no case must bare conductors be installed in the earth.
- C. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by bonding plate, connector, terminal and clamp manufacturers for indicated applications.
- D. Ground Electrodes must be stainless steel, 3/4 inch dia. x 10 feet for a maximum resistance of 5 ohms.
1. For single ground point installation if more than one rod is needed to achieve a maximum of 5 ohms, install additional rods not closer than 6' - 0" on center.
 2. For counterpoise grounding, no ground rod must exceed 10 ohm maximum resistance. The completed counterpoise system must have a maximum resistance of 2 ohms. If 2 ohms cannot be met, as installed, additional rods must be installed at

a minimum of 6' - 0" spacing between rods until the 2 ohms is met.+-.

3. Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, etc. as recommended by accessories manufacturers for type service indicated.
4. Comply with AWS Code for procedures, appearance and quality of welds; and for methods used in correcting welding work. Provide welded connections where grounding conductors connect to underground grounding and plate electrodes.

PART 3 EXECUTION

3.01 EXAMINATION:

- A. Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify the Commissioner in writing of conditions detrimental to proper completion of Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the Commissioner.

3.02 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS:

- A. Install electrical grounding and bonding systems as indicated and specified and in accordance with manufacturer's instructions and applicable portions of Chicago Electrical Code, NECA's "Standard of Installation" and in accordance with recognized industry practices to ensure that products comply with requirements. EXCEPTION: No ground connection to waterlines.
- B. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.
- C. Connect grounding conductors to underground grounding electrodes, using mechanical connectors. All ground rods are to be accessible to allow for periodic testing. Provide suitable covers and/or handholes for this purpose.
- D. Ground the electrical service system neutral at the service entrance equipment to the grounding system.
- E. Ground each separately-derived system neutral to the grounding system.
- F. Connect together system neutral, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment,

metal raceway systems, grounding conductor in raceways and cables, wiring device ground connectors, light fixtures and plumbing systems.

- G. Install counterpoises which encircle the building and are connected to structural columns, as shown on the Drawings, and to each driven electrode. Each connection to the building must be made using the exo-thermic welding process.
- H. Terminate feeder and branch circuit insulated equipment grounding conductors to grounding lug, bus or bushing.
- I. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- J. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible to minimize transient voltage rises.
- K. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.
- L. Install clamp-on connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.
- M. All conduits must contain a ground wire.

3.03 FIELD QUALITY CONTROL:

- A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance testing. These tests must be witnessed by the Commissioner. Where tests show resistance-to-ground is over the required ohms, take appropriate action to reduce resistance to the required ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Grounding will not be measured separately for payment.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Grounding will not be paid for separately, but will be considered incidental to the electrical work specified elsewhere in the contract documents.

END OF SECTION 16452

TRANSFORMERS

SECTION 16460

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Work under this section is subject to the requirements of the Contract Documents.
- B. Furnish and install Transformers as shown on the Drawings and as specified herein
- C. Types of Transformers specified in this section include the following:
 - 1. Dry-type transformers.
 - 1. Extent of transformer work is indicated schematically by Drawings, schedules and/or as specified herein.

1.02 RELATED WORK:

- A. As specified in the following and other sections as required:
 - 1. Section 03200 - Concrete Reinforcement
 - 2. Section 03300 – Cast-In-Place Concrete

1.03 REFERENCES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.03 References.

1.04 SUBMITTALS:

- A. The Contractor must submit data to the Commissioner prior to purchasing and installation. The data must include but not be limited to the following:
 - 1. Installation design Drawings - schematic, wiring, and one line diagrams; lighting panel schedules; lighting; conduit; duct banks; conduit and cable schedules; grounding; symbols and legends; etc. must be included.
 - 2. The equipment manufacturers' wiring diagrams must show terminal blocks for external wiring. Wiring diagrams must identify all devices, wire codes, and terminal numbers.

3. Catalog cuts and major electrical equipment manufacturers' Drawings must include, but is not limited to, relays, meters, current and potential transformers, disconnect switches, fuses, Contractors, lighting and more.
 4. Complete rating data for all equipment must be provided.
 5. Instruction books, operation and maintenance manuals with spare parts must be provided.
- B. Product Data - Submit manufacturer's technical product data including rated kVA, frequency, primary and secondary voltages, percent taps, polarity, impedance and certification of transformer performance efficiency at indicated loads, percentage regulation at 100 and 80 percent power factor, no-load and full-load losses in watts, percent impedance at 75 degrees C, hot-spot and average temperature rise above 40 degrees C ambient temperature, sound level in decibels, and standard published data. This data must be current, i.e. no older than 1 year.
- C. Show Drawings - Submit manufacturer's Drawings indicating dimensions and weight loadings for transformer installations, showing layouts, mountings and supports, spatial relationship to panelboards and associated equipment, include transformer connections to electrical equipment.
- D. Wiring Diagrams - Submit wiring protection and control diagrams for power distribution transformers. Clearly differentiate between portions for wiring that are manufacturer-installed and portions to be field-installed.

1.05 QUALITY CONTROL:

- A. See Specification Section 16010 Basic Electrical Requirements 1.05 Quality Control.

1.06 DELIVERY STORAGE AND HANDLING:

- A. See Specification Section 16010 Basic Electrical Requirements 1.06 Delivery Storage and Handling.

1.07 WARRANTIES AND GUARANTEES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.07 Warranties and Guarantees.

1.08 EXTRA MATERIALS AND SPARE PARTS:

- A. None required.

1.09 ENVIRONMENTAL REQUIREMENTS:

- A. The Transformer shall be stable and reliable over an operating temperature range of -65 to 158 °F (-55 to 70 °C).

1.10 SPECIAL REQUIREMENTS:

- A. Field Measurements - Before proceeding with the fabrication of the Work, the Contractor must verify all dimensions and take such measurements as are required for proper fabrication and erection of the Work.
- B. Coordination - Coordinate Work of this section with related Work specified in the other divisions/sections of the Contract Documents.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Products of one of the following Manufacturers will be acceptable (for each type of transformer):
 - 1. General Electric Co.
 - 2. Sorgel Electric Div.
 - 3. Eaton/Cutler Hammer/Westinghouse Electric Corp.
 - 4. ITE/Siemens.
 - 5. Square D.

2.02 POWER/DISTRIBUTION TRANSFORMERS:

- A. General - Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.
 - 1. Furnish and install, single phase and three phase general purpose individually mounted dry-type transformers of the two-winding type, self-cooled, with ratings and voltages as indicated on the Drawings.
 - 2. Transformers must be designed, manufactured and tested in accordance with all the latest applicable ANSI, NEMA and IEEE

standards. All transformers must be UL or CSA listed and bear the UL or CSA label.

3. Transformers must be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.

B. Insulation Systems

1. Transformers must be insulated as follows:
 - a. 2 kVA and below - Class B insulation for 150 degrees C total temperature, based on 80 degrees C rise.
 - b. 3 through 30 kVA - Class F insulation for 185 degrees C total temperature, based on 115 degrees C rise.
 - c. 30 kVA and above: Class H insulation for 220 degrees C total temperature, based on 150 degrees C rise.
2. Required performance must be obtained without exceeding the above indicated temperature rise in a 40 degrees C maximum ambient, with a 30 degrees C average ambient over 24 hours.
3. All insulation materials must be flame-retardant and must not support combustion as defined in ASTM Standard Test Method D635.

C. Winding Taps

1. Transformers less than 15 KVA: Two 5 percent below rated voltage, full capacity taps on primary windings.
2. Transformers 15 KVA and larger: NEMA ST 20: A minimum of two 5 percent taps below and two 5 percent taps above rated voltage, at full capacity rating.

D. Core and Coil Assemblies

1. Transformer core must be constructed with high grade, non-aging, grain-oriented silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Maximum magnetic flux densities must be substantially below the saturation point. The transformer core volume must allow efficient transformer operation at 10 percent above the highest tap voltage. The core laminations must be tightly clamped and compressed. Coils must be wound of electrical grade aluminum with continuous wound construction.

2. On units rated below 30 kVA, the core and coil assembly must be completely encapsulated in a proportioned mixture of resin and aggregate to provide a moisture-proof, shock resistant seal.
3. On units rated 30 kVA and above, the core and coil assembly must be impregnated with a non-hygroscopic, thermo-setting varnish and cured to reduce hot spots and seal out moisture. The assembly must be installed on vibration-absorbing pads and securely bolted to the base to minimize sound transmission.

E. Enclosures

1. The enclosure must be made of heavy gauge steel and must be degreased, cleaned, primed and finished with ANSI 61 grey weather-resistant enamel. All transformers must be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring. The maximum temperature of the enclosure must not exceed 90 degrees C. The core of the transformer must be visibly grounded to the enclosure.
2. On units rated below 30 kVA, the enclosure construction must be totally enclosed, non-ventilated, NEMA 3R, with lifting eyes.
3. On units rated 30 kVA and above, the enclosure construction must be ventilated, NEMA 2, drip-proof, with lifting holes. All ventilation openings must be protected against falling dirt. On outdoor units, provide suitable weather shields over ventilation openings.

F. Transformer sound levels must not exceed the following ANSI and NEMA levels for self-cooled ratings:

- | | | | | | |
|----|------|----|------|-----|-------|
| 1. | Up | to | 9 | kVA | 40 db |
| 2. | 10 | to | 50 | kVA | 45 db |
| 3. | 51 | to | 150 | kVA | 50 db |
| 4. | 151 | to | 300 | kVA | 55 db |
| 5. | 301 | to | 500 | kVA | 60 db |
| 6. | 501 | to | 700 | kVA | 62 db |
| 7. | 701 | to | 1000 | kVA | 64 db |
| 8. | 1001 | to | 1500 | kVA | 65 db |

G. Factory Tests

1. The following tests must be made on all transformers:

- a. Ratio tests on the rated voltage connection and on all tap connections.
 - b. Polarity and phase-relation tests on the rated voltage connection.
 - c. Applied potential tests.
 - d. Induced potential test.
2. Certified test reports will be submitted to the Commissioner and are considered as Shop Drawing submittals. Test reports must be less than one (1) year old.

H. Terminations

1. Each dry type transformer must be provided with a suitable terminal compartment to accommodate the required primary and secondary wiring connections and side or bottom conduit entrance. Transformers having ratings not exceeding 25 kVA must be provided with terminal leads equipped with Contractor installed connectors arranged and supported in a workmanlike manner. Transformers having ratings exceeding 25 kVA must have terminal boards equipped with Contractor installed clamp type connectors.
2. The terminal compartment temperature must not exceed 75 degrees C when the transformer is operating continuously at rated load with an ambient temperature of 40 degrees C. Transformers having ratings not exceeding 10 kVA must be UL-listed for operation with connecting cables rated for use at 75 degrees C.

- I. Equipment/System Identification: Provide equipment/system identification nameplates complying with Section 16010 - Basic Electrical Requirements and Section 16195 - Electrical Identification.

PART 3 EXECUTION

3.01 INSPECTION:

- A. The Contractor must examine areas and conditions under which power/distribution transformers and ancillary equipment are to be installed, and notify the Commissioner in writing of conditions detrimental to the proper completion of the Work. Do not proceed with the Work until satisfactory conditions have been corrected in a manner acceptable to the Commissioner.

3.02 INSTALLATION OF TRANSFORMERS:

- A. Install transformers as indicated, complying with manufacturer's written instructions, applicable requirements of CEC, NESC, NEMA, ANSI, IEEE and in accordance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- C. Install units on vibration mounts as shown, comply with manufacturer's indicated installation method, if any.
- D. Connect transformer units to electrical wiring system.
- E. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A and B.

3.03 GROUNDING:

- A. Provide equipment grounding connections for power/distribution transformers as indicated and as required by Code. Tighten connections to comply with tightening torques specified in UL Std. 486A to assure permanent and effective grounding, in accordance with Section 16452-Grounding.
- B. The secondary side of all transformers must be grounded. This ground must be to the main ground grid. In no case must the Contractor take this ground to a panel, MCC, switchboard or switchgear.

3.04 FIELD TESTING:

- A. Prior to energization of transformers, check all accessible connections for compliance with manufacturer's torque tightening specifications.
- B. Prior to energization, check circuitry for electrical continuity, for short-circuits and improper grounds.
- C. Upon completion of installation of transformers, energize primary circuitry at rated voltage and frequency from normal power source and test transformers, including, but not limited to, audible sound levels, to demonstrate capability and compliance with all requirements. Where possible, correct malfunctioning units at site, then retest to

demonstrate compliance, otherwise, remove and replace with new units or compartments, and proceed with retesting.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. No separate measurement will be made for items described in this Section of the Specifications.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- B. No separate payment will be made for items described in this Section of the Specifications. All costs for this work will be considered included in the unit prices for the pay items requiring the various work items delineated in this Specification Section.

END OF SECTION 16460

PANELBOARDS

SECTION 16470

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Work under this section is subject to the requirements of the Contract Documents.
- B. Furnish and install Panelboards as shown on the Drawings and as specified herein, including but not limited to the following:
 - 1.
- C. The Contractor must furnish and install all power-distribution panelboards and lighting and appliance panelboards as shown on the Contract Drawings.

1.02 RELATED WORK:

- A. As specified in the following and other sections as required:
 - 1. Section 16010 – Basic Electrical Requirements
 - 2. Section 16100 – Basic Materials and Methods
 - 3. Section 16195 – Electrical Identification
 - 4. Section 16452 – Grounding
 - 5. Section 16520 – Roadway/Parking Lot/Tunnel Lighting
 - 6. Section 16950 – Testing

1.03 REFERENCES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.03 References.

1.04 SUBMITTALS:

- A. See Specification Section 16010 Basic Electrical Requirements 1.04 Submittals.

1.05 QUALITY CONTROL:

- A. See Specification Section 16010 Basic Electrical Requirements 1.05 Quality Control.

1.06 DELIVERY STORAGE AND HANDLING:

- A. See Specification Section 16010 Basic Electrical Requirements 1.06 Delivery Storage and Handling.

1.07 WARRANTIES AND GUARANTEES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.07 Warranties and Guarantees.

1.08 EXTRA MATERIALS AND SPARE PARTS:

- A. See Specification Section 16010 Basic Electrical Requirements 1.08 Extra Materials and Spare Parts.

1.09 ENVIRONMENTAL REQUIREMENTS:

- A. None required.

1.10 SPECIAL REQUIREMENTS:

- A. Field Measurements - Before proceeding with the fabrication of the Work, the Contractor must verify all dimensions and take such measurements as are required for proper fabrication and erection of the Work.
- B. Coordination - Coordinate Work of this section with related Work specified in the other divisions/sections of the Contract Documents.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Products of one of the following Manufacturers will be acceptable (for each type and rating of panelboard and enclosure):
 - 1. General Electric Company
 - 2. Eaton/Cutler-Hammer/Westinghouse
 - 3. Square D Company
 - 4. ITE/Siemens
- B. Where special construction is specified the Contractor may employ the services of a custom builder to fabricate the panels. This custom builder must follow all Specification requirements. The electrical components must be from the manufacturers specified above. Acceptable custom builders are:

1. Chicago Switchboard.
2. Erickson Electrical Equipment Co.
3. Peterson Electric Panel Mfg. Co.

2.02 PANELBOARDS:

- A. General - Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials, with the design and construction in accordance with published product information; equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with CEC, UL and established industry standards for those applications indicated.
- B. Power Distribution Panelboards - Provide dead-front safety type power distribution panelboards as indicated, with switching and protective devices in quantities, ratings, types, and with arrangement shown; with anti-turn solderless pressure type main lug connectors approved for use with copper conductors. Equip with copper bus bars and with full-sized neutral bus; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide molded-case main or branch circuit-breakers, as indicated, with toggle handles that indicate when tripped. Where multiple-pole breakers are indicated, provide with common trip so overload on one pole must trip all poles simultaneously. Provide panelboards with bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures, including mats and doors, fabricated by same manufacturer as panelboards, which mate and match properly with all panelboard components.
- C. Lighting and Appliance Panelboards - Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types and arrangements shown; with anti-turn solderless pressure type lug connectors approved for use with copper conductors; equip with copper bus bars, full-sized neutral bar, with bolt-in type heavy-duty, quick-make, quick-break, circuit-breakers, as indicated, with toggle handles that indicate when tripped. Provide suitable lugs on neutral bus for each outgoing feeder required; and provide bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures, including mats and doors, fabricated by same manufacturer as panelboards, which mate and match properly with all panelboard components.
- D. Each panelboard in general must be enclosed in code gauge, minimum 16 gauge galvanized sheet steel cabinet of dead front type in

sizes and NEMA type as indicated, having steel trim and door with continuous concealed piano hinges. For NEMA 1 applications construct with multiple knockouts and wiring gutters. For NEMA 12 and NEMA 4X applications no knock-outs must be provided. Provide fronts with adjustable trim clamps, doors with flush locks and keys, all panelboard enclosures keyed alike, and door swings as indicated.

1. Cabinets must comply with applicable NEMA standards, and must be suitable for flush or surface mounting in locations as shown on the Contract Drawings.
2. Cabinets must provide not less than 6 inches clear space for wiring gutters at top, bottom and sides, respectively. Each cabinet must be a minimum of 20 inches wide.
3. Each cabinet must be thoroughly cleaned and bonderized before painting. Painting must consist of baked enamel or lacquer over a rust inhibitor, ANSI 61 light gray color.
4. All free standing cabinets must be securely and adequately supported by approved angle iron and channel type frame work.
5. Doors and trim must each be in one piece so designed that doors must close against a rabbet. Double doors must be provided where necessary or as indicated on the Contract Drawings.
6. A typewritten directory with metal frame and clear plastic cover must be furnished and installed on the inside of the door of each cabinet. Directory will indicate the service controlled by each breaker.
7. Each cabinet must be large enough to accommodate the external cables and any special lug arrangement required to connect the cable(s).

- E. Molded-Case Circuit Breakers - Provide factory-assembled, molded-case, bolt on type circuit breakers of frame sizes, characteristics, and ratings including RMS symmetrical interrupting ratings indicated. The short circuit interrupting rating must be confirmed by the short circuit study. Select breakers with permanent thermal and instantaneous magnetic trip, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position, and operating in an ambient temperature of 40 deg. C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.

1. Circuit breakers for 480 volt and 277 volt service must have a minimum frame size of 100 amperes and must be rated for 600 volts. The trip settings must be as shown on the Contract Drawings. The breaker interrupting rating must be a minimum of 65,000 amperes, symmetrical at 480 volts ac.
 2. Circuit breakers for 120 volt and 208 volt service must be 240 volt rated, must be of the "bolt-on" type and must have a minimum interrupting rating of 25,000 amperes at 240 volts ac. The trip settings must be as shown on the Contract Drawings.
 3. All circuit breakers must be fully rated. Series rated breakers are not acceptable.
- F. Each panelboard must comply with the following:
1. All bus must be copper and must be hard drawn electrolytic copper having 98 percent conductivity and sized on a basis of 1000 amperes, maximum, per square inch of cross sectional area.
 2. Circuit breakers for all panels must be thermal-magnetic type with each pole providing inverse time delay and instantaneous short-circuit protection.
 3. Circuit breakers, back connected to bus bars, must be molded case heavy duty type.
 4. Each panelboard must be furnished with a full length ground bus drilled and tapped to accommodate a ground cable for each circuit breaker. Cable terminals must be provided.
 5. Branch circuit breakers must be single or multiple pole with capacities and trip ratings as specified or shown on the Contract Drawings.
 6. Each branch circuit breaker must be identified by a card holder or designating button mounted adjacent to the circuit breaker for properly identifying each circuit.
 7. Neutrals, where called for, must be grouped and arranged on a common bus and each terminal must be stamped to indicate the number of the breaker with which it is associated. Neutral bars must be located at top or bottom as required.
 8. Each panel interior must be provided with adjustable brackets to permit leveling and aligning in the cabinet.
 9. All lugs and terminators must be copper. Aluminum/copper connectors are not acceptable.

- G. Each panelboard must be acceptable agency listed and fully rated for the short circuit rating as specified for the circuit breakers. Series integrated ratings are not acceptable.
- H. Each panelboard main breaker for a four (4) wire system must have a ground fault interrupter circuit in addition to the thermal-magnetic trip.
- I. Each panelboard main breaker must be connected to the main bus with copper bus bar. Insulated cable is not acceptable.
- J. Provide panelboard accessories and devices not mentioned above, but recommended by panelboard manufacturer for ratings and applications indicated.

PART 3 EXECUTION

3.01 EXAMINATION:

- A. Examine areas and conditions under which panelboards and enclosures are to be installed, and notify Commissioner in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer and the Commissioner.

3.02 INSTALLATION OF PANELBOARDS:

- A. Install panelboards and enclosures as indicated, in strict accordance with approved shop drawing, manufacturer's written instructions, applicable requirements of the Chicago Electrical Code, NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Each surface mounted panelboard must be supported and mounted away from the wall with "C" shaped channel. The minimum separation between the equipment and the wall must be one (1) inch.
- C. The equipment must be installed with work space clearances required by the Code.
- D. The equipment must be installed to permit maintenance and replacement of parts, and must be clear of all openings with swinging or moving doors, partitions or access panels.
- E. Each panelboard and control equipment enclosure must be mounted with the top a maximum of 6'-6" above the finished floor unless shown otherwise on the Contract Drawings.

- F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A.
- G. Fasten enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically anchored.
- H. Provide properly wired electrical connections for panelboards within enclosures.
- I. Fill out panelboard's circuit directory card upon completion of installation work.

3.03 GROUNDING:

- A. Provide equipment grounding connections for panelboards enclosures as indicated or as required by the Chicago Electrical Code. Tighten connections to comply with tightening torques specified in UL Std. 486A to assure permanent and effective grounds.

3.04 FIELD QUALITY CONTROL:

- A. Prior to energization of electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.
- B. Prior to energization of panelboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
- C. Prior to energization, check panelboards for electrical continuity of circuits, and for short-circuits.

3.05 ADJUSTING AND CLEANING:

- A. Adjust operating mechanisms for free mechanical movement.
- B. Touch-up scratched or marred surfaces to match original finishes.
- C. The interior of each panel must be clean. All construction debris must be removed.

3.06 DEMONSTRATION:

- A. After wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary,

correct malfunctioning units, and then retest to demonstrate compliance.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT:

- A. No separate measurement will be made for the Work as specified in this Section.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT:

- A. No separate payment will be made for items described in this specification. All costs for this work will be considered incidental to those items requiring the various work items delineated in this specification.

END OF SECTION 16470

INTERIOR LIGHTING

SECTION 16510

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Work under this section is subject to the requirements of the Contract Documents.
- B. Furnish and install Interior Lighting as shown on the Drawings and as specified herein, including but not limited to the following:
 - 1. Fluorescent light fixtures.
 - 2. Incandescent light fixtures.
 - 3. High intensity discharge (HID) light fixtures.
 - 4. Specialty type fixtures.

1.02 RELATED WORK:

- A. As specified in the following divisions:
NOT USED

1.03 REFERENCES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.03 References.

1.04 SUBMITTALS:

- A. The Contractor must submit data to the Commissioner prior to purchasing and installation. The data must include but not be limited to the following:
- B. The equipment manufacturers' wiring diagrams must show terminal blocks for external wiring. Wiring diagrams must identify all devices, wire codes, and terminal numbers.
- C. Catalog cuts and major electrical equipment manufacturers' Drawings must include, but is not limited to, light fixtures, ballasts and lamps.
- D. Complete rating data for all equipment must be provided.

- E. Instruction books, operation and maintenance manuals with spare parts must be provided.
- F. Shop Drawings
 - 1. See Specification Section 16010 Basic Electrical Requirements 1.04 Submittals - B. Shop Drawings.
- 1.05 QUALITY CONTROL:
 - A. See Specification Section 16010 Basic Electrical Requirements 1.05 Quality Control.
- 1.06 DELIVERY STORAGE AND HANDLING:
 - A. See Specification Section 16010 Basic Electrical Requirements 1.06 Delivery Storage and Handling.
- 1.07 WARRANTIES AND GUARANTEES:
 - A. See Specification Section 16010 Basic Electrical Requirements 1.07 Warranties and Guarantees.
- 1.08 EXTRA MATERIALS AND SPARE PARTS:
 - A. See Specification Section 16010 Basic Electrical Requirements 1.08 Extra Materials and Spare Parts.
- 1.09 ENVIRONMENTAL REQUIREMENTS:
 - A. Florescent lamps, Metal Halide lamps and Mercury Vapor lamps are required to be treated as hazardous materials. The Contractor must comply with all Federal, State and Local requirements when disposing of these lamps. The Contractor must dispose of these lamps via a certified special waste disposal company. The Contractor must provide the Commissioner with evidence that this requirement has been met.
- 1.10 SPECIAL REQUIREMENTS:
 - A. Field Measurements - Before proceeding with the fabrication of the Work, the Contractor must verify all dimensions and take such measurements as are required for proper fabrication and erection of the Work.
 - B. Coordination - Coordinate Work of this section with related Work specified in the other divisions/sections of the Contract Documents.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with the requirements manufacturers offering products which may be incorporated in the work are listed on fixture schedules contained on the Contract Drawings.

2.02 LIGHTING FIXTURES:

- A. Fixtures must be new and of the manufacturers and types indicated on the fixture schedules and must be suitable for the mounting indicated.
- B. Fixtures must be complete with all lamps, sockets, glassware, diffusers, ceiling canopies, stems, etc. and all other necessary accessories for the mounting and installation indicated on the Contract Drawings.
- C. All fixtures must be suitable for operating at the voltage indicated on the or as required for the Work.
- D. Exceptions to the operating voltages may exist. It must be the Contractors responsibility to provide fixtures which will operate at the voltage indicated for the branch circuit serving the lighting fixture.
- E. Enameled finishes must be electrostatically applied and baked. Finish of fixtures must be uniform in quality and appearance, durable and free from defects.

2.03 BALLASTS:

- A. Fluorescent Ballasts
 - 1. All fluorescent lamp ballasts must be CBM/ETL approved and must be of high power factor type, low noise, Class P with internal capacitor protection. Ballast must meet the minimum efficiency standards of Public Law No 100-357 National Appliance Energy Conservation Amendments of 1988, and must not exceed 90°C operating temperature. Fuse protection must be provided in lighting fixtures for all fluorescent lighting fixtures. Electronic ballasts must be provided whenever they are available.
 - a. Electronic ballasts must be integrated circuit (IC).
 - b. Electronic ballasts must operate 4 foot and 3 foot T-8 rapid start lamps and must maintain constant light output over an input voltage range of 120 Volts, plus or minus 20%.

- c. Electronic ballasts must withstand line transients and input current third harmonic content must not exceed 10%.
 - d. Ballasts must have a sequenced start progression which first heat cathode filaments and then ignites the lamp.
 - e. Ballasts must have a high operation frequency of 20 KHZ or greater.
- 2. When electronic ballasts are not available the ballasts with a sound rating of "A" must be provided. Should a sound rating of "A" not be available the lowest sound rating available must be provided.
 - 3. Fluorescent lamp ballasts for lamps over 30 watts must be rapid start and energy saving. When outdoors or in non-temperature controlled environments ballasts must be rated for a minimum starting temperature of -20 degrees F.
 - 4. Ballasts must not attenuate neighboring systems nor cause interference with other electronic systems in the area.
 - 5. Acceptable manufacturers must be Advance, Valmont, Motorola and Magnetek

B. HID Ballasts

- 1. HID ballasts must be of high power factor, constant wattage, auto-transformer isolation type, with Class H insulation and electronic starter which is integral to the fixture. Outdoor luminaries must have ballasts rated for -20 degrees F starting.
- 2. HID ballasts must have the following characteristics and requirements:
 - a. Regulations - Line voltage at plus or minus 5%, lamp watts within applicable ANSI Trapezoid limitations.
 - b. Power factor must be a minimum of 90%
 - c. Lamp Dropout Voltage of 90% of nominal voltage.
 - d. Minimum starting temperature of -20 degrees F.
 - e. Insulation Rating of 180 degrees C (IEEE Temperature Index 180).
 - f. Frequency must be 60 HZ.
 - g. Starting current must be less than operating current.
- 3. Requirements
 - a. All ballasts must be listed under the component program of Underwriters Laboratories, Inc.
 - b. All leads must be a minimum of #14 AWG wire with at least seven (7) strands. Insulation must be a UL listed

abrasion resistant thermoplastic or elastomeric compound having a minimum temperature rating of 150 degrees C at 600 V.

- c. The terminals for incoming wires must be capable for the termination of at least 2 #10 AWG wires.
 - d. All ballasts must be marked with the manufacturers part number, wiring diagram and other pertinent information.
 - e. All outer surfaces of the coils must have protective insulation in addition to wire insulation.
 - f. Maximum allowable table top temperature rise of the hottest coil must be 96 degrees C.
 - g. Lamps connected to these ballasts must remain operating when line voltage varies plus or minus 10% from normal.
 - h. Ignitor and capacitor must have a 10,000 amp UL listed current rating.
 - i. The capacitor must have a UL listed fault current rating of 10,000 amps.
 - j. All ballasts must have fuse protection.
4. Ballasts manufacturers will be General Electric, Crouse Hinds, Jefferson, Sola, Advance or Universal. The fixture manufacturers ballasts will be acceptable provided they meet or exceed the requirements of this specification.
- C. Lampholder for light fixtures must be made of porcelain or high heat, non-hygroscopic, non-inflammable molded compound and must be firmly held in place so as to prevent damage to conductor insulation and to prevent socket turning during lamp replacement.
- D. Lamps
- 1. Furnish all lamps for the lighting fixtures provided under this section.
 - 2. Fluorescent lamps must be energy saving type in the required configurations, lengths and wattages as shown on the fixture schedule. Lamps and ballasts must be coordinated for maximum energy savings. Lamp color must be as shown on the fixture schedule.
 - 3. Acceptable manufacturers are OSRAM/Sylvania, Phillips and Venture.

PART 3 EXECUTION

3.01 EXAMINATION:

- A. Examine areas and conditions under which lighting fixtures are to be installed and substrate for supporting lighting fixtures. Notify the Commissioner in writing of any conditions detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner consistent with the Contract Documents.

3.02 INSTALLATION OF LIGHTING FIXTURES:

- A. Install light fixtures at locations and heights as indicated, in accordance with the fixture manufacturers written instructions, applicable requirements of the CEC, NECA's "Standard of Installation," NEMA Standards and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- B. Provide fixtures and/or fixture outlet boxes with hangers to properly support fixture weight. Submit design of hangers, method of fastening if other than indicated or specified herein for review by the Commissioner.
- C. Install flush mounted fixtures properly to eliminate light leakage between fixture frame and finished surface.
- D. Fasten fixtures securely to indicated structural supports; and ensure that pendant mount fixtures are plumb and level. Provide individually mounted pendant fixtures longer than 2 feet with twin stem hangers. Provide stem hangers with ball aligners and provisions for a minimum of 1 inch vertical adjustment. Mount continuous rows of fixtures with an additional stem hanger greater than number of fixtures in the row.
- E. Fasten electrical lighting fixtures and brackets securely to indicated structural supports and insure that installed fixtures are plumb and level.
- F. Tighten connectors and terminals, including screws and bolts, in accordance with the fixture manufacturers published torque tightening values for equipment connections. Where manufacturers torquing values are not available tighten connections and terminals to comply with tightening values specified in UL Std. 486A.
- G. Support fixtures longer than 2 feet in length at a point in addition to the fixture stud in the outlet box.

- H. Each lighting fixture must be rigidly supported from the building structure and must include suspension hanger devices and additional steel work for fixture support where required.
- I. The Contractor must coordinate with the work of all trades to determine modifications required to make fixtures suitable for ceilings as installed and the types of ceiling construction prior to fixture fabrication. The Contractor must determine that the suspension method and flange arrangement for the fixtures coordinates with the ceiling type and the suspension system. Fixtures which do not match the ceiling system must be returned for correction at no cost to the City.
- J. Where suspended ceilings with steel channels occur, fixtures must not be supported from the main channel framework. No chains will be used for supporting light fixtures.
- K. The Contractor must not use recessed lighting fixtures as raceways. Unistrut or other similar mounting devices are not acceptable for use as raceways.

3.03 FIELD QUALITY CONTROL

- A. Replace defective and burned out lamps for a period of one (1) year following the date the fixtures are placed into operation.
- B. At Date of Substantial Completion replace lamps in lighting fixtures which are observed to be noticeably dimmed after Contractors use and testing, as determined by the Commissioner.
- C. Refer to the Contract Documents for the replacement/restoration of lamps in lighting fixtures where used for temporary lighting prior to Date of Final Completion.

3.04 ADJUSTING AND CLEANING:

- A. Aim adjustable lighting fixtures and lamps in night tests of system. Verify that the measured illuminance values comply with isolux plot diagram values.
- B. Clean lighting fixtures of dirt and construction debris, inside and out, upon completion of the installation. Clean all fingerprints and smudges from reflectors and lenses.
- C. Protect all fixtures from damage and dirt during remainder of construction.

- D. Final adjustment of lighting fixtures must be made after dark and will be reviewed by the Commissioner.

3.05 GROUNDING:

- A. Provide equipment grounding connections to all lighting fixtures. In no case must the grounding connection be eliminated. Tighten connections to comply with tightening torque values as set forth in UL Std. 486A to assure permanent and effective grounding.

3.06 DEMONSTRATION:

- A. Upon completion of installation of lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with all requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliances; otherwise, remove and replace with new units, and proceed with the demonstration.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. No separate measurement will be made for items described in this Section of the Specifications.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. No separate payment will be made for items described in this Section of the Specifications. All costs for this work will be considered included in the unit prices for the pay items requiring the various work items delineated in this Specification Section.

END OF SECTION 16510

ROADWAY/PARKING LOT/TUNNEL LIGHTING

SECTION 16520

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Work under this Section is subject to the requirements of the Contract Documents.
- B. Furnish and install Lighting as shown on the Drawings and as specified herein, including, but not limited to the following:
 - 1. LED Roadway Lighting

1.02 RELATED WORK:

- A. As specified in the following divisions:
 - 1. Section 16010 – Basic Electrical Requirements
 - 2. Section 16100 – Basic Materials and Methods
 - 3. Section 16452 – Grounding
 - 4. Section 16470 – Panelboards
 - 5. Section 16950 – Testing

1.03 REFERENCES:

- A. Illuminating Engineering Society of North America Handbook – applicable sections.
- B. AASHTO “LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals”, current edition.
- C. IDOT Lighting Design Criteria for spacing of poles on frequently travelled roadways under Airport jurisdiction.
- D. See Specification Section 16010 Basic Electrical Requirements 1.03 References.

1.04 SUBMITTALS:

- A. The Contractor must submit data to the Commissioner prior to purchasing and installation. This data must include, but not be limited to, the following:
 - 1. Catalogue cuts of all light fixtures, light poles, mast arms, breakaway bases, disconnect switches, and transformer bases.
 - 2. Approved listing by FHWA for light poles and breakaway devices.
 - 3. Photometric data on each light fixture type.
 - 4. Structural calculations and all data as necessary to show full compliance with the specifications.
 - 5. Point to point calculations.

1.05 QUALITY CONTROL:

- A. See Specification Section 16010 Basic Electrical Requirements 1.05 Quality Control.

1.06 DELIVERY STORAGE AND HANDLING:

- A. See Specification Section 16010 Basic Electrical Requirements 1.06 Delivery Storage and Handling.
- B. Poles and fixtures must be stored above ground and protected from damaging conditions.
- C. Poles must remain wrapped in protective material as shipped from the manufacturer until time of installation.

1.07 WARRANTIES AND GUARANTEES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.07 Warranties and Guarantees.

1.08 EXTRA MATERIALS AND SPARE PARTS:

- A. See Specification Section 16010 Basic Electrical Requirements 1.08 Extra Materials and Spare Parts.

1.09 ENVIRONMENTAL REQUIREMENTS:

- A. High Intensity Discharge (HID) lamps are classified as hazardous materials and as such disposal must be in compliance with all laws governing such material.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Subject to compliance with the requirements, manufacturers offering products which may be incorporated into the work are as follows:

- 1. Light Poles

- a. Valmont
 - b. Lexington
 - c. Union Metal

- 2. LED Fixtures for Roadway and Parking Lot Applications

- a. General Electric
 - b. Cooper
 - c. American Electric

2.02 LIGHT FIXTURES FOR ROADWAYS AND PARKING LOT:

- A. General. The luminaire including the housing, driver and optical assembly shall be assembled in the U.S.A. The luminaire shall be assembled by and manufactured by the same manufacturer. The luminaire shall be in compliance with ANSI C136.37. LED light source(s) and driver(s) shall be RoHS compliant.

- B. Housing. Material. The luminaire shall be a single device not requiring on-site assembly for installation. The power supply for the luminaire shall be integral to the unit.

The luminaire shall slip-fit on a mounting arm with a 2" diameter tenon (2.375" outer diameter), and shall have a barrier to limit the amount of insertion. The slip fitter clamp shall utilize four (4) bolts to clamp to the tenon arm. The luminaire shall be provided with a leveling surface and shall be capable of being tilted ± 5 degrees from the axis of attachment in 2.5 degree increments and rotated to any degree with respect to the supporting arm.

The housing shall be designed to prevent the accumulation of water, ice, dirt and debris and to ensure maximum heat dissipation.

The exterior must be aluminum finish (or if coated, must be baked acrylic enamel to an architectural aluminum finish) to match the aluminum light pole and must contain UV inhibitors. The manufacturer must submit through the Contractor the particular paint/finish for the review and acceptance of the Commissioner.

A passive cooling method with no moving, rotating parts, or liquids shall be employed for heat management.

The luminaire shall include a fully prewired, 7-pin twist lock ANSI C136.41-compliant receptacle. Unused pins shall be connected as directed by the Manufacturer and as approved by the Engineer. A shorting cap shall be provided with the luminaire.

Vibration Characteristics. All luminaires shall be vibration tested and pass ANSI C136.31 requirements. Luminaires shall be rated for "3G" peak acceleration. Vibration testing shall be run using the same luminaire in all three axes.

Labels and Decals. All luminaires shall have labels in accordance with ANSI C136.15 for an external label, and ANSI C136.22 for an internal label.

The luminaire shall be Listed for wet locations by a U.S. Occupational Safety Health administration (OSHA) Nationally Recognized Testing Laboratory (NRTL) and shall be in compliance with UL 8750 and UL 1598. It shall be identified as such by the NRTL tag/sticker on the inside of the luminaire.

Hardware. All fasteners shall be stainless steel. Captive screws are required on any components that require maintenance after installation.

Internal Luminaire Electrical Connections. Quick connect/disconnect plugs shall be supplied between the discrete electrical components within the luminaire such as the driver, surge protection device and optical assembly for easy removal. The quick connect/disconnect plugs shall be operable without the use of tools while wearing insulated gloves.

Circuiting shall be designed to minimize the impact of individual LED failures on the operation of the other LED's.

Wiring. Wiring within the electrical enclosure shall be rated at 600v, 105°C or higher.

C. Driver.

The driver shall be integral to the luminaire. Integral driver components shall be mounted in the rear of the luminaire on the inside of a removable door or on a removable mounting pad. Driver wiring shall be connected by means of plugs. Upon unplugging the driver wiring the entire driver assembly shall remove for maintenance. The removable door or pad shall be secure when fastened in place and all individual components shall be secured upon the removable element. Each component shall be readily removable from the removable door or pad for replacement.

The plugs shall be keyed and shall be operable without the use of special tools by insulated, gloved hands

The driver shall tolerate indefinite open and short circuit output conditions without damage.

Ingress Protection. The driver Ingress Protection (IP) rating as defined in the ANSI/IEC 60529 standard shall have an IP66 rating.

Input Voltage. The driver shall be suitable for operation at 480 volts as required by the system operating voltage.

Operating Temperature. The driver shall have an operating ambient temperature range of -40°C to 70°C.

Driver Life. The driver shall provide a life time of 100,000 hours at 25° C ambient.

Safety/UL. The driver shall be UL Listed under standard UL 1012.

Power Factor. Drivers shall maintain a power factor of 0.9 or higher and total harmonic distortion of less than 20%.

Driver efficiency. Efficiency of the driver is defined by the ratio of output power and input power. The driver shall deliver a maximum efficiency of >90% at maximum load and an efficiency of >85% for the driver operating at 50% power.

Electrical Interference. The driver shall meet the Electromagnetic Compatibility (EMC) requirements per FCC Title 47 Code of Federal Regulations (CFR) Part 15 Class A.

Thermal Fold Back. The driver shall reduce the current to the LED module if the driver is overheating due to abnormal conditions.

Dimming. The driver shall have dimming capability. The driver shall accept a dimming control signal that is compliant with the 0-10V protocol in accordance with ANSI C136.37.

Leakage current. The driver shall comply with safety standards in accordance with IEC 61347-1.

The Surge Protection Device shall be UL 1449 labeled as Type 4 and be an integral part of the luminaire. The SPD shall be compliant with ANSI C136.2-2014 (Draft).

D. Thermal performance.

Thermal Testing shall be provided as defined by ANSI/UL 1598. The luminaire shall start and operate in the ambient temperature range specified in the driver section. The maximum rated case temperature of the driver, LEDs, and other internal components shall not be exceeded when the luminaire is operated in the ambient temperature range specified.

Mechanical design of protruding external surfaces (heat sink fins) shall facilitate hose-down cleaning and discourage debris accumulation. Testing shall be submitted (whenever is available) to show the maximum rated case temperature of the driver, LEDs, and other internal components are not exceeded when the luminaire is operated with the heat sink filled with debris.

E. LED Optical Assembly.

The LED optical assembly shall be a scalable array consisting of discrete LED panels or modules. Each panel or module shall have a minimum IP rating of 66.

The optical assembly shall utilize high brightness, long life, minimum 70 CRI, 4,000K color temperature (+/-300K) LEDs binned in accordance with ANSI C78.377. Lenses shall be UV-stabilized acrylic or glass.

Lumen depreciation at 50,000 hours of operation shall not exceed 15% of initial lumen output at the specified LED drive current and an ambient temperature of 25° C.

The luminaire may or may not have a glass lens over the LED modules. If a glass lens is used, it must be a flat lens. Material other than glass will not be acceptable. If a glass lens is not used, the LED modules may not protrude lower than the luminaire housing.

The assembly shall have individual serial numbers or other means for manufacturer tracking.

F. Photometric Performance.

Luminaires shall be tested according to IESNA LM-79. This testing shall be performed by a test laboratory holding accreditation from the National Institute of Standards and Technology (NIST) National Voluntary Laboratory Accreditation Program (NVLAP) for the IESNA LM-79 test procedure.

Data reports as a minimum shall yield an isofootcandle chart, with max candela point and half candela trace indicated, maximum plane and maximum cone plots of candela, a candlepower table (house and street side), a coefficient of utilization chart, a luminous flux distribution table, spectral distribution plots, chromaticity plots, and other standard report outputs of the above mentioned tests.

Lumen maintenance shall be measured for the LEDs according to LM-80 or for the luminaires according to LM-84. The LM-80 report shall be based on a minimum of 6,000 hours, yet 10,000 hour reports shall be provided for luminaires where those tests have been completed.

The luminaire shall have a BUG rating of Back Light B3 or less, Up Light rating of U0, and a Glare rating of G4 or less unless otherwise indicated in the luminaire performance table.

G. Luminaire Maintenance Projection.

The luminaire shall have long term lumen maintenance documented according to IESNA TM-21 or IESNA TM-28. Ambient temperature shall be 25° C.

The submitted calculations shall incorporate the light loss factors as indicated the respective performance tables.

H. Photometric Calculations

Calculations. Submitted report shall include a luminaire classification system graph with both the recorded lumen value and percent lumens by zone along with the BUG rating according to IESNA TM-15.

Complete point-by-point luminance and veiling luminance calculations as well as listings of all indicated averages and ratios as applicable shall be provided in accordance with IESNA RP-8 recommendations. Lighting calculations shall be performed using AGi32 software with all luminance calculations performed to two decimal places (i.e. x.xx cd/m²). Uniformity ratios shall also be calculated to two decimal places (i.e. x.xx:1). Calculation results shall demonstrate that the submitted luminaire meets the lighting metrics specified in the project Luminaire Performance Table(s). Values shall be rounded to the number of significant digits indicated in the luminaire performance table(s).

All photometry must be photopic. Scotopic or mesopic factors will not be allowed.

LUMINAIRE PERFORMANCE TABLE
LUMINAIRE TYPE “A”

GIVEN CONDITIONS		
ROADWAY DATA	Pavement Width	N/A
	Number of Lanes	N/A
	Median Width	N/A
	I.E.S. Surface Classification	R3
	Q-Zero Value	.07
LIGHT POLE DATA	Mounting Height	30 (ft)
	Mast Arm Length	8 (ft)
	Pole Set-Back From Edge Of Pavement	4 (ft)
LUMINAIRE DATA	Lumens	25,000 – 29,000
	BUG Rating	B3 – U0 – G4 (Max)
	I.E.S. Vertical Distribution	Medium
	I.E.S. Lateral Distribution	Type IV
	Total Light Loss Factor	0.70
LAYOUT DATA	Spacing	N/A
	Configuration	See Figure
	Luminaire Overhang over EOP	N/A

NOTE: Variations from the above specified I.E.S. distribution pattern may be requested and acceptance of variations will be subject to review by the Engineer based on how well the performance requirements are met.

PERFORMANCE REQUIREMENTS

NOTE: These performance requirements shall be the minimum acceptable standards of photometric performance for the luminaire, based on the given conditions listed above.

ROADWAY	Average Illuminance, E_{AVE}	N/A
ILLUMINANCE	Uniformity Ratio, E_{MAX}/E_{MIN}	N/A

2.03 POLE STANDARDS:

- A. The pole and mast arms must be manufactured in accordance with the AASHTO "LRFD Specifications for Structural Support for Highway Signs, Luminaires and Traffic Signals", current edition.
- B. Each pole must be one piece shaft consisting of a tapered aluminum pole with an aluminum base plate. Each pole must have a ten (10) inch diameter base and a six (6) inch diameter top. Each pole must have a removable top cap which must be fastened in place using stainless steel screws. Poles, mast arms, and attachments must be of same color and finish. The aluminum poles will have no painting or coating.
- C. The poles must be made of 6063 T6 aluminum. The wall thickness must be .312 inches. The shaft must be spun drawn to a smooth, circular, seamless taper. All aluminum poles must have a satin ground finish, 100 grit or finer. The shaft must be provided with internal vibration damper. Height must be as indicated on the Contract Drawings.
- D. Each pole must have a base plate of 356-T6 aluminum which must allow the pole to telescope into the base and be welded to the pole in both the external and internal joints.
- E. Each pole must be designed and constructed to allow for the mast arm to be installed between the pole and the light fixture. Each pole must have a grommited hole located to allow the light fixture wires to safely pass through the arm and into the pole. This grommet must be replaceable and be compatible with type XLP-USE wire.
- F. The mast arm must be truss type and must be made of aluminum. The length of the mast arm and the number of mast arms per pole must be as indicated on the Drawings and as shown on the lighting layout plan.
- G. Each pole must be designed to withstand a wind loading of 100 MPH with a gust factor of 1.3. Each pole must also allow for single or double 24" x 60" banner(s) and/or single or double flower basket(s) attachments.
- H. Where shown on the Drawings, the pole must have a reinforced handhole, four (4) inches by six and one half (6 ½) inches minimum size. The bottom of the handhole must be located twelve (12) inches from the bottom of the pole. All hardware for the handhole must be stainless steel. Each pole must have a grounding lug provided within

easy reach of the handhole to provide for the connection of the required grounding system.

- I. Each pole must have an aluminum disconnect switch mounted on the exterior side of the pole as shown on the Drawings.
- J. The shaft must be provided with a festoon box with blank cover as located in the Drawings, for future mounting of a 120 volt electrical GFI receptacle. The festoon box and cover must be formed of the same aluminum and finish as the shaft, and its opening must be reinforced with a cross section to adequately support the opening in the shaft.
- K. The base plates must be as sized by the pole manufacturer. Each base plate must be provided with either oversized holes or slots, as required by the anchor bolt size, in a pattern which must allow for proper installation of the anchor bolts and correct orientation of the mast arm.
- L. Pole to be mounted on breakaway transformer base must be fabricated with a cast aluminum base shoe or sleeve base in lieu of a base plate. The shoe must be provided with holes as required by the anchor bolt size, in a pattern which must allow for proper mounting and installation of the shoe to the top of the breakaway base at the correct orientation of the mast arm.
- M. Each pole must be provided with four (4) anchor bolts, diameter and length as shown on the Drawings or as determined by the pole manufacturer, with six (6) inch hooked end. The threaded end must be galvanized. Each anchor bolt must be furnished with two (2) flat washers, two (2) nuts and one (1) lockwasher. The installed base plate must be provided around its perimeter with a stainless steel wire screen secured by stainless steel band strap as rodent and vermin deterrent. All hardware must be non-corroding. Hardware for the breakaway device must be as required by the approved breakaway base manufacturer.
- N. The testing of the pole shaft must be done during manufacturing for straightness, twist, wall thickness and welding integrity. Tensile, hardness, flattening, Charpy V notch test and metallurgical examinations must be required. Certified copies of all test reports must be furnished to the Commissioner prior to shipping of the light poles to the project site.
- O. All openings must be free of burrs and rough edges.

- P. The poles and mast arms must be designed to support the weight and E. P. A. of the luminaire without objectionable deflection or swaying.

2.04 BREAKAWAY BASE

- A. The breakaway device must be a cast and welded aluminum transformer base type pole base. The breakaway device must have a listing approval by FHWA to AASHTO breakaway requirements. This will require compliance to the latest edition of "Standard Specifications of Structural Supports for Highway Signs, Luminaire and Traffic Signals" published by AASHTO. Submittal information must document the approval listing.
- B. The device shall be approximately 17 inches high and shall have a large aluminum access door to match the base finish which shall be held in place with a button-type tamper resistant stainless steel screw or other means approved by the Commissioner. The door shall be gusseted and have tabs on the bottom to lock into the breakaway base door frame. The location of the access door to be as shown on the Drawings.
- C. The appearance of the breakaway device shall be of such general configuration as not to detract from the aesthetic value of the light pole. The device shall have a natural aluminum finish to match the pole.
- D. The breakaway base shall be of the flared style and shall fit the 13 inch bolt circle of the pole foundation. The flared breakaway base shall have a slot range of 10 ½ to 13 ½ inches at the top and 12 to 14 inches at the bottom, or as shown on the manufacturer's shop drawings.

2.05 LIGHT POLE FOUNDATIONS:

- A. Each light pole foundation must be as shown on the Contract Drawings. The concrete must be per Specification Section 03300.
- B. Reinforcement bars must conform to Section 1006.10 of the IDOT Standard Specifications for Road and Bridge Construction, latest edition.
- C. Anchor rods must have a minimum yield strength of 50,000 psi unless noted otherwise on the Drawings.

- D. The top of the foundation must be cast and finished true and level to allow the mounting of the light poles flush and plumb without the use of washers or shims. Use of washers and shims will not be allowed. Foundation tops that are not level must be corrected by grinding level at the expense of the Contractor.
- E. Conduit must conform to Specification Section 16100 Basic Materials and Methods.

2.06 POLE WIRING:

- A. Wire connections to the light poles must be made via the fused disconnect unit provided with each pole, as shown on the Contract Drawings. Standard cable insulation for pole wiring from disconnect to fixture is XLP-USE.
- B. Each disconnect enclosure must be NEMA 4X fabricated from aluminum. Each unit must contain a fused disconnect mechanism rated 480 Volts, 30 amps, which must contain two (2) 480 Volt 5 amp slow blow fuses. The disconnect mechanism must be as manufactured by Boltswitch or Wadsworth.
- C. Each disconnect switch box must be made so that the mounting hardware conform to the contour of the pole.
- D. Acceptable manufacturers
 - 1. J & A Sheet Metal
 - 2. Chicago Switchboard
 - 3. Simplex System Controls

2.07 POLE GROUNDING AND LIGHTNING PROTECTION:

- A. Provide equipment grounding connections to the lighting fixture. In no case may the grounding connection be eliminated.
- B. Bronze connectors, suitable and listed for grounding and bonding applications, in configurations required for this particular installation, must be used.
- C. The light poles must be installed with lightning protection system as shown on the plan sheets.

- D. All items installed for lightning protection must be listed for installation in a lightning protection system. For example, the down conductor must be listed as a Class I down conductor.
- E. Grounding electrodes must be stainless steel, ¾ inch dia. X 10 feet.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL:

- A. The Contractor must examine the area and conditions under which the light poles and fixtures are to be installed and substrate for supporting the light poles. The Contractor must notify the Commissioner, in writing, of any conditions deemed detrimental to the proper installation of the work. The Contractor must not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Commissioner.

3.02 INSTALLATION OF LIGHT POLES:

- A. Each light pole must be installed on a concrete foundation designed for the particular pole usage as indicated on the Contract Drawings. Each pole must be provided with a concrete handhole for maintenance purposes as indicated on the Plan and Contract Drawings.
- B. Every light pole foundation must be installed at the location designated on the Drawings and in the manner herein specified. From time to time the Contractor may be required to locate foundations at places other than those indicated on the Drawings. The Commissioner reserves the right to make such relocations as may be deemed necessary or required, and when directed to do so, the Contractor must locate foundations as indicated by the Commissioner.
- C. Care must be taken to install a level light pole foundation and to ensure adequate bolt projections to allow for proper double nut installation or installation on breakaway bases. The foundation must be centered back from the face of the curb in accordance with the dimensions shown on the Drawings. The ends of the conduit which protrude above the top of the foundation must be terminated with grounding bushings as specified in other sections of these specifications. Depth of the foundations must be as shown on the Contract Drawings.
- D. Anchor bolts must be set in accordance with the applicable construction Drawings so that when the poles are mounted on the

foundations or breakaway bases, the arms must be properly oriented as indicated on the Drawings. The Contractor must take extreme care in the placing of the anchor bolts and during the concrete pour to insure that the anchor bolts remain in proper alignment. Under no circumstances will the Contractor be allowed to realign any bolts which have not been properly installed. Misaligned anchor bolts will result in foundations being replaced at the Contractors expense. The Contractor must insure that the anchor bolts protrude a sufficient distance above the top of the foundation to allow for proper installation and adjustment of the light poles and breakaway bases.

- E. The Contractor must set the light poles true and plumb. The luminaires must be installed square to the surface being illuminated. The Contractor must adequately secure all covers, caps, etc., to the poles. All bolts, nuts, etc. must be properly tightened. The Contractor must take readings of all torquing tensions and record these for presentation to the Commissioner that proper values have been achieved.

3.03 INSTALLATION OF BREAKAWAY DEVICES

- A. Install breakaway bases on light poles for roadway lighting as shown on the Drawings. Breakaway devices are not allowed on bridge parapets, barrier walls, or pedestrian conflict areas, and are not required behind guardrail.
- B. Breakaway base shall be installed level and flush with the foundation without the use of washers or shims according to the manufacturer's installation procedures. All nuts, bolts, washers, and lock washers required to complete the installation of the breakaway base shall be included.
- C. All entryway points created by the use of breakaway devices shall be permanently and completely sealed against rodent entry. This includes base plate and foundation plate openings, elongated holes for anchor rods, and opening below the pole base plate, and the wireway slots in the foundation.

3.04 INSPECTION AND TESTING:

- A. Contractor must provide the Commissioner seven (7) business day notification prior to conducting any testing. Testing must be witnessed by the Commissioner and all results tabulated. After the lighting system has been accepted by the Commissioner the Contractor must provide three (3) copies of all tabulated test results to the

Commissioner. Original field test records must be signed, dated, and available upon request.

- B. All splices, taps and grounding connections must be inspected by the Commissioner before wires are permanently trained in the light pole.
- C. Current, insulation resistance and voltage readings must be taken. Any indications of grounds, open or short circuit, etc., must be thoroughly investigated and any and all repairs and/or replacements must be done before retesting and acceptance.
- D. Line voltages must be taken at the power source and at fused disconnects, as designated by the Commissioner, The Contractor must record and tabulate these reading and provide three (3) copies to the Commissioner. Maximum voltage drop must not exceed one (1) percent from the panels to the light fixture.
- E. All conductors of size #6 and larger must be megger tested at 1000 Volts. The minimum acceptable reading must be 250 Megohms. The megger test must not be done until any and all splicing is completed. All megger tests must be recorded on Form 16950, which is available through the Commissioner.
- F. The Commissioner must have free entry at all times while the work is in progress to all parts of the manufacturers facilities which will concern the manufacturing of the equipment for this Project. The manufacturer must afford the Commissioner, without charge, all reasonable facilities to satisfy the Commissioner with the Contract requirements. The Commissioner will inspect the poles and fixtures at the point of delivery and after installation. Any poles and/or fixtures found to be defective or damaged must be replaced immediately at the Contractors expense.
- G. After the lighting installation has been completed and all cable and material test results have been found to be satisfactory a field test must be conducted to insure that all lighting and control equipment is in proper operation condition. This test will be witnessed by the Commissioner. This test must confirm the lighting levels as required by the Contract Documents.
- H. The Contractor must furnish any and all special tools, test devices and miscellaneous items which may be required to complete the testing.
- I. Should any failures occur during testing or during the start-up of any of the equipment the Contractor must immediately investigate the problem and make any and all repairs necessary to restore the

equipment into proper operating condition. Any equipment which cannot be repaired in the field must be removed and new equipment brought in to replace the defective equipment. The Contractor must assume any and all costs associated with the repair or replacement of faulty equipment.

- J. After all installation and testing is complete the Contractor must make any and all repairs to the finish of the poles and fixtures which can be reasonably done in the field. All repairs must be done with the same materials and methods as provided in the factory. If field repairs cannot be accomplished the Contractor must remove the damaged equipment and have the factory make the necessary repair(s). The Contractor must provide temporary equipment should the repair take longer than 24 hours.
- K. All test equipment must be in good operating condition and must have been calibrated within six month of date of usage. At the time of testing the Contractor must present a copy of the certification of calibration to the Commissioner.

3.05 ADJUSTING AND CLEANING:

- A. Aim adjustable lighting fixtures in night tests of the lighting system. Verify the measured illuminance values comply with the manufacturers point-to-point values.
- B. Clean the lighting fixture of dirt and construction debris, inside and out, upon completion of the installation. Clean all fingerprints and smudges from the reflectors and lenses.
- C. Protect all fixtures from damage and dirt during the remainder of construction.
- D. Final adjustment of lighting fixtures must be made after dark and be done in the presence of the Commissioner.

3.06 GROUNDING:

- A. Provide equipment grounding connections to all lighting fixtures. In no case must the grounding connection be eliminated. Tighten connections to comply with the tightening torque values as set forth in U.L. Standard 486A to assure permanent and effective grounding.
- B. Install electrical grounding and bonding systems as indicated and specified and in accordance with manufacturer's instructions and

applicable portions of Chicago Electrical Code, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements. EXCEPTION: No ground connection to waterlines.

- C. Tighten grounding connections to comply with the tightening torque values as set forth in U.L. Standard 486A to assure permanent and effective grounding.
- D. Lightning protection must be installed on the light pole as indicated on the plans.
- E. Equipment grounding and lightning protection must be installed as separated systems, each with its own ground rod. The two ground rods must be bonded together below grade. In addition, if the site fencing is installed as a grounded system (as opposed to mounded on a concrete barrier), then a fence post must be bonded to a ground rod within 10 feet of the light pole and this ground rod also bonded to the lightning protection and equipment grounding ground rods.
- F. Upon completion of installation of electrical grounding and bonding systems, test ground resistance. Where tests show resistance-to-ground is over five ohms, take appropriate action to reduce resistance to the required ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.
- G. Where exothermic welding is utilized, Contractor must comply with AWS Code for procedures, appearance and quality of welds; and for methods used in correcting welding work.
- H. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action. For repair to galvanized metallic surfaces, a zinc-rich paint-on product must be used, a spray is not permitted.

3.07 DEMONSTRATION:

- A. Upon completion of the installation of the light poles and fixtures, and after lighting circuitry has been energized, apply energy to demonstrate capability and compliance with all Contract Document requirements. Where possible correct malfunctioning units at the site then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with the demonstration.

- B. In no case must the Contractor temporarily connect any equipment or circuits to meet this requirement.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Each type of lighting unit furnished and installed will be measured per each.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment will be made at the Contract unit price for each type of lighting unit completed by the Contractor and accepted by the Commissioner. This price includes full compensation for furnishing all materials; for all preparation, assembly, and installation of these materials; for all excavation and backfilling, for all restoration of disturbed areas and for all labor, equipment, tools and incidentals including light pole foundations, luminaire, ground rod and grounding, disconnect enclosure, pole wiring, and all associated items necessary to complete this item as required by these Specifications and as detailed on the Contract Drawings.

- B. Payment will be made under the following item:

ITEM NO. DESCRIPTION UOM		
16520-01	ROADWAY LIGHT ASSEMBLY, TYPE "A", LED, 480V, TYPE III CUTOFF	EA

END OF SECTION 16520

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TESTING

SECTION 16950

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Work under this section is subject to the requirements of the Contract Documents.
- B. Furnish and provide all work, materials, instruments and accessories necessary to provide, but is not limited to, the following:
 - 1. Testing of electrical systems.

1.02 RELATED WORK:

- A. As specified in the following sections:
 - 1. 16010 – Basic Electrical Requirements
 - 2. 16100 – Basic Materials and Methods
 - 3. 16123 – Building Wire and Cable
 - 4. 16125 – Fiber Optic Cable and Equipment
 - 5. 16131 – Cabinets and Enclosures
 - 6. 16140 – Wiring Devices
 - 7. 16195 – Electrical Identification
 - 8. 16452 – Grounding
 - 9. 16460 – Transformers
 - 10. 16470 – Panelboards
 - 11. 16510 – Interior Lighting
 - 12. 16520 – Roadway/Parking Lot/Tunnel Lighting

1.03 REFERENCES:

- A. See Specification Section 16010 Basic Electrical Requirements 1.03 References.

1.04 SUBMITTALS:

- A. The Contractor must submit data to the Commissioner prior to purchasing and installation. The data must include but not be limited to the following:
 - 1. All test reports as witnessed and signed by the Commissioner.
 - 2. All certified test reports as specified elsewhere.

1.05 QUALITY CONTROL:

- A. See Specification Section 16010 Basic Electrical Requirements 1.05 Quality Control.

1.06 DELIVERY STORAGE AND HANDLING:

- A. See Specification Section 16010 Basic Electrical Requirements 1.06 Delivery Storage and Handling.

1.07 WARRANTIES AND GUARANTEES:

- A. None required.

1.08 EXTRA MATERIALS AND SPARE PARTS:

- A. None required.

1.09 ENVIRONMENTAL REQUIREMENTS:

- A. None required.

1.10 SPECIAL REQUIREMENTS:

- A. None required.

PART 2 PRODUCTS

2.01 TESTING:

- A. The following tests are required, but must not be limited to, this list. All tests will be witnessed by the Commissioner.
 - 1. Proper phase rotation.
 - 2. Short circuits.
 - 3. Improper grounds.
 - 4. Power and control electrical circuits for circuit continuity and functional tests.

5. Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems must be in accordance with NETA ATS.
- B. The Contractor must furnish all meters, instruments, cable/wire connections, etc. for all tests.
- C. The Contractor must check all transformers, power panels, feeders, power and control cables and connections and motors to assure correct phase sequence and rotation. Phase sequence must be A-B-C as follows:
 1. Top to bottom, left to right, and front to rear when facing protective or disconnecting mechanism.
 2. Phasing must be done using distinctive colors for the various phases as indicated in the Contract Documents.
- D. After wires and cables are in place and connected to devices and equipment, the system must be tested for short circuits, improper grounds and other faults. If a fault condition occurs the trouble must be corrected and the system must be retested.
- E. Phase conductors, if shorted, grounded or at fault must be replaced and retested.
- F. A voltage test must be made at each lighting panel, distribution panel, receptacle panel and at the last power consuming device in the circuit to check the voltage drop. This test must be done under the full load of the circuit being tested. For receptacles there must be a load of 1200 watts applied to the last outlet and the voltage drop must be tested at this point. If a voltage drop exceeds 1 percent for lighting and 3 percent for power the Contractor must correct the condition by locating the high resistance splice or connection and must then retest the system.
- G. Any wiring device, electrical apparatus or lighting fixture grounded or shorted on any "live" part must be removed and the trouble rectified by replacing the defective parts or materials.
- H. Upon completion of the electrical work the Contractor must place the entire installation in operation, test for proper function and show systems and equipment to be free from all defects. Motors and driven equipment must not run until properly lubricated. Pumps must not be run until water or process fluid supply is connected and turned on. Test and record maximum load amperage and terminal voltage when coupled and uncoupled for each motor.

- I. The Commissioner will conduct from time to time such tests as may be required to any part of the equipment to determine if it is installed in accordance with the Contract Documents. The Contractor will extend to the Commissioner all facilities to this end and must furnish skilled or unskilled help required. All tests will be witnessed by the Commissioner and three copies of the verified test report must be given to the Commissioner promptly upon completion of the test.
- J. The Contractor must provide assistance to the various equipment manufacturer's field personnel as required in the testing and adjusting of the electrical power and control equipment. Cooperation of the Contractor must be such that a minimum of time is required for equipment testing.
- K. A log must be maintained by the Contractor of all tests. This log must be certified before completion of the job, both as to test values and date of test. All major equipment such as switchgear, motor control centers and motors must be initially energized in the presence of the Commissioner.
- L. Any faults in the work performed by the Contractor or in materials or equipment furnished by the Contractor must be corrected or replaced promptly by the Contractor at his/her own expense. Any faults in materials or equipment furnished by the Contractor which are the result of careless, incompetent or improper handling or installation by the Contractor must be corrected or replaced, as directed by the Commissioner, at the Contractors expense.
- M. All tests must be made by the Contractor at the Contractors' expense and certification of the tests will be submitted to the Commissioner. If any failures occur during the tests the Contractor must replace the faulty equipment of materials and retest.
- N. The Contractor shall take current readings with a true RMS Ammeter for the purpose of load balancing. These readings shall be taken at the service entrance, each feeder panelboard, each branch panelboard, and each separately derived source. The Contractor shall redistribute single phase loads where there is a greater than 20% difference in readings in any two phases. The loaded 80% of the rating of the over current protective device. All recordings are to be included with the as-built drawings in a binder.

2.02 WIRE AND CABLE TESTING (600 VOLTS):

- A. The 600 volt insulated wire and cables must be factory tested prior to shipping in accordance with IECA Standards for the insulation specified.
- B. The following 600 volt wires and cables must be tested after installation before and after final connections are made up:
 - 1. All feeders from 480 volt switchgear or unit substations.
 - 2. All feeders from 480 volt switchboards.
 - 3. All feeders from 480 volt distribution panels.
 - 4. All feeders from 480 volt motor control centers.
 - 5. All feeders to panelboards.
 - 6. All conductors #6 and larger.
- C. For the above listed wires and cables the Contractor must megger test them at 1000 volts. The minimum acceptable reading must be 250 Megohms. The megger test must not be done until any and all splicing is completed.

2.03 GROUND ROD TESTING

- A. See Specification 16452 GROUNDING

PART 3 EXECUTION

3.01 TEST EQUIPMENT:

- A. All test equipment must be in good operating condition and must have been calibrated within 6 months of date of usage. At the time of testing the Contractor must present a copy of the certification of calibration to the Commissioner.
- B. All test must be done with the proper equipment for the type of test being performed. When necessary the Contractor must obtain the services of a testing company to perform those tests which the Contractor either does not have trained personnel or proper testing equipment.
- C. All megger tests must be recorded on Form 16950. When an outside testing company is used the test report form will be submitted to the Commissioner for review and acceptance.
- D. All test reports must be signed and dated.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Testing will not be measured separately for payment.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Testing will not be paid for separately, but will be considered incidental to the electrical work specified elsewhere in the contract documents.

END OF SECTION 16950



Rosemarie S. Andolino
Executive Director

FORM 16950

SINGLE AND MULTIPLE CONDUCTOR POWER CABLE MEGGER TEST, 600V AND LESS WIRING-FEEDER CIRCUITS

**Testing must be performed before connecting the cables to the terminals at either end.
Continuity of each conductor must be checked at this time.**

**Each conductor must be checked with a 1000 volt megger to ground, with all other conductors
in the cable and shield, grounded. The minimum acceptable resistance will be 250 megohms
for each conductor to ground.**

Date:	_____	Project Name:	_____
Feeder Number:	_____	Location:	_____
From:	_____	To:	_____
Cable Size:	_____	Cable Length:	_____
Number of Conductors:	_____	Insulation Type:	_____
Manufacturer:	_____	Line Voltage:	_____
Temperature:	_____	Humidity:	_____
Megger Type:	_____	Serial Number:	_____
Test Voltage:	_____	Date of Calibration:	_____

Remarks: _____

If Applicable, All Shields Must Be Properly Grounded.

Cable No.	MEGOHMS Phase A	MEGOHMS Phase B	MEGOHMS Phase C	MEGOHMS Neutral

Test Performed By: _____
Signature/Name/Company Date

Test Witnessed By: _____
Signature/Name/Company Date

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PIPE FOR STORM DRAINS

SECTION D-701

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item must consist of the construction of storm drains and sewers, in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the Drawings. The work under this Section is subject to the requirements of the Contract Documents.
- B. This Section includes Specification for the installation of pipe(s) using open cut / cover, jacking and boring pipe(s) under runway and taxiway pavements where shown on the drawings, and / or tunneling technique.
- C. For pipe jacking and / or tunnel initial support system, shaft excavation, temporary earth retention system, ventilation, dewatering, contact grouting, structural portland cement concrete and monitoring requirements are described elsewhere in these specifications.

1.02 RELATED WORK

- A. As specified in the following Section
 - 1. Section 02240 – Dewatering
 - 2. Section 02241 – Control of Water
 - 3. Section D-751 – Manholes, Catch Basins, Inspection Holes and Manholes Adjustments
 - 4. Section P-152 – Excavation and Embankment
 - 5. Section P-157 – Trench Backfilling
 - 6. Section P-610 – Structural Portland Cement Concrete

1.03 SUBMITTALS

- A. Prior to performing the Work, the Contractor must submit shop Drawings in accordance with the General Conditions for review and approval by the Commissioner.
- B. Prepare and submit all submittals in accordance with the Schedule and Submittal Section Requirements.
- C. Describe and submit the Storm Sewer Installation Work Plan, include the following information:
 - 1. Sequence for shaft and pipe excavation and drainage structure and pipe installation, including number, location, length, and construction duration.
 - 2. Method of installation (open cut/cover or tunneled) of storm sewer pipe not under pavement areas.
 - 3. Method of excavation and trenching, and equipment to be used.
 - 4. Dimensions of excavation and trenching.
 - 5. Method of preventing loss of ground in excavation areas.
- D. Prepare and submit all submittals in accordance with the Schedule and Submittal Section requirements.
- E. Contact Grouting composition, equipment and procedure, including grout hole pattern. For pipe-in-tunnel construction and sliplining construction, describe procedures and equipment for installing carrier pipe, methods for placing pipe in the vertical alignment shown on the Drawings, and methods for maintaining carrier pipe in alignment during contact grouting. Also describe plan for repair and removal of unacceptable or damaged pipe sections and plan for patching and repair of pipe joints and non-smooth surfaces.
- F. For cast-in-place concrete lining, describe concrete forms including diameter and length, methods of transporting concrete, methods of placing concrete behind forms, methods of vibrating concrete, and duration of curing before stripping forms. Also describe plan for repair or removal of unaccepted lining sections and plan for patching and repair of cold joints and non-smooth surfaces.
- G. Provide Control of Water Plan, Contract Grouting Plan, and Geotechnical Instrumentation Plan in accordance with Specification Sections 02241 – Control of Water

1.04 REFERENCES

- A. ASTM C 76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- B. ASTM C 150 – Standard Specification for Portland Cement
- C. ASTM C 425 – Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
- D. ASTM C 443 – Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- E. ASTM C 700 – Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
- F. ASTM C 923 – Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
- G. ASCE 15-98 – Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installation
- H. ASCE 27-00 – Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction
- I. AASHTO – LRFD Bridge Specification, Section 12.10.4.2
- J. Illinois Department of Transportation, Standard Specifications for Road and Bridge Construction, (SSRBC), latest edition.
- K. Illinois Department of Transportation, Supplemental Specifications and Recurring Special Provisions, latest edition.
- L. Occupational Safety & Health Administration (OSHA) – Excavations OSHA 2226 -2002 (Revised)

1.05 PERFORMANCE REQUIREMENTS – PIPE INSTALLATION

- A. The Contractor must size, design, and construct all necessary construction shafts for jacking / tunneling pipe in accordance³ with all applicable Federal, State, local, City of Chicago, and O'Hare Airport regulations.
- B. The Contractor must expect to construct pipe sections in glacial till material with confined and pressurized water bearing silt and sand layers and inclusion of cobbles and boulders as expected in glacial tills

and as indicated in the boring logs. The subsurface data, including boring logs and tests results, are included with the bidding documents.

- C. The Contractor must employ appropriate equipment and methodologies to successfully complete pipe installation and the project by open cut / cover, pipe jacking, or tunneling methods of installation or any combination of such. By submitting his Bid, the Contractor attests that he has satisfied himself as to the practicality and feasibility of his selected installation method(s) based on the site conditions and restrictions, available soil and subsurface data, and/or any other investigations and analysis performed by him or others.
- D. The Contractor may elect to use a one-pass jacking / tunneling technique to provide both initial ground support and final lining; or elect to use a two-pass conventional tunneling technique and install carrier pipe or cast-in-place concrete lining inside the initial ground support system. If a one-pass tunneling technique is elected, Contractor must provide means to prevent the collapse of pressurized silt and sand into the tunnel overcut area. If two-pass tunneling with the initial support system is elected, a layer of filter fabric must be used outside the initial support system preventing the silt and sand intrusion into the excavated tunnel.
- E. For pipe-in-tunnel construction, initial ground support system inside diameter must be at least 12 inches larger than the carrier pipe outside diameter.
- F. The porous silt and sand layers (aquifers) under piezometric pressure head that may be encountered by jacking and / or tunneling installation methods must be relieved by an appropriate dewatering system. A minimum dewatering requirement must consist of dewatering system to lower and maintain the groundwater 4-feet below the tunnel invert prior to and during construction.
- G. Pipe jacking / tunneling under runway and taxiway pavements and / or major utilities must be arranged and completed nonstop or on an around the clock basis if warranted by field conditions and approved by the Commissioner.
- H. Contractor is responsible for installation of any additional intermediate workshafts and any intermediate jacking stations that may become necessary to facilitate the pipe installation, without any additional cost to the commissioner.

PART 2 MATERIALS

2.01 GENERAL

- A. The pipe must be the type and class called for on the Drawings and must be in accordance with the following requirements as applicable.
- B. All pipes must be subject to field inspection by the Commissioner. Any section of pipe that is damaged by handling or is defective as determined by the Commissioner will be definitively marked and returned to the manufacturing plant.

2.02 PIPE

- A. Reinforced Concrete Pipe shall conform to – ASTM C 76, Class IV unless otherwise specified in the plans.
- B. Extra Strength Vitrified Clay Pipe shall conform to – ASTM C 700.

2.03 CONCRETE

- A. Concrete for pipe cradles must conform to the requirements of Section P-610 Structural Portland Cement Concrete of these Specifications.

2.04 GASKETS

- A. Gaskets for rigid pipe must conform to the requirements of ASTM C 443. Gaskets must be consistent with oil, fuel JP8, propylene glycol, urea and potassium acetate. A swelling test based on Methods 6001 and 6211 of Federal Standard 601 must be used. When the latter method is used with No. 3 oil for 70 hours at 212 degrees F., the swelling must not exceed 100% by volume. Gaskets must meet the low temperature brittleness requirement of ASTM D 2137 Standard Test Method for Rubber Property – Brittleness Point of Flexible Polymers and Coated Fabric.

2.05 MORTAR

- A. Mortar for pipe to pipe wyes and connections to other drainage structures must consist of one part Portland cement and two parts sand. The Portland cement must conform to the requirements of ASTM C 150, Type I. The sand must conform to the requirements of ASTM C 144. Hydrated lime meeting the requirements of ASTM C-206 may be added to the mixture of sand and cement in an amount equal to 15 percent of the weight of sand used.

2.06 COMPRESSION JOINTS

- A. Material for compression joints for the vitrified clay pipe must meet the requirements of ASTM C 425.

2.07 BEDDING MATERIAL

- A. Bedding material must conform to the requirements of Section P-157 Trench Backfilling.

PART 3 CONSTRUCTION METHODS

3.01 EQUIPMENT

- A. All equipment necessary and required for the proper construction of storm drains must be on the Project, in first-class working condition, and approved by the Commissioner before construction is permitted to start.
- B. The Contractor must provide appropriate hoisting equipment to handle the pipe while unloading and placing it in the final position without damage to the pipe.
- C. The Contractor must provide vibratory means to obtain the required compaction of the aggregate pipe bedding and backfill as specified in Section P-157 Trench Backfilling of these Specifications.

3.02 EXCAVATION

- A. Excavations must meet OSHA's minimum Excavation and Trenching Standards (OSHA 2226, 2022 (Revised) Publication).
- B. Control of water in excavations must be in accordance with Section 02241 – Control of Water, in these specifications.
- C. The width of the pipe trench must be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but must not be less than the external diameter of the pipe plus 6 inches on each side. The trench walls must be approximately vertical except where safety considerations require benching of the trench walls.
- D. Where rock, hardpan, or other unyielding material is encountered, it must be removed below the foundation grade for a depth of at least 4 inches. The excavation below grade must be backfilled with bedding stone in accordance with Section P-157 Trench Backfilling and

compacted in layers not over 6 inches in uncompacted depth to form a uniform but yielding foundation.

- E. Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil must be removed and replaced with stabilization stone in accordance with Section P-157 Trench Backfilling for the full trench width. The Commissioner must determine the depth of removal necessary. The granular material must be compacted to provide adequate support for the pipe in accordance with Section P-157 Trench Backfilling.
- F. The excavation for pipes that are placed in embankment fill must not be made until the embankment has been completed to a height above the top of the pipe as shown on the Plans.
- G. The description of compaction equipment and soil classifications, including contaminated materials, and their disposal are contained in Section P-152 Excavation and Embankment of these Specifications. Excavation must not be measured for direct payment. The cost of this work must be included in the Contract unit price for each kind and size of pipe.
- H. The Contractor must construct such trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to governing laws. The bracing, sheathing, or shoring must not be removed in one operation but must be done in successive stages to prevent overloading of the pipe during backfilling operations. The cost of bracing, sheathing, or shoring, and the removal of same, must be included in the unit price for the pipe.

3.03 BEDDING

- A. The pipe bedding must conform to the details as shown on the Drawings and in accordance with Section P-157 Trench Backfilling.

3.04 LAYING PIPE

- A. The Contractor must provide the necessary lines and supports to insure installation of the pipe to line and grade. The Contractor's facilities for lowering the pipe into the trench must be such that neither the pipe nor the trench must be damaged or disturbed.
- B. The Commissioner and Contractor QC must inspect all pipe before it is laid, and reject any section that is damaged by handling or is defective to a degree which must materially affect the function and service of the pipe.

- C. The pipe laying must begin at the lowest point of the trench and proceed upgrade. The lower segment of the pipe must be in contact with the bedding throughout its full length. Bell or groove ends of rigid pipes must be placed facing upgrade.
- D. Paved or partially lined pipe must be placed so that the longitudinal center line of the paved segment coincides with the flow line.
- E. Elliptical and elliptically reinforced pipes must be placed with the manufacturer's top of pipe mark within five degrees of a vertical plane through the longitudinal axis of the pipe.
- F. Pipe must not be laid on frozen ground. The Contractor must provide for the temporary diversion of flows in order to permit the installation of the pipe under dry conditions.

3.05 JOINING PIPE

- A. Joints must be made to form a flexible watertight seal. Gaskets must be installed according to the manufacturer's requirements. The method of joining pipe sections must be such that the ends are fully entered and the inner surfaces are reasonably flush and even.

3.06 CONNECTIONS TO STRUCTURES AND PIPES

- A. Where the Plans show connections to existing or proposed pipe or structures, these connections must be watertight and made so that a smooth uniform flow line must be obtained throughout the drainage system.
- B. All branch sewer connections must meet the structural jointing and water-tightness requirements for the mainline pipe to which they are made. Break-in-connections will not be allowed. Connections of pipe 18 inches in diameter or smaller to RCP may be made using cast-in or cored-in flexible couplings meeting ASTM C 923, or pre-cast wye or tee fittings, as approved by the Commissioner. Connections of pipe larger than 18 inches in diameter to RCP must be made with precast wye or tee fittings as approved by the Commissioner.

3.07 BACKFILLING

- A. Pipes must be inspected before any backfill is placed; any pipes found to be out of alignment, unduly settled, or damaged must be removed and re-laid or replaced at the Contractor's expense. Trenches must be backfilled in accordance with Section P-157 Trench Backfilling.

- B. All excavations made for pipe installation must have piping installed and backfilled by the end of each work day. The open end of any installed pipe must be covered (i.e. bulkhead, plywood, etc.) by the Contractor and accepted by the Commissioner before backfill is placed.

3.08 CLEANING AND RESTORATION OF SITE

- A. After the backfill is completed, the Contractor must dispose of all surplus material, and rubbish from the site. Excess dirt and excavated material must be embanked within the project embankment limits in accordance with Section P-152 Excavation and Embankment, and will be considered incidental to the work. The Contractor must restore all disturbed areas to their original condition. Where the original condition is grass, topsoil and sod or permanent seeding must be used for restoration as shown on the drawings. All costs for restoration will be included in the Contract unit price. Any future settlement of trenches must be restored at the Contractor's expense.
- B. After all the work is completed, the Contractor must remove all tools and other equipment, leaving the entire site free, clear and in good condition.

3.09 INSPECTION

- A. Prior to final acceptance of the drainage system, the Commissioner, accompanied by the Contractor, must make a thorough inspection by an appropriate method of the entire installation. Defects in material or workmanship or obstruction to the flow in the pipe system must be corrected by the Contractor without additional compensation as directed by the Commissioner.
- B. For pipes smaller than 72 inches in diameter, an internal television inspection must be performed by the Contractor following the completion of installation and backfill compaction testing showing a complete, clean installation. Any debris or deficiencies encountered must be cleaned or repaired, to the satisfaction of the Commissioner, and the segment(s) must be re-televised showing a complete, clean installation. The television camera used must be high-resolution color, must be equipped with a revolving head, and must be equipped with a footage counter which records on the video recording. Video recordings in DVD format must be made of the internal inspection and submitted to the Commissioner. The costs associated with televising must be considered incidental and no additional payment will be made for this work.

- C. For pipes 72 inches and larger in diameter, a visual inspection must be performed by the Contractor following the completion of installation and backfill compaction testing. The Contractor must obtain the service of an independent inspection company qualified to perform the visual inspection. The Contractor must obtain the approval of the Commissioner before employing the inspection company. The costs of the inspection will be considered incidental to the pipe installation and no additional payment will be made for this work.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. The length of pipe must be measured in lineal feet of pipe in place, completed, and accepted. It must be measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The several classes, types and sizes must be measured separately. All fittings must be included in the footage as typical pipe sections in the pipeline being measured.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment must be made at the Contract unit price per lineal foot for each kind of pipe of the type, class, and size designated. The price must be full compensation for furnishing all materials and for all preparation, excavation, excavation for launch and reception shafts for pipe jacking, disposal of excavation (unclassified or unclassified, special), pavement sawcutting, installation of these materials, pipe jacking where required, backfilling and compaction, and restoration; and for all labor, equipment, tools, and all work necessary to complete the item.

5.02 Payment will be made under the following items:

ITEM #	DESCRIPTION	UOM
D-701-01	REINFORCED CONCRETE PIPE – 15" DIA, CLASS IV	LF
D-701-02	REINFORCED CONCRETE PIPE – 24" DIA, CLASS IV	LF
D-701-03	REINFORCED CONCRETE PIPE – 24" DIA, CLASS V	LF
D-701-04	EXTRA STRENGTH VITRIFIED CLAY PIPE – 15" DIA	LF

D-701-05	EXTRA STRENGTH VITRIFIED CLAY PIPE – 18" DIA	LF
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END OF SECTION D-701

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PIPE UNDERDRAINS FOR AIRPORTS

SECTION D-705

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item must consist of the construction of pipe underdrains in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the Plans. The work under this Section is subject to the requirements of the Contract Documents.

1.02 REFERENCES

- A. ASTM F 758 – Standard Specification for Smooth Wall PVC Plastic Underdrain Systems for Highway, Airport, and Similar Drainage .

PART 2 MATERIALS

2.01 PIPES

- A. Materials must meet the requirements shown on the Plans or specified below.
 - 1. Smooth-Wall Perforated and Non-Perforated PVC Pipe, Sch 40 ASTM F 758

2.02 MORTAR

- A. Mortar must consist of one part Portland cement and two parts sand. The Portland cement must conform to the requirements of ASTM C 150, Type I. The sand must conform to the requirements of ASTM C 144.

2.03 WASHED COARSE AGGREGATE

- A. Washed coarse aggregate used to surround underdrains and subdrains shall be IDOT gradation CA-7 crushed stone in accordance with Section 1004 of the IDOT Standard Specifications for Road and Bridge Construction (SSRBC), latest edition and any Supplemental Specifications and Recurring Special Provisions, except as modified.

2.04 POROUS BACKFILL

- A. Porous backfill must be free of clay, humus, or other objectionable matter, and must conform to the gradation in Table 1 when tested in accordance with ASTM C 136.

TABLE -1 GRADATION OF POROUS BACKFILL		
Sieve Designation (Square Openings)	Percentage By Weight Passing Sieves (CA-7)	Percentage By Weight Passing Sieves (CA-11)
1 ½ inch (37.5 mm)	100	
1 inch (25.0 mm)	95 ± 5	100
¾ inch (19 mm)		92 ± 8
½ inch (12.5 mm)	45 ± 15	45 ± 15
No. 4 (4.75 mm)	5 ± 5	6 ± 6
No. 16 (1.18 mm)		3 ± 3

2.05 GEOTEXTILE FABRIC

- A. Non-woven geotextile fabric to be used for perforated pipe underdrains must be as specified in Section P-629 Geotextile Fabric of the Specifications.

PART 3 CONSTRUCTION METHODS

3.01 EQUIPMENT

- A. All equipment necessary and required for the proper construction of pipe underdrains must be on the Project, in first-class working condition, and approved by the Commissioner before construction is permitted to start.

3.02 EXCAVATION

- A. The width of the pipe trench must be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but must not be less than the external diameter of the pipe plus 8 inches on each side. The trench walls must be approximately vertical.
- B. Where rock, hardpan, or other unyielding material is encountered, it must be removed below the foundation grade for a depth of at least 4

inches. The excavation below grade must be backfilled with selected fine compressible material, such as silty clay or loam, and lightly compacted in layers not over 6 inches in uncompacted depth to form a uniform but yielding foundation.

- C. Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil must be removed and replaced with approved granular material for the full trench width. The Commissioner will determine the depth of removal necessary. The granular material must be compacted to provide adequate support for the pipe.
- D. Excavated material not required or acceptable for backfill must be disposed of by the Contractor as directed by the Commissioner. The excavation will not be carried below the required depth; when this is done, the trench must be backfilled at the Contractor's expense with material approved by the Commissioner and compacted to the density of the surrounding earth material.
- E. The bed for the pipe must be so shaped that at least the lower quarter of the pipe must be in continuous contact with the bottom of the trench. Spaces for the pipe bell must be excavated accurately to size to clear the bell so that the barrel supports the entire weight of the pipe.
- F. The Contractor must do such trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to governing laws. Unless otherwise provided, the bracing, sheathing, or shoring must be removed by the Contractor after the completion of the backfill to at least 12 inches over the top of the pipe. The sheathing or shoring must be pulled as the granular backfill is placed and compacted to avoid any unfilled spaces between the trench wall and the backfill material. The cost of bracing, sheathing, or shoring, and the removal of same, will be included in the unit price bid per foot for the pipe.

3.03 LAYING AND INSTALLING PIPE

- A. The laying of the pipe in the finished trench must be started at the lowest point and laid upgrade. When bell and spigot pipe is used, the bells must be laid upgrade. If tongue and groove pipe is used, the groove end must be laid upgrade. Holes in perforated pipe must be placed down, unless otherwise shown on the Plans. The pipe must be firmly and accurately set to line and grade so that the invert must be smooth and uniform. Pipe must not be laid on frozen ground.

- B. Pipe which is not true in alignment, or which shows any settlement after laying, must be taken up and relaid without extra compensation.
- C. PVC pipe must be installed in accordance with the requirements of ASTM D 2321 or AASHTO Standard Specification for Highway Bridges Section 30.
- D. Unless otherwise indicated on the Drawings, pipe perforations must be arranged as described below. Rows of perforations must be arranged in one (1) or two (2) equal groups at equal distance from the bottom on each side of the vertical centerline of the pipe. The lowermost rows of perforations must be separated by an arc of about 90 degrees; the uppermost rows, by an arc of about 160 degrees. On both the inside and outside of the pipe, perforations must be free of cuttings or frayed edges, and any materials that would reduce the effective opening. All perforated PVC underdrain pipes must be surrounded by CA-7 stone coarse aggregate and non-woven geotextile fabric over their entire length as shown in Section 3.03 (G) of this Specification. The pipe must be laid accurately to line and grade.

Nominal Pipe Size	Perforation Arrangement
4"	Hole Size: 3/8" Center-to-Center: 3-1/4" +/-1/4" Rows of Holes: 2, 90° +/-3°
6"	Hole Size: 3/8" Center-to-Center: 3-1/4" +/-1/4" Rows of Holes: 4, 2 @ 90°, 2 @ 160° +/-3°
8"	Hole Size: 3/8" Center-to-Center: 3-1/4" +/-1/4" Rows of Holes: 4, 2 @ 90°, 2 @ 160° +/-3°

- E. All Types of Pipe. The upgrade end of pipelines, not terminating in a structure, must be plugged or capped as approved by the Commissioner.
- F. Unless otherwise shown on the Plans, a 4-inch bed of granular backfill material must be spread in the bottom of the trench throughout the entire length under all perforated pipe underdrains.
- G. Underdrain pipe shall be fully wrapped with non-degrading, non-woven, geotextile fabric with minimum width of Outside Diameter of

Pipe + 8". Aggregate fill should be washed CA-7 stone surrounding the perforated pipe.

- H. Pipe outlets for the underdrains must be constructed when required or shown on the Plans. The pipe must be laid with tight-fitting joints. Porous backfill is not required around or over pipe outlets for underdrains. All connections to other drainage pipes or structures must be made as required and in a satisfactory manner. If connections are not made to other pipes or structures, the outlets must be protected and constructed as shown on the Plans.

3.04 MORTAR

- A. The mortar must be of the desired consistency for making connections to other pipes or to structures only. Mortar that is not used within 45 minutes after water has been added must be discarded. Retempering of mortar will not be permitted.

3.05 BACKFILLING

- A. Granular Material. The placement of granular backfill in the trench and about the pipe must be as shown on the Plans. Special care must be taken in placing the backfill. The granular backfill must not contain a damaging amount of foreign matter, nor must earth from the sides of the trench or from the windrow be allowed to filter into the backfill. The backfill must be placed in loose layers not exceeding 6 inches in depth and compacted by hand and pneumatic tampers to the requirements as given for earth backfill. Backfilling must be done in a manner to avoid injurious top or side pressure on the pipe or damage to the filter fabric. The granular backfill must be made to the elevation of the trench, as shown on the Plans.
- B. When perforated pipe is specified, granular backfill material must be placed along the full length of the pipe. The position of the granular material must be as shown on the details in the Plans.
- C. When porous backfill is to be placed in paved or adjacent areas prior to the completion of grading or subgrade operations, the backfill material must be placed immediately after laying the pipe. The depth of this granular backfill must be not less than 12 inches, measured from the top of the underdrain. During subsequent construction operations, this minimum backfill of 12 inches of depth must not be disturbed until such time as the underdrains are to be completed. When the underdrains are to be completed, the unsuitable material must be removed until the porous backfill is exposed. That part of the porous backfill which contains objectionable material must be removed

and replaced with suitable material. The cost of removing and replacing any such unsuitable material must be borne by the Contractor.

- D. Whenever a granular subbase blanket course is to be used under pavements which extend several feet beyond the edge of paving to the outside edge of the underdrain trench, the granular backfill material over the underdrains must be placed in the trench up to an elevation of 2 inches above the bottom surface of the granular subbase blanket course. Immediately prior to the placing of the granular subbase blanket course, the Contractor must blade this excess trench backfill from the top of the trench onto the adjacent subgrade where it can be incorporated into the granular subbase blanket course. Any unsuitable material which remains over the underdrain trench must be removed and replaced. The subbase material must be placed to provide clean contact between the subbase material and the underdrain granular backfill material for the full width of the underdrain trench.

3.06 CONNECTIONS

- A. When the Plans call for connections to existing or proposed pipe or structures, these connections must be watertight and made so that a smooth uniform flow line will be obtained throughout the drainage system.

3.07 CLEANING AND RESTORATION OF SITE

- A. After the backfill is completed, the Contractor must dispose of all surplus material, and rubbish from the site. Excess dirt and excavated material must be embanked within the project embankment limits in accordance with Section P-152 Excavation and Embankment, and will be considered incidental to the work. The Contractor must restore all disturbed areas to their original condition. Where the original condition is grass, topsoil and sod or permanent seeding must be used for restoration as shown on the drawings. All costs for restoration will be included in the Contract unit price. Any future settlement of trenches must be restored at the Contractor's expense.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. The length of pipe to be paid for must be the number of linear feet of pipe underdrains in place, completed, and approved; measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. All fittings must

be included in the footage as typical pipe sections in the pipeline being measured.

- B. The quantity of granular backfill and geotextile fabric will not be measured separately for payment, but will be included in the Contract unit price for the pipe.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment will be made at the Contract unit price per linear foot for pipe underdrains of the type, class, and size designated. The price will be full compensation for furnishing all materials and for all preparation, excavation, backfilling, and installation of these materials, and restoration, and for all labor, equipment, tools, and all work necessary to complete the item.
- B. Payment will be made under the following item:

ITEM #	DESCRIPTION	UOM
D-705-01	SMOOTH WALL PVC PIPE, 8 INCH, SCH. 40, PERFORATED	LF

END OF SECTION D-705

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MANHOLES, CATCH BASINS, INSPECTION HOLES AND

MANHOLE ADJUSTMENTS

SECTION D-751

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item must consist of construction of manholes, catch basins, inspection holes, and the adjustment of manholes in accordance with these Specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the Drawings or required by the Commissioner. The work under this Section is subject to the requirements of the Contract Documents.

PART 2 MATERIALS

2.01 CONCRETE

- A. Plain and reinforced concrete used in structures, connections of pipes with structures, and the support of structures or frames must conform to the requirements of Section P-610 Structural Portland Cement Concrete.

2.02 PRECAST CONCRETE PIPE MANHOLE RINGS

- A. Precast concrete pipe manhole rings must conform to the requirements of ASTM C 478. Precast concrete pipe section risers must conform to ASTM C-76, Class IV. Unless otherwise specified, the risers and offset cone sections must have an inside diameter of not less than 36 inches nor more than 48 inches.

2.03 FRAMES, COVERS, AND GRATES

- A. The castings must conform to one of the following requirements as appropriate:
 - 1. Gray iron castings must meet the requirements of ASTM A 48, Class 30B and 35B.
 - 2. Malleable iron castings must meet the requirements of ASTM A 47.
 - 3. Steel castings must meet the requirements of ASTM A 27.
 - 4. Structural steel for grates and frames must conform to the requirements of ASTM A 283, Grade D.

5. Ductile iron castings must conform to the requirements of ASTM A 536.
 6. Austempered ductile iron castings must conform to the requirements of ASTM A 897.
- B. Each frame and cover or grate unit must be provided with fastening members to prevent it from being dislodged by traffic but which must allow easy removal for access to the structure.
 - C. Frames, covers and grates located airside or subject to aircraft loading must be rated for a minimum 100,000 pound live load. If not subject to aircraft load, design for HS-20 loading.
 - D. Castings must be thoroughly cleaned. After fabrication, structural steel units must be galvanized to meet the requirements of ASTM A 123.
 - E. The frames and covers for the “Manholes/Covers - To Be Adjusted” and “Inspection Holes – To Be Adjusted” must be new, unless specified otherwise on the Drawings and Specifications.
 - F. Acceptable manufacturers are:
 1. Neenah Foundry Company
 2. East Jordan Iron Works, Inc.
 3. Campbell Foundry
 - G. Frames and covers shall be standard solid lid for manholes, perforated for catch basins or as specified on the plans.

2.04 STEPS

- A. The steps or ladder bars must be aluminum. The steps must be the size, length, and shape shown on the Drawings. Portions in contact with concrete or mortar should be painted.

2.05 STEEL REINFORCEMENT

- A. Reinforcing bars must conform to the requirements of ASTM A 615, Grade 60.

2.06 NON-SHRINK GROUT

- A. Non-shrink grout must conform to the requirements of Section 1024 of IDOT's SSRBC (latest edition) and meet the approval of the Commissioner.

2.07 EPOXY CONCRETE ADHESIVE

- A. The epoxy concrete adhesive must conform to the requirements of Section 1025.01 of IDOT's Standard Specifications for Road and Bridge Construction (latest edition) and meet the approval of the Commissioner.

2.08 GRATING FOR CONCRETE FLARED END SECTION

- A. Metal gratings for concrete flared end sections must conform to the requirement contained in Section 542 of the IDOT Standard Specification for Road and Bridge Construction (SSRBC), latest edition, and any supplemental Specifications and Recurring Special Provisions.

PART 3 CONSTRUCTION METHODS

3.01 UNCLASSIFIED EXCAVATION

- A. The Contractor must do all excavation for structures and structure footings to the lines and grades or elevations, shown on the Drawings, or as staked by the Commissioner. The excavation must be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the Drawings, must be considered as approximately only; and the Commissioner may order, in writing, changes in dimensions or elevations of footings necessary to secure a satisfactory foundation.
- B. Boulders, logs, or any other objectionable material encountered in excavation must be removed. All rock or other hard foundation material must be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the Commissioner. All seams or crevices must be cleaned out and grouted. All loose and disintegrated rock and thin strata must be removed. When concrete is to rest on a surface other than rock, special care must be taken not to disturb the bottom of the excavation, and excavation to final grade must not be made until just before the concrete or reinforcing is to be placed.
- C. The Contractor must do all bracing, sheathing, or shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring must be included in the unit price bid for the structure.

- D. Unless otherwise provided, bracing, sheathing, or shoring involved in the construction of this item must be removed by the Contractor after the completion of the structure. Removal must be effected in a manner which will not disturb or mar finishing masonry. The cost of removal must be included in the unit price bid for the structure.
- E. After each excavation is completed, the Contractor must notify the Commissioner to that effect; and concrete or reinforcing steel must be placed after the Commissioner has approved the depth of the excavation and the character of the foundation material.
- F. The Contractor must verify the required minimum allowable bearing on the subgrade beneath the concrete structures. Contractor QC to verify to 3 feet minimum, or to depth as directed by the Commissioner. The cost of verifying the required bearing will be considered included and incidental to the price of the structure.
- G. Where suitable bearing condition is not encountered at subgrade indicated for footings, foundations and manholes, the Commissioner may direct additional excavation and backfill with stabilization stone per Section P-157 Trench Backfilling as necessary.

3.02 CONCRETE STRUCTURES

- A. Cast in place and precast concrete structures for manholes and catch basins located within the Runway and Taxiway Safety Areas (RSA, TSA) must be designed to support aircraft loading.
- B. Concrete structures must be built on prepared foundations, conforming to the dimensions and form indicated on the Drawings. The construction must conform to the requirements specified in Section P-610 Structural Portland Cement Concrete. Any reinforcement required must be placed as indicated on the Drawings and must be approved by the Commissioner before the concrete is placed.
- C. All invert channels must be constructed and shaped accurately so as to be smooth, uniform and cause minimum resistance to flowing water. The interior bottom must be sloped downward toward the outlet.

3.03 PRECAST CONCRETE PIPE STRUCTURES

- A. Precast concrete pipe structures must be constructed on prepared or previously placed slab foundations and must conform to the dimensions and locations shown on the Drawings. All precast concrete pipe sections necessary to build a completed structure must be furnished. The different sections must fit together readily, and all

jointing and connections must be cemented with mortar or watertight gasket/cement material as specified. The top of the upper precast concrete pipe member must be suitably formed and dimensioned to receive the metal frame and cover or grate, or other cap, as required. Provision must be made for any connections for lateral pipe, including drops and leads that may be installed in the structure. Penetrations for pipe connections must be sized to accommodate the type of sealing mechanism specified. The flow lines must be smooth, uniform, and cause minimum resistance to flow. The metal steps which are embedded or built into the side walls must be aligned and placed as shown in the Drawings. When a metal ladder replaces the steps, it must be securely fastened into position.

3.04 INLET AND OUTLET PIPES

- A. Inlet and outlet pipes must extend through the walls of the structures for a sufficient distance beyond the outside surface to allow for connections but must be cut off flush with the wall on the inside surface, unless otherwise directed. For concrete or brick structures, the mortar must be placed around these pipes so as to form a tight, neat connection.

3.05 PLACEMENT AND TREATMENT OF CASTINGS, FRAMES, AND FITTINGS

- A. All castings, frames, and fittings must be placed in the positions indicated on the Drawings or as directed by the Commissioner, and must be set true to line and to correct elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts must be in place and position before the concrete or mortar is placed. The unit must not be disturbed until the mortar or concrete has set.
- B. When frames or fittings are to be placed upon previously constructed masonry, the bearing surface or masonry must be brought true to line and grade and must present an even bearing surface in order that the entire face or back of the unit will come in contact with the masonry. The unit must be set in mortar beds and anchored to the masonry as indicated on the Drawings or as directed and approved by the Commissioner. All units must set firm and secure.
- C. After the frames or fittings have been set in final position and the concrete or mortar has been allowed to harden for 7 days, then the grates or covers must be placed and fastened down.

3.06 INSTALLATION OF STEPS

- A. The steps must be installed as indicated on the Drawings or as directed by the Commissioner. When the steps are to be set in concrete, they must be placed and secured in position before the concrete is poured. The steps must not be disturbed or used until the concrete or mortar has hardened for at least 7 days. After this period has elapsed, the steps must be cleaned and painted.
- B. When steps are required with precast concrete pipe structures, they must be cast into the sides of the pipe at the time the pipe sections are manufactured or set in place after the structure is erected by drilling holes in the concrete and cementing the steps in place.
- C. In lieu of steps, prefabricated ladders may be installed. In the case of brick or concrete structures, the ladder must be held in place by grouting the supports in drilled holes.

3.07 ADJUSTMENT OF STRUCTURES

- A. Manholes requiring vertical adjustment must be brought to proposed grade by either adding or removing concrete adjustment rings as required. Mortar must be placed between each layer of adjusting rings and must be composed of one-part masonry cement to three parts sand, by volume. Frames must be set firm, secure, true to line and to the correct elevations.
- B. When precast concrete adjusting rings are used to adjust frames to proposed or new elevation, no more than four rings may be used. Total adjustment must be no more than 12 inches.
- C. Adjustments in excess of one foot must have new precast riser sections installed. Should special riser sections be required the materials used must be as specified in Section P-610 Structural Portland Cement Concrete. All required riser sections must be considered included in the adjustment of structures.
- D. Existing frames and covers located airside or subject to aircraft loading must be replaced with new heavy frames and covers capable of supporting 100,000 lbs. loads. This work must be considered included in the adjustment of structures.
- E. Existing underdrain inspection holes indicated in the Drawings must have their existing frames and grates adjusted to the proposed pavement elevations. The adjustment must include the breakout of the existing structure to a depth of at least 12 inches below the existing

grade. Drilling and grouting reinforcing bars, application of an epoxy concrete adhesive, setting new frames and covers and extending the inspection hole as indicated on the Contract Drawings to the proper elevation and the placement of Portland cement concrete to the dimensions of the existing structure and to the proper elevation.

- F. Any areas around inspection holes that have been disturbed or removed during the construction of the inspection hole adjustments must be restored with bituminous concrete meeting the materials and methods requirements of Section P-405 Bituminous Concrete Pavements. This restoration work must not be measured and paid for separately. This work is to be included in the unit price for each inspection hole adjustment.

3.08 BACKFILLING

- A. After a structure has been completed, the area around it must be filled with approved material, in horizontal layers not to exceed 8 inches in loose depth, and compacted to the density required in Item P-152 Excavation and Embankment. Each layer must be deposited all around the structure to approximately the same elevation. The top of the fill must meet the elevation shown on the Drawings or as directed by the Commissioner.
- B. Backfilling must not be placed against any structure until permission is given by the Commissioner. In the case of concrete, such permissions must not be given until the concrete has been in place 7 days, or until tests made by the Contractor's QC organization and tested by the Contractor's approved laboratory, subject to the verification by the QA laboratory working under supervision of the Commissioner establish that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it.
- C. Backfill must not be measured for direct payment. Performance of this work must be considered as a subsidiary obligation of the Contractor covered under the Contract unit price for the structure involved.
- D. Structures in pavements must be backfilled with Trench Backfill unless otherwise indicated on the Drawings. See Specification Section P-157 Trench Backfilling for Trench Backfill gradation.

3.09 CLEANING AND RESTORATION OF SITE

- A. After the backfill is completed, the Contractor must dispose of all surplus material, and rubbish from the site. Excess dirt and excavated

material must be embanked within the project embankment limits in accordance with Section P-152 Excavation and Embankment, and will be considered incidental to the work. The Contractor must restore all disturbed areas to their original condition. Where the original condition is grass, topsoil and sod or permanent seeding must be used for restoration as shown on the drawings. All costs for restoration will be included in the Contract unit price. Any future settlement of trenches must be restored at the Contractor's expense.

- B. After all work is completed, the Contractor must remove all tools and equipment, leaving the entire site free, clear, and in good condition.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Catch basins, manholes, inspection holes and the adjustment of manholes must be measured per each for payment.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. The accepted quantities of drainage structures will be paid for at the Contract unit price per each, complete and in place. This price will be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials; furnishing and installation of frames and covers, hardware, and connections to pipes and other structures as may be required to complete the item and shown on the Drawings; and for all labor equipment, tools and all work necessary to complete the structure.
- B. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
D-751-01	FLARED END SECTION, 24"	EA
D-751-02	MITERED END SECTION, 15"	EA
D-751-03	MITERED END SECTION, 18"	EA
D-751-04	MITERED END SECTION, 24"	EA
D-751-05	CATCH BASIN – STANDARD	EA
D-751-06	CATCH BASIN – STANDARD (AIRCRAFT LOADED)	EA
D-751-07	UNDERDRAIN INSPECTION HOLE	EA
D-751-08	MANHOLE ADJUSTMENT	EA

END OF SECTION D-751

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CHAIN-LINK FENCES

SECTION F-162

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Furnish and install all Fence(s) and Gate(s) work as shown on the Drawings and as specified herein, including but not limited to the following:
 - 1. Furnishing and installing new vertical posts and horizontal rails.
 - 2. Furnishing and installing new chain link fabric and gates.
 - 3. Foundations for vertical posts.
 - 4. Furnishing and installing chain link fence fabric underground along the fence and/or constructing concrete pads at fence gates to serve as wildlife deterrent barrier.
 - 5. Furnishing and installing all related accessories for a complete fence installation.
 - 6. Furnish and install a complete microprocessor based vehicular barrier and slide gate operator system, with a solid-state board to control all functions of the barrier and slide operators, as specified herein and shown on the Plans. Include all necessary boards, power supplies, loop detectors, connectors, and accessories for a complete operational system.

1.02 RELATED WORK:

- A. As specified in the following sections:
 - 1. 16010 – Basic Electrical Requirements
 - 2. 16100 – Basic Materials and Methods
 - 3. 16140 – Wiring Devices
 - 4. 16195 – Electrical Identification
 - 5. 16452 – Grounding
 - 6. 16460 – Transformers
 - 7. 16950 – Testing
 - 8. P-610 – Structural Portland Cement Concrete

- B. Installation of the barrier and slide gate operator system must be coordinated with the installation of other security systems.

1.03 REFERENCES:

- A. ASTM A 123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A 153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM A 392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
- D. ASTM F 567 - Standard Practice for Installation of Chain-Link Fence.
- E. ASTM F 626 - Standard Specification for Fence Fittings.
- F. ASTM F 900 - Standard Specification for Industrial and Commercial Swing Gates.
- G. ASTM F 1043 - Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
- H. ASTM F 1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
- I. ASTM F2200 – Standard Specification for Automated Vehicular Gate Construction
- J. FAA Advisory Circular 107-1, Aviation Security
- K. Selection Guide - “A Guide for the Selection of Line Post Spacing For Chain Link Fence” (WLG 2445) by the Chain Link Fence Manufacturers Institute.
- L. Product Manual – “Product Manual” by the Chain Link Fence Manufacturers Institute
- M. SSRBC - Standard Specifications for Road and Bridge Construction, Illinois Department of Transportation Section 640 and Art 1006.27.

1.04 DESIGN REQUIREMENTS

- A. Post selection and spacing must conform to the Chain Link Manufacturer’s Selection Guide.

1.05 SUBMITTALS:

A. Submit the following:

1. Shop Drawings: Provide complete layout of all fences including physical relationship to all buildings, structures or other objects within close proximity of the fences and details showing how fence is connected to any existing objects. Include indications of where and how the fence is braced.
2. Samples and/or Product Data
 - a. Product Data: Provide product data on all manufactured products including showing how each product conforms to the requirements of this Section.
 - b. Samples {If desired, included samples to be required, else delete}
3. Tests Reports
 - a. Submit test reports necessary to show compliance with the Contract Documents.
4. Calculations
 - a. Submit a copy of the table from the Chain Link Fence Manufacturer's Selection Guide and circle or otherwise indicate the selection criteria used in the design of the fence.
 - b. Manufacturer's Certification-submit certification that product(s) meet(s) or exceed(s) the specified requirements.

1.06 QUALITY CONTROL:

- A. All equipment must be new, in current production, and the standard products of a manufacturer of barrier and slide gate operator equipment.
- B. The manufacturer must guarantee availability of slide gate operator parts for a minimum of seven (7) years from the date of shipment.
- C. If required, the manufacturer will be able to demonstrate features, functions, and operating characteristics of the slide gate to the Commissioner.
- D. On-site maintenance and repair service of slide gate operators must be available locally and within four (4) hours notification for emergency conditions.
- E. Contractor Qualifications: Installation of fences and gates must be

performed only by a qualified Installer. The term qualified means experienced in performing the Work required by this Section on projects of comparable scope, size, and complexity. The Contractor must be able to demonstrate to the satisfaction of the Commissioner and the City that it and/or any Subcontractors performing such Work have the qualifications, experience, and, if applicable, licenses and permits to perform the Work in accordance with the terms and conditions of this Contract. The Contractor must submit evidence of such qualifications, licenses and permits upon request by the Commissioner.

- F. Perform Work in accordance with the latest edition, of the appropriate divisions, of the following:
 - 1. Manufacturer's printed directions.
 - 2. "Product Manual" by the Chain Link Fence Manufacturers Institute
 - 3. Standard Specifications for Road and Bridge Construction, (SSRBC), Illinois Department of Transportation, latest edition
 - 4. Design fences, post, footers and gates in conformance to the Chain Link Fence Manufacturers Selection Guide.
 - 5. Submit calculations, if required by the Commissioner.
- G. Delivery, Storage and Handling - Materials must be delivered to the Project in sealed containers and/or bundles bearing manufacturer's name and material identification. Materials must be stored in strict accordance with the manufacturer's printed directions, copies of which must be furnished to the Commissioner.
- H. Protect materials against damage from mechanical abuse, plaster, salts, acids, staining and other foreign matter by an approved means during transportation, storage and erection and until completion of construction Work. All unsatisfactory materials must be removed from the premises, and all damaged materials replaced with new materials.
- I. Access and Storage Areas
 - 1. All access routes and storage areas must be subject to the approval of the Commissioner in order to reduce interference with Airport Operations.

1.07 WARRANTIES AND GUARANTEES:

- A. Chain Link Fences and Gates must be covered under the Contractor's general construction warranty.

1.08 SPECIAL REQUIREMENTS:

- A. Field Measurements - Before proceeding with fabrication the fence and gate work, the supplier/installer must verify all dimensions and take such measurements as are required for proper fabrication and erection of the work.
- B. Protection - Protect materials against damage from mechanical abuse, plaster, salts, acids, staining and other foreign matter by an approved means during transportation, storage and erection and until completion of construction work. All unsatisfactory materials must be removed from the premises, and all damaged materials replaced with new materials.
- C. Coordination - Coordinate Work of this Section with related Work specified in the other divisions/sections of the Contract Documents.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Products from any member of the Chain Link Fence Manufacturer's Institute will be acceptable.
- B. Cantilever Slide Gate Operators:
 - 1. Products from one of the following manufacturers will be acceptable:
 - a. Chamberlain Professional Products
 - b. DoorKing, Inc.
 - c. Linear LLC
 - d. Hy Security

2.02 MATERIALS:

- A. Post and Rails - All posts rails, fittings and fasteners must be new material throughout conforming to the following:
- B. Line posts, rails and braces must conform to the requirements of ASTM F1043 or ASTM F1083 as follows: Galvanized tubular steel pipe must conform to the requirements of Group 1A, (Schedule 40) coatings conforming to Type A, or Group 1C (High Strength Pipe), External coating Type B, and internal coating Type B or D.
- C. Line posts - Not less than 2-1/2 inches Nominal O.D. Size

- D. End and corner posts: Not less than 3 inches Nominal O.D. Size
- E. Gate posts - Not less than 3 inches Nominal O.D. Size
- F. Top Rails - Not less than 1-5/8 inches Nominal O.D. and provide sleeve type couplings approximately every 20 feet. Rails are to pass through intermediate post tops and form a continuous brace from end to end of each run of fence. Fasten rails to terminal posts by heavy pressed steel connections.
- G. Braces - Same material as top rails are to be installed midway between the top rail and ground and to extend from terminal or corner post to first adjacent line post. Securely fasten braces to posts by heavy pressed steel connections, then trussed from line post back to terminal post with minimum 3/8 inch diameter adjustable round tension rod. Provide braces at all corner posts and end posts, including at all gates.
- H. Bottom Tension Wire and Wire Ties: No. 7 gauge aluminum coated spring coil or crimped wire. Minimum weight of aluminum coating 0.40 ounces per square foot of wire surface. Stretch tension wire taut from terminal post to terminal post and securely fastened to each intermediate post 6 inches above the grade line. Wire fabric ties must be hog rings of galvanized steel wire not less than 9-gauge. All materials must conform to Fed. Spec. RR-F-191/4.
- I. Chain-Link Fabric: Two-inch diamond mesh of 9 gauges (0.148 inch diameter) wire or heavier with knuckled bottom selvage and twisted and barbed top selvage. Attach fabric to top rail and bottom tension wire or cable by means of double wrapped zinc coated wire, spaced approximately 2 feet on center. The weight of zinc coating on the fabric will be in accordance with ASTM A392, Class2 which must not be less than 2.0 oz/ft² of uncoated wire surface, on wire of fabric coated before weaving. On fabric coated after weaving, the weight of zinc coating must not be less than 2.0 oz/ft² of uncoated wire surface as determined for the average of two or more specimens, and not less than 1.8 oz/ft² of uncoated wire surface for any individual specimen. The fabric to be used for the underground wildlife deterrent barrier must be 5'-0" wide.
- J. Barbed Wire: Barbed wire must be 2 strand 12 – ½ gauge, zinc coated steel meeting the requirements of ASTM A121, Class 3. Barbs must be 4-point spaced, not more than 6 inches on center.
- K. Razor Ribbon: Razor ribbon must be fabricated from stainless steel and must be furnished in coils 30 inches in diameter. Concertina clips

must be placed around the circumference of the razor coil to prevent undue distortion of the razor coil. Razor ribbon must be converted to concertina by clipping alternate adjacent loops at 3 places about the circumference, continuous along the entire roll's length. Stainless steel clips must be 0.375 inch by 0.065 inch and mechanically closed to withstand a minimum pull load of 200 pounds.

- L. Pipe Caps: Provide cast or wrought galvanized steel pipe caps to close and prevent water from entering all pipe used in the construction of the fence. Pipe Caps must be secured to the pipes mechanically. Pipe cap may be one and the same as the barbed wire support. Submit proposed pipe cap as a part of required products submittals.
- M. Privacy Inserts: PVC, double wall (flattened tube), with or without wings to be inserted vertically. *{Designer to verify whether privacy inserts are required and desirable. The Designer may also consider aluminum or wood inserts and diagonal insertion based on specific Project requirements. If inserts are used wind loads for the tables in the Selection Guide must be increased by a factor of two or greater.}*
- N. Concrete Foundation and Pads: IDOT Class SI concrete, $f'_c = 3,500$ psi at 14 days minimum with 5%-8% entrained air in accordance with SSRBC Article 1020 and Section P-610 Structural Portland Cement Concrete. Depth and diameter must be as required by soil conditions. Minimum depth and diameter of footing and minimum post embedment must be as shown on the Drawings. Actual footing size, depth and post embedment must be based on the design loads.
- O. Materials for Vegetation Free Zone: Base materials will be 6 inches thick crushed stone or crushed recycled concrete CA-6 or bituminous grinding as shown on the Drawings. Geotextile fabric will be in accordance with Section P-629 Geotextile Fabric.
- P. Where required, a commercially available weed control material must be applied at the manufacturer's recommended rate.

2.03 HARDWARE:

- A. Provide all hardware as necessary to provide for proper functioning of all gates and items requiring hardware.
- B. Line posts, rails and braces must conform to the requirements of ASTM F1043 or ASTM F1083 as follows:
- C. Galvanized tubular steel pipe must conform to the requirements of Group 1A, (Schedule 40) coatings conforming to Type A, or Group 1C

(High Strength Pipe), external coating Type B, and internal coating Type B or D.

- D. Line posts - Not less than 2-1/2 inches Nominal O.D. Size
- E. End and corner posts - Not less than 3 inches Nominal O.D. Size
- F. Gate posts - Not less than 3 inches Nominal O.D. Size
- G. Top Rails – Not less than 1-5/8 inches Nominal O.D. and provide sleeve type couplings approximately every 20 feet. The couplings used to join the top rail lengths must allow for expansion. Rails are to pass through intermediate post tops and form a continuous brace from end to end of each run of fence. Fasten rails to terminal posts by heavy pressed steel connections.
- H. Marking: Each roll of fabric must carry a tag showing the kind of base metal, kind of coating, the gauge of the wire, the length of fencing in the roll, and the name of the manufacturer. Posts, wire, and other fittings must be identified as to manufacturer, kind of base metal, and kind of coating.

2.04 CANTILEVER SLIDE GATE OPERATOR:

- A. The cantilever slide gate operator must use a microprocessor based solid-state control board that controls all functions of the operator. The cantilever slide gate operator must include two (2) convenience outlets, built-in power switch, and built-in reset switch.
 - 1. Commercial (UL Class III-IV) applications.
 - 2. Maximum gate length is 24 feet; maximum gate weight is 2000 lbs. Gate weight with 5 HP motor. Verify in field for exact gate length as shown in Drawing.
 - 3. 5 HP continuous duty motor operates at 208 volts, 3 phase.
 - 4. Typical current draw for the 5 HP motor is 16 amps at 208 V.
 - 5. Primary reduction and power transfer is provided by worm gear running in a continuous oil bath.
 - 6. The pulling medium consists of roller chain.
 - 7. UPS battery backup.
- B. Amperage ratings are nominal under load.
- C. The gate operator to be able to operate up to a speed of 14 feet per second.

- D. The gate operator must have two convenience outlets available for accessory transformer power, and also have a built-in lockable power disconnect and reset switch.
- E. A positive dead bolt must operate in a fail-safe mode, i.e. only when the gate is forced open, to reduce solenoid lock wear and failure, or be capable of operating in a fail-secure mode, i.e. after each operation.
- F. Control Circuit:
 - 1. The slide gate operator must be a microprocessor based control board that will control all functions of operation.
 - 2. An adjustable timer must be built into the control board to allow the gate to automatically close.
 - 3. The operator must allow a stop or a stop and reverse function (settable) from a safety related input.
 - 4. The control board must have two ports for plug in of optional loop detectors.
 - 5. A dry set of relay contacts must be available for external use, and must have four programmable functions.
 - 6. A special input must allow the gate to be partially opened.
 - 7. A timer override function must cause an opening gate to stop and then reverse direction when the reverse loop(s) or reverse input is clear even if the gate has not reached the full open position, to help reduce tailgating.
 - 8. The control board must have separate inputs for external contact and non-contact entrapment protection devices.
 - 9. Functions must be user programmable by DIP switches located on the control board.
 - 10. Loop Detectors: Loop detectors plug into the main control board and prevent the gate from closing on vehicular traffic.
 - a. Two-channel loop detector.
- G. Inherent Reverse
 - 1. The gate operator must be designed in such a way that if an obstruction is met during the opening or closing cycles, the gate operator will automatically reverse the gate.
 - 2. For enhanced safety, the control board must check the primary entrapment sensing system circuit at each cycle of the operation. Should the control board detect a fault in the system, the motor must not be allowed to start.

3. The reverse system must be inherently designed into the operator so that if the external reverse devices fail or become inoperative, the operator will still have the capability to sense the obstruction and reverse the gate.
4. The inherent reverse system in the gate operator must consist of a primary sensing system that will reverse the gate if an obstruction is sensed. Should the primary system fail or become inoperative, a secondary inherent system must sense the obstruction and reverse the gate.
5. The primary system must monitor motor current and reverse the gate upon a significant increase in current draw.

H. Entrapment Protection:

1. The gate operator must stop and activate the internal alarm upon sensing an entrapment (two sequential activations of the inherent sensing system) and must require activation of the reset switch prior to returning to normal operation, as required by the UL 325 safety standard.
2. For enhanced safety, the operator must, upon sensing an entrapment, release pressure on the gate and must assume a fail-safe condition to allow any entrapment the opportunity to free itself without the need of outside intervention.

I. Manual Release

1. The gate operator must incorporate a “fail-safe” design that will allow manual operation of the gate from either the inside or the outside without any hand cranks, keys, or other mechanical devices, as the primary manual release device.
2. The manual release device must be affixed to the operator and be capable of being quickly operated in an entrapment situation.
 - a. The release must be an integral (non-removable) part of the operator.
 - b. A single non-repetitive movement must cause an action that will allow the gate to be manually operated.
 - c. The manual release or manual operation of the gate must not result in a risk of injury to persons if the operator is activated while the manual release is activated or being used.

J. Optional Equipment:

1. Contact Edges: Padded contact edge sensors reverse gate on contact with any object.

2. Gate tracker: The vehicular slide gate operator must have output for connection to the optional gate tracker control board. The gate tracker must maintain a detailed electronic record of cycles, input errors, loop detector errors, obstruction hits, and each time power is applied to the operator. This record must be time and date stamped and must be analyzed using the manufacturer's software.
 - a. A programmable telephone entry or access control system is required for gate tracker operations.
3. Convenience Open Drive System
 - a. A battery powered convenience open DC drive system must be provided.
 - b. The DC drive system must monitor the primary power source and must power the gate upon command, or automatically, if power to the operator is interrupted.
 - c. When power is restored, the DC drive system must automatically set the operator to return to normal operation and disengage.
 - d. The system must provide a trickle charge to the batteries to maintain nominal battery power levels.
 - e. The convenience open DC drive system is not intended to operate the slide gate operator continuously during a power interruption. Its sole purpose is to provide a convenient method to open the slide gate should a power interruption occur.

PART 3 EXECUTION

3.01 INSPECTION:

- A. Before commencing installation, examine substrate surfaces to determine that they are free of conditions which might be detrimental to proper and timely completion of the work. Start of work must indicate acceptance of the substrate.
- B. All brush, stumps, and other debris which would interfere with the proper construction of the underground wildlife deterrent fence barriers in the required location must be removed. The material removed and disposed of will not constitute a pay item and will be considered included in the fence construction.

3.02 INSTALLATION:

- A. Installation must be in strict accordance with the fence and gate manufacturer's printed installation instructions and ASTM F 567 and "Product Manual" by the Chain Link Fence Manufacturers Institute. After installation is completed, make final adjustments to insure proper operation of gates.
- B. Line post spacing must conform to the Selection Guide, but must not exceed 10 feet.
- C. Excavate for posts and set posts in concrete foundations with all exposed horizontal surfaces formed and troweled to a smooth, dense finish and provided with a ½" cement wash with top of footing at post to be 2 inches above grade.
- D. All posts must be accurately located, set plumb and true to line and elevation, and uniformly spaced in each run. All rails, braces, and accessories must be installed in accordance with the approved shop Drawings and the concrete cured a minimum of 7 days before the fabric is stretched. Stretch chain link fabric taut and fasten as required by the manufacturer and by the structural design. Size and space fasteners as required by the structural design, but no greater than 14 inches apart. All fasteners and related accessories must be new.
- E. Stretch fabric between terminal posts or at intervals not exceeding 100 feet, whichever is less.
- F. Position bottom of fabric 2 inches above finished grade, unless noted otherwise.
- G. Where no bottom rail is used, install bottom tension wire stretched taut between terminal posts.
- H. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Provide a bottom rail in all bays containing center brace rails and truss rods.
- I. Gates must include top, center and bottom rails and truss rods.
- J. Provide top rail continuous through line post tops and splice between posts as indicated by structural design with at least 6 inch long rail sleeves. The coupling used to join the top rails must allow for expansion.
- K. Securely attach hinges so as to not twist or turn when gate is opened or closed.

- L. Where razor ribbon is used, the single row of barbed wire must be strung through the top slots of the galvanized barb arm and attached to the posts. The razor ribbon must be securely attached to the chain link fence using 18 gauge stainless steel ties spaced approximately 16 inches on center along both the top of the chain link fence fabric and the top row of barbed wire.
- M. Extension of underground conduit and electrical wiring must be provided as specified under Division 16 - Electrical. *{If electrical power is required for the gate, include this paragraph and other information as necessary, otherwise eliminate.}*
- N. Install wildlife deterrent fence barrier as shown and at locations indicated on the Drawings. Excavate ground to the depth required for proper installation of wildlife deterrent fence barrier. Obtain Commissioner's approval of depth of excavation before placing the wire fabric. Place the fabric and lap splice to the above ground fence fabric and tie with wire ties at two (2) feet spacing. Cut wire fabric around fence past footing to allow proper placement. Backfill with native soil to final grade. Compact all backfill and fill to attain a minimum 85% of ASTM D 1557. Gate concrete pads must be installed at each gate or as shown on the Drawings. Weed control material must be applied over an area 5 feet wide, measured from the fence centerline, and over the wildlife deterrent fence. Apply weed control material as recommended by the manufacturer's instructions and in compliance with state and local regulations.
- O. Electrical grounds must be constructed where a power line passes over the fence and at 500 foot intervals. The ground must be installed directly below the point of crossing. The ground must be accomplished with stainless steel solid rod 8 feet long and a minimum of $\frac{3}{4}$ inches in diameter driven vertically until the top is six inches below the ground surface. A No. 6 green-insulated solid copper conductor must be clamped to the rod and to the fence in such a manner that each element of the fence is grounded. Installation of the ground rods must not constitute a pay item and must be considered included in fence construction.
- P. The Contractor must comply with *FAA-STD-019, Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment*, Paragraph. 4.2.3.8, Lighting Protection for Fences and Gates, when fencing is adjacent to FAA facilities.
- Q. Install vegetation free zone in locations indicated in the Drawings. The base course must be compacted to 95% of the modified proctor ASTM

D 1557.

- R. Where the Fencing Plan and details do not indicate a vegetation free zone at the sides, weed control must be applied. Weed control material must be applied over an area 3 feet wide, measured from the fence centerline and over the wildlife fence. Apply weed control material as recommended by the manufacturer's instruction and in compliance with state and local regulations.
- S. For cantilever slide gate operators designed to be pad mounted:
 - 1. Mount directly to a concrete pad.
 - 2. The operator is designed to be front mounted.
 - 3. Rear mount units require the use of optional idler sprocket.
- T. Wiring must be uniform and in accordance with the Chicago Electrical Code and the manufacturer's instructions.
- U. All splices must be in easily accessible junction boxes or on terminal boards.
- V. All cable runs in all junction boxes must be tagged and identified.
- W. Coordinate work with other trades as required.
- X. Install AOA warning signs on airside side of fence line in accordance with the CDA/OMP Detail No. 04-06/A9 Warning Sign Detail for AOA Area Separation.

3.03 CANTILEVER SLIDE GATE OPERATOR SYSTEM INITIALIZING AND PROGRAMMING

- A. The system must be turned on and adjustments made to meet requirements of the Specifications and on-site conditions.
- B. The system must function as specified.

3.04 CANTILEVER SLIDE GATE OPERATOR TRAINING

- A. The Contractor must provide two (2) hours of training in use, operation, and troubleshooting of the system for a maximum of five (5) individuals designated by the Director within 30 days of system acceptance.

3.05 CANTILEVER SLIDE GATE OPERATOR MANUALS AND DRAWINGS:

- A. The Contractor must provide two copies of standard factory prepared

operation, installation, and maintenance manuals to the Director. Manuals must include typical wiring diagrams.

- B. The Contractor must provide two copies of any risers, layouts, and special wiring diagrams showing any changes to standard drawings, if required on the project, to the Director.

3.06 ERECTION TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From True Position: 1 inch.
- C. Components must not infringe adjacent property lines.

3.07 REPAIR AND TOUCH UP

- A. After field installation has been completed, all abraded spots, weld marks, scratches, areas showing rust, etc. must be cleaned, wire brushed, and touched up with cold galvanizing paint.
- B. Products of one of the following manufacturers will be acceptable for cold galvanizing:
 - 1. "ZRC Cold Galvanized" – ZRC Chemical Products
 - 2. "Crown Cold Galvanizing Compound" – AERVOE
 - 3. "Clearco Cold Galvanizing" - CLEARCO

3.08 ADJUSTMENTS

- A. Adjust all gates and other moving parts for smooth and balance movement.

3.09 GENERAL CLEAN-UP:

- A. Clear entire site of all debris, scrap metals and debris resulting from the Work of this Section must be collected, removed from the site and disposed of legally.
- B. All work areas must be left in a broom clean condition.

3.10 FENCE REMOVAL

- A. The Contractor shall remove the existing chain link fence, gates, fence posts, post anchors, and concrete footings as indicated in the plans and dispose of them in a manner approved by the Commissioner. Salvaged material shall be delivered to a location on the Airport as

directed by the Commissioner.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Type A (10 feet high), Type B (8 feet high), Type C (6 feet high) and Type D fences will be measured in lineal feet along the centerline of fence. Electrical grounding, installation of vegetation free zone (where shown in the Drawings), weed control, and installation of AOA warning signs will not be measured separately, but will be considered included in the cost of fence installation of the various types of fences and no additional compensation will be allowed.
- B. Driveway Gates/Cantilever Slide Gate will be measured per each.
- C. Borrow material for fill must be furnished by the Contractor. Backfill material and compaction will not be measured separately but will be considered included in the work.
- D. Weed control will not be measured separately but will be considered included in the work.
- E. Cantilever slide gate operators will be measured for payment per each.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Type A (10 feet high), Type B (8 feet high), Type C (6 feet high), and Type D fence will be paid at the Contract unit price per lineal feet of fence installed and accepted by the Commissioner. Electrical grounding and installation of vegetation free zone (where shown in the Drawings) and weed control will be considered included in the cost of fence installation of the various types of fences and no additional compensation will be allowed.
- B. Driveway Gates/Cantilever Slide Gate will be paid at the Contract unit price per each gate installed and accepted by the Commissioner.
- C. All unit prices will be full compensation for all tools, labor (including preparation, excavation, backfilling, materials, equipment, and all work necessary to complete this item as shown on the Plans and specified herein.
- D. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
F-162-01	TYPE A FENCE (10')	LF
F-162-02	TYPE D FENCE (10')	LF
F-162-03	TYPE D FENCE ON CONCRETE BARRIER (10')	LF
F-162-04	DRIVEWAY GATES/CANTILEVER-SLIDE GATE AND OPERATOR, COMPLETE – 18' OPENING	EA

END OF SECTION F-162

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MARKER LIGHT BASES, LIGHTING FIXTURES, AND
GUIDANCE SIGNS
SECTION L-100

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item consists of furnishing all labor, equipment and material, and performing all operations in accordance with the latest FAA standards, Advisory Circulars, and Engineering Briefs to install and connect taxiway edge lights, light bases, and guidance signs and bases at the locations shown on the Drawings. The work under this Section is subject to the requirements of the Contract Documents.
- B. Where shown on the Drawings, the scope of this item includes, but is not limited to, the following:
 - 1. Constructing, furnishing, installing, and making operational new Type 1 Marker Light Bases with L-861T – LED (L) taxiway elevated edge light fixture with blue lens complete with accessories as shown on the Drawings and as specified in this Specification. Fixtures shall be furnished by CDA and installed by Contractor.
 - 2. Furnishing, installing, and making operational new L-861T - LED (L) taxiway elevated edge light fixture on Existing Type 1 Marker Light Bases with blue lens complete with accessories as shown on the Drawings and as specified in this Specification. Fixtures shall be furnished by CDA and installed by Contractor.
 - 3. Furnishing, installing, and making operational new L-852T - LED (L) taxiway in-pavement edge light fixture on Existing in-pavement Light Bases with blue lens complete with accessories as shown on the Drawings and as specified in this Specification. Fixtures shall be furnished by CDA and installed by Contractor.
 - 4. Constructing, furnishing, installing, and making operational new Concrete Light Bases - Special L-861T - LED (L) taxiway elevated edge light fixture with orange or blue lens complete with accessories as shown on the Drawings and as specified in this Specification. Fixtures shall be furnished by CDA and installed by Contractor.
 - 5. Constructing, furnishing, installing, and making operational new Concrete Light Bases - Special L-861T - LED (L) taxiway elevated edge light fixture with or blue lens on a Cored light

base in existing pavement, complete with accessories as shown on the Drawings and as specified in this Specification. Fixtures shall be furnished by CDA and installed by Contractor.

6. Constructing, furnishing, installing, and making operational new guidance signs and new runway distance remaining signs with new bases with L-858Y/R/L/B - LED (L) airfield guidance signs complete with accessories as shown on the Drawings and as specified in this Specification. Sign housings and sign panels shall be furnished by CDA and installed by Contractor.
 7. Furnishing and installing new amber lens complete on existing taxiway in-pavement edge light fixtures. Removal of existing blue lens complete from existing fixture where shown on the Drawings and as specified in this Specification.
 8. Salvage and deliver to the Chicago Department of Aviation existing signs, light fixtures, and lamps removed within the Project area shown on the Drawings or as directed by the Commissioner. Properly dispose of any/all used transformers removed within the Project Area.
- C. Accessories for Type 1 marker light bases will include but not limited to: base cans, conduit hubs, isolation transformers, ground rods, miscellaneous fixture mounting and grounding hardware, elevated R/W or T/W fixtures, lamps, handhole frame and cover, concrete and reinforcement, drain hubs and pipes, French drains where shown, identification tags and other items shown on the Drawings. Cost for these items is included in the unit price for the respective L-100 pay item.
- D. Accessories for elevated light fixtures will include but not limited to: isolation transformers, miscellaneous cover mounting and grounding hardware, identification tags and other items shown on the Drawings. Cost for these items is included in the unit price for the respective L-100 pay item.

- E. Accessories for guidance signs will include but not limited to: L-867 base can with threaded hubs, conduit hubs, non-metallic chair, stainless steel clip-on cover, ground rods, connectors, power leg conduit, blank steel cover, exterior metallic frame and interior lamps, electrical connections, miscellaneous sign mounting and grounding hardware, concrete foundation and reinforcement, drain hubs and pipes, French drains where shown, identification tags and other items shown on the Drawings. Cost for these items is included in the unit price for the respective L-100 pay item.

PART 2 EQUIPMENT AND MATERIALS

2.01 GENERAL

- A. Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) equipment Specifications must have the prior approval of the Office of Airport Safety and Standards, Attention: AAS-200, FAA, 800 Independence Avenue SW, Washington, DC 20591, and will be listed in the latest issue of FAA Advisory Circular (AC) 150/5345-53 (latest revision), "Airport Lighting Equipment Certification Program, including Appendices 1 to 7, with current Addendum for Appendices 1, 3 & 4. Light sources other than incandescent and xenon technologies subject to certification under AC 150/5345-53 (latest revision) and other documents, will be subject to the additional requirements of Engineering Brief No. 67 (latest revision) *Light Sources Other Than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures*. Materials covered by other reference Specifications will be subject to acceptance through manufacturer's certification of compliance with the applicable Specifications, determined by a Third Party Certifier when so requested by the Commissioner.
- B. The certified equipment list and address list of certified airport lighting equipment manufacturers are available on the Internet at the FAA Office of the Associate Administrator for Airports (ARP) home page. The direct Internet FAA home page is www.faa.gov.
- C. This equipment must have series circuit lamps. Elevated fixture height must be 24 inches except for L-862 HIRL fixtures installed on 200' wide runways where the fixture height must be 30 inches.
- D. For 200 feet wide runways only, the elevated runway edge lights with L-862 HIRL fixtures must be supplied with 2 inch heavy duty frangible couplings (that must resist a moment of 350-450 ft. lbs. and separate cleanly before reaching 500 ft. lbs.) and a matching L-867 fixture base plate with 2 inch threaded opening. Coupling fixture stem inside

diameter to be 1.2 inches. Frangible coupling and its installation must conform to AC 150/5345-66 (latest revision). Frangible coupling to be manufactured by Crouse Hinds, ADB Airfield Solutions, or Airport Lighting Company in aviation yellow.

2.02 LIGHTING FIXTURES

- A. Use FAA Specification L-852T - LED (L) for taxiway in-pavement edge lights. These lights must have blue lenses, 5 watt LED, 6.6 amp as manufactured by ADB Airfield Solutions. The LED fixtures must be equipped with the arctic kit option. Fixtures shall be provided by CDA and installed by Contractor.
- B. Use FAA Specification L-861T – LED (L) for taxiway elevated medium intensity edge lights. These lights must have blue lenses, 7 watt LED, 6.6 amp ADB LED (model L-861T (L) / ETES – L) as manufactured by ADB Airfield Solutions. The LED fixtures must be equipped with the arctic kit option. Fixtures shall be provided by CDA and installed by Contractor.
- C. The wattage for the LED fixture refers to the lamp only. The arctic kit option will add to the total power requirement for the LED fixture and required isolation transformer selection.
- D. For all elevated runway and taxiway light fixtures, the light base plate must be provided with a frangible fitting and electrical disconnect at the L-867 base can per the OMP Standard Drawings; meeting the requirements of the FAA AC 150/5345-46 (latest revision), *Specification for Runway and Taxiway Light Fixtures*; AC 150/5345-47 (latest revision), *Specification for Series to Series Isolation Transformers for Airport Lighting Systems* and; AC 150/5345-26 (latest revision), *FAA Specification for L-823 Plug and Receptacle, Cable Connectors*.
- E. All light fixtures must be bonded to the light base internal ground lug via a #6 AWG standard copper wire rated for 600 volts with green XHHW insulation or a braided ground strap of equivalent current rating in accordance with AC150/5340-30 (latest edition). The ground wire length must be sufficient to allow the removal of the light fixture from the light base for maintenance. Refer to the light manufacturer's instruction for proper methods of attaching the bonding wire.

2.03 ISOLATION TRANSFORMERS

- A. The isolation transformers for runway and taxiway lighting and signs must conform to the requirements of AC 150/5345-47 (latest revision),

"Specification for Series to Series Isolation Transformers for Airport Lighting Systems".

- B. The installation of the isolation transformers must conform to the applicable requirements of the FAA Specifications and as shown on the Drawings.

2.04 SIGNS

- A. The guidance signs must be as specified in AC 150/5340-18 (latest revision) "Standards for Airport Sign Systems" and AC 150/5345-44 (latest revision), "Specification for Taxiway and Runway Signs". The guidance signs for this Project must be FAA Specification L-858 (with LED Lighting System), Size 3, up to a maximum of four modules. For a sign array, requiring more than 4 modules, the extra module(s) must be installed separately adjacent to the 4 modules and must be powered from a separate isolation transformer installed at the other end of the foundation slab as shown on the Drawings. Connect the two isolation transformer base cans with a concrete encased 2" PVC Sch 40 conduit for the power cabling.
- B. The Airport signs must be mounted according to the manufacturer's directions and as shown in the Drawings. The signs must be provided with frangible fittings and electrical disconnect at the L-867 base plate per the OMP Standard Drawing, meeting the requirements of FAA AC 150/5345-44 (latest revision), *Specification for Taxiway and Runway Signs*; AC 150/5345-47 (latest revision), *Specification for Series to Series Isolation Transformers for Airport Lighting Systems*; and AC 150/5345-26 (latest revision) *FAA Specification for L-823 Plug and Receptacle, Cable Connectors*. Signs must be provided with non-corrosive tethers.
- C. Signs must be wired to edge light circuits indicated on the Drawings.
- D. All sign lamps to be LED.
- E. Guidance Signs
 - 1. Airfield guidance signs must be Lumacurve by Standard Signs, Inc. Mode 3 signs at runway exits must be Lumacurve system by Standard Signs to provide blow over protection from jet blast.
 - 2. For runways and parallel taxiway applications, Mode 3 signs to have 4 bolt mounting flange anchored with 1/2-inch bolts.
 - 3. All guidance signs must have LED lighting system.
 - 4. Sign housings and panels shall be provided by CDA and

installed by Contractor.

- F. Taxiway mandatory hold signs are to be installed and located in line with the pavement holding position markings in accordance with AC 150/5340-18, with the following exception: At ORD the tolerance of +/- 10 feet (3m) that is listed in AC 150-5340-18, paragraph 14.e, regarding the positioning of taxiway mandatory hold signs relative to pavement holding position markings will NOT BE ALLOWED. Mandatory hold signs must be equipped with backup lamps.
- G. In a sign array consisting of multiple individual signs, AC 150/5345-44 requires that there be no above ground electrical connection between signs in an array. For this arrangement, an additional, separate L-867 base can must be installed with 2" interconnecting PVC duct, base plate and sign cord disconnect, to provide underground wiring required.
- H. All signage placards shall be provided by CDA.
- I. The Contractor must install a spare 2" RGS conduit from the base can and stub this conduit with cap above the sign concrete pad at the center of sign module (typical).

2.05 LIGHT BASE

- A. Light bases must conform to the requirements of AC 150/5345-42G, "Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories", except that they must be Class 1A, metallic 12-inch or 16-inch diameter, Type L-867 or L-868 as shown on the Drawings and must be listed in AC 150/5345-53 (latest revision) addendum. All light bases must be provided with factory installed ground lugs, one external lug for grounding and one internal lug for light fixture bonding. The 16-inch base cans for use by and in the jurisdiction of the FAA must be verified with FAA if they will be stainless steel Class 1 B, which is preferred by the FAA for its facilities.
- B. Installation of spacers, extension ring, dam or mud rings, and other base can accessories must conform strictly to the requirements of AC 150/5345-42 (latest edition) or as indicated on the Drawings. The base can must be set precisely to the proper grade, level, and orientation to minimize the use of excessive number of spacers and shims or long bolts.
- C. Acceptable manufacturers for light bases and accessories are Jacquith Industries, Inc., Olson Industries, Inc., Airport Lighting Equipment, and

other certified manufacturers listed in the current AC 150/5345-53 (latest revision) addendum.

2.06 BOLTS FOR BASE CAN AND ACCESSORIES

- A. SAE Grade 5 carbon steel bolts with anti-seize compound must be used to secure light fixtures to L-868 and L-867 light bases with 2 part locking washers in accordance with FAA Engineering Brief No. 83 "In-Pavement Light Fixture Bolts" issued June 28, 2010.
- B. Installation and torquing of the bolts must be in conformance with the FAA Engineering Brief No. 83 and must follow the recommended industry best practices for installing and torquing bolts.

2.07 CONCRETE

- A. Concrete required for the construction of bases and other work under this item must conform to the requirements of Section P-610 Structural Portland Cement Concrete, using $\frac{3}{4}$ inch maximum size aggregate.

2.08 GROUND RODS

- A. Ground rods must be Type 304 stainless steel, 10 feet long and $\frac{3}{4}$ inch diameter unless otherwise shown on the Contract Drawings.

2.09 PAINT

- A. The paint must meet the requirements of Federal Specification TT-P-1952. The paint must be yellow without reflective media.

2.10 FRAMES AND COVERS

- A. Handhole frame and covers for Type I Marker light bases are based on Neenah Foundry No. R3495 labeled on casting "Airfield Lighting".
Acceptable manufacturers are:
 - 1. Neenah Foundry Company
 - 2. East Jordan Iron Works, Inc.
 - 3. Campbell Foundry
- B. The castings must conform to the following requirements:
 - 1. Gray iron castings must meet the requirements of ASTM A 48.
 - 2. Malleable iron castings must meet the requirements of ASTM A 47.
 - 3. Ductile iron castings must conform to the requirements of

ASTM A 536.

4. Austempered ductile iron castings must conform to the requirements of ASTM A 897.
5. All castings must conform to the dimensions shown on the Contract Drawings and must be designed to support the loading specified.
6. Each frame and cover must be provided with fastening members to prevent it from being dislodged by traffic, but which must allow easy removal for access to the structure.
7. Frames and covers must be rated for a live load of 100,000 pounds.

2.11 IDENTIFICATION NUMBERS FOR EDGE LIGHTS AND GUIDANCE SIGNS

- A. Identification numbers for each light and sign will be as directed by the Commissioner, and will be provided to the Contractor during construction.
- B. Identification numbers for edge lights and guidance signs must be permanently engraved or cut in a phenolic or nonmetallic disc or plate not less than two (2) inches in diameter or square. The disc or plate must be fastened to the base cover by the regular hold down bolts or by at least two metal screws of rust-proof material. Plate must not be fastened to fixture cover.

2.12 EPOXY CONCRETE BONDING ADHESIVE

- A. The epoxy concrete bonding adhesive between old and new concrete must conform to ASTM C881, Type IV, Grade 1, Class A, B, or C and must meet the approval of the Commissioner. The class supplied must be governed by the range of temperature for which the material is to be used.

2.13 ANTI-SEIZE COMPOUND

- A. Where required, anti-seize compounds must meet the requirements of MIL-A-907E, have a temperature range from at least -65 degrees F to +180 degrees F, be compatible with the various metals being united, and not affected by deicing agents. The light fixture manufacturer must furnish the proper torque values in their installation manual with the type of anti-seize compound that must be used.
- B. Anti-seize compound must not be used on fluoropolymer ceramic-metallic coated bolts.

2.14 POLYMER PATCHING MORTAR

- A. Patching mortar installed around in-pavement light fixtures must be a three component, 100% solids, multi-purpose, high strength, non-shrink, waterproof, non-conductive, and semi-flexible polymer patching mortar for longer lasting patches with excellent workability. The system must combine a high quality polymer resin and curing agent with an engineered blend of added aggregates.
- B. Acceptable products are SSI Flexpatch by Silicone Specialties, Inc. (www.ssicm.com) and equivalent products conforming to 2.14 A above and meeting the approval of the Commissioner. Application and installation of the product must be in accordance with the manufacturer's procedures and instructions.

2.15 DRAIN PIPES FOR LIGHT BASE CANS AND MARKER LIGHT BASES

- A. PVC drain pipes must be Schedule 80 complying with ASTM D1785. The conduit must be manufactured from PVC compound that meet the applicable requirements of ASTM D1784. Standard fittings and cement must be obtained from the same conduit manufactures.
- B. Acceptable PVC pipe manufacturers are Carlon, J-M, National Pipe, or Georgia Pipe.

PART 3 CONSTRUCTION

3.01 GENERAL

- A. The work being performed under this item of these Specifications must conform to the Chicago Electrical Code and the National Electrical Code. The electrical systems must be complete with all necessary accessories for the required results with the greatest assurance of protection to life and property.
- B. The Plans indicate the extent and general arrangement of the electrical work. If any departures from the Drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore will be submitted in writing as soon as practicable to the Commissioner for approval. No such departures will be made without the prior written approval from the Commissioner.

3.02 UNCLASSIFIED EXCAVATION

- A. Unclassified excavation must be in accordance with these Specifications.

- B. The Contractor must excavate for the light bases and the structure to the lines and grades or elevation, shown on the Drawings, or as directed by the Commissioner. The excavation must be of sufficient size to permit the placing of the full width and length for the structure. The elevations of the bottoms of structures, as shown on the Plans, must be considered as approximate only; and the Commissioner may order in writing changes in dimensions or elevations of structure necessary to secure a satisfactory foundation.
- C. Boulders, logs, or any other objectionable material encountered in excavation must be removed and must be disposed off the Airport property. These removals will be considered included in the unit price for the lighting structure pay items of this Specification. When concrete is to rest on a surface other than rock, special care must be taken not to disturb the bottom of the excavation, and excavation to final grade must not be made until just before the concrete or reinforcing is to be placed.
- D. The Contractor must do all bracing, sheathing, or shoring necessary to implement and protect the excavation and the structures as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring must be included in the unit price for the lighting structure pay item.
- E. Unless otherwise provided, bracing, sheathing, or shoring involved in the construction of this item will be removed by the Contractor after the completion of the structure. Removal must be performed in a manner which will not disturb or mar finished masonry. The cost of removal will be included in the unit price for the lighting structure pay item. The Contractor must place concrete and reinforcing steel only after the Commissioner has approved the depth of the excavation and the character of the foundation material.

3.03 CONCRETE STRUCTURES

- A. Concrete structures must be built on prepared foundations, conforming to the dimensions and form indicated on the Drawings. The construction must conform to the requirements specified in Section P-610 Structural Portland Cement Concrete. Any reinforcement required must be placed as indicated on the Plans and must receive approval by the Commissioner before the concrete is placed.

3.04 PLACEMENT AND TREATMENT OF CASTINGS, FRAMES AND FITTINGS

- A. Castings, frames and fittings must be placed in the position indicated on the Drawings or as directed by the Commissioner, and must be set

true to line and to correct elevation. If frames or fittings are to be set in concrete or cement mortar, anchors or bolts must be in place and position before the concrete or mortar is placed. The unit must be brought true to line and grade and must be set in mortar beds and anchored to the masonry as indicated on the Drawings or as directed and approved by the Commissioner. All units must set firm and secure.

- B. After the frames or fittings have been set in final position and the concrete or mortar has been allowed to harden for 7 days, then the grates or covers must be placed and fastened down.

3.05 BACKFILLING

- A. After the structure has been completed, the area around it will be backfilled in accordance with this Specification. Backfilling must not be placed against any structure until permission is given by the Commissioner. In the case of concrete, such permission will not be given until the concrete has been in place a minimum of seven (7) days or until tests made by the Contractor's QC organization and tested by the Contractor's approved laboratory, subject to verification by the laboratory under supervision of the Commissioner establish that the concrete has attained sufficient strength to provide a factor of safety against damage in withstanding any pressure created by the backfill or the methods used in placing it.
- B. All trenches and excavations must be backfilled within a reasonable time after the structures are installed, unless other protection of the structures is directed. The backfill material must be as specified herein. Backfill materials and compaction procedures must be acceptable to the Commissioner. In all backfilling, any compressible or destructible rubbish and refuse must be removed from the excavated space before backfilling is started.
- C. Fine aggregate for backfill must be brought up evenly on each side of the structure. If the excavation is to be under pavement, or within 2 feet of the proposed, future or existing pavement edge, then placement and compaction of the fine aggregate backfill must continue until the top of subgrade is reached. If the excavation is not under, or adjacent to, existing, proposed or future pavement, then acceptable fill must be placed and compacted to top of subgrade.
- D. Fine aggregate for backfill must consist of natural sand or washed crushed limestone having a FA-6 gradation conforming to Section 1003 of the Standard Specifications for Road and Bridge Construction, Illinois Department of Transportation. Acceptable fill for backfill is defined as suitable unclassified excavation material that is non-

organic, non-decayable and non-rubble material having a maximum dry density of not less than 98 pounds per cubic foot. It will contain no rock, stones, or broken concrete greater than 3 inches in the largest dimension. The material must be easily compactable to the required density and approved by the Commissioner.

- E. If the backfill is fine aggregate backfill, it must be placed in uniform layers not greater than 8 inches in loose thickness and thoroughly compacted in place with suitable vibratory equipment to not less than 95% of the maximum density as determined by ASTM D-1557. Each lift of Acceptable Fill must be within +/-2% of optimum moisture content before the succeeding lift is placed. If the backfill is acceptable fill it must be placed in uniform layers not greater than 12 inches in loose thickness and each layer compacted to 85% of maximum density as determined by ASTM D 1557.
- F. Finish grading must be performed in accordance with the completed contour elevations and grades shown and must be made to blend into the existing ground surfaces. All finished grading surfaces must be left smooth and free to drain. Finish grades must be brought to elevations within plus or minus 0.10 foot of elevations or contours shown.
- G. Any depression which may develop from settlement in backfilled areas within 1 year after the work is fully completed and accepted must be the responsibility of the Contractor. The Contractor must provide as needed, at his own expense, additional backfill material, pavement, base replacement, permanent pavement repairs or replacement and must perform the necessary reconditioning and restoration work to bring such depressed areas to proper grade as acceptable to the Commissioner.
- H. Backfill compaction must be tested and monitored by the Contractor. All material and backfill operations may be subjected to testing by the Commissioner with the assistance of the Contractor.
- I. Backfill will not be measured for direct payment. Performance of this work will be considered as a subsidiary obligation of the Contractor covered under the Contract unit price for the structure involved.
- J. The suitability of compacting equipment must be acceptable to the Commissioner. Tamping rollers (generally referred to as Sheepfoot Rollers) will be considered the proper type of equipment for compaction of cohesive soils and vibratory/mechanical tamping equipment will be applicable for compacting granular soils. In all cases, the adequacy of the equipment will be determined by the Commissioner.

3.06 CLEANING AND RESTORATION OF THE SITE

- A. After the backfill is completed, the Contractor must dispose of all surplus material, soil, and rubbish from the site. Surplus soil may be deposited in embankments, shoulders, or as ordered by the Commissioner. The Contractor must restore all disturbed areas to their original condition.
- B. After all work is completed, the Contractor must remove all tools and equipment, leaving the entire site free, clear, and in good condition.

3.07 OTHER ELECTRICAL WORK

- A. All other electrical work required under this item of these Specification must be installed in accordance with the Chicago Electrical Code and the National Electrical Code.

3.08 REMOVAL OF EXISTING STRUCTURES

- A. If shown on the Drawings, remove certain light bases in the existing electrical system as indicated. Dispose of or deliver salvaged light bases to the Commissioner as directed by the Commissioner.

3.09 PAINTING

- A. The exposed surface of Type 1 marker light bases must be painted with two (2) coats of aviation yellow paint. The painting must be performed only when the existing surface is dry and clean, when the atmospheric temperature is above 40 degrees F, and when the weather forecast is for dry weather.

3.10 LIGHTING FIXTURES

- A. The installation of lighting units must be as directed by the manufacturer. After each light unit is completely installed, the void between and around the top of the light fixture flange ring and the pavement must be filled with a polymer patching mortar.

3.11 APPLICATION OF EPOXY CONCRETE BONDING ADHESIVE

- A. Where shown on the Drawings the epoxy concrete bonding adhesive must be uniformly applied to coat the entire surface of the concrete remaining in place prior to placement of the new concrete.

3.12 NEW BASES

- A. The light and sign bases must be installed where indicated on the Contract Drawings.
- B. The installation of the light and sign base units must be in accordance with the manufacturer's installation instructions and the FAA installation requirements and as directed by the Commissioner.
- C. The light and sign bases must be installed as detailed on the Drawings.

3.13 DRAIN PIPES AND HUBS FOR LIGHT BASE CANS AND MARKER LIGHTS BASES

- A. The drain pipes and hubs must be installed where indicated on the Contract Drawings.
- B. The drain pipes and hubs must be installed as detailed on the Drawings.

3.14 TESTING

- A. The Contractor must accomplish operational testing of the lighting fixtures and circuits after cable testing described in Specification Section L-108 Installation of Underground Cable for Airports, paragraph 3.10 and 3.11 to ensure compliance with the Contract documents. The Commissioner will witness all testing. The Contractor must furnish all meters, instruments, cable connections, equipment or apparatus necessary for performing and recording the results of all tests.
- B. Upon completion of the electrical work and cable testing, the Contractor must energize each of the affected circuits under this Contract, and:
 - 1. Demonstrate that each lighting fixture and guidance sign is operational and is connected to the designated circuit.
 - 2. Test the power and control of electrical circuits for continuity and function from both the control tower and the airfield lighting vault.
 - 3. Show and verify in writing that the systems and equipment are free from all defects.
- C. Any wiring device, electrical apparatus, or lighting fixture grounded or shorted on any integral "live" part, must be removed and the trouble rectified by replacing the defective parts or materials.

- D. Tests must be coordinated with the field schedule and field conditions. Before testing, all necessary precautions must be taken to ensure the safety of personnel and equipment. All enclosures for conductors and equipment must be properly grounded.
- E. The Commissioner will conduct from time to time such tests as may be required to any part of the equipment to determine if it is installed in accordance with these Specifications. The Contractor must extend to the Commissioner all facilities to this end and must furnish the skilled or unskilled help required. Three copies of the verified test results must be given to the Commissioner promptly upon completion of a test.
- F. The Contractor must provide assistance to the various Equipment Manufacturers' field engineers as required in the testing and adjusting of the electrical power and control equipment. Cooperation of the Contractor must be such that a minimum of time is required for equipment testing.
- G. A log must be maintained for all tests. This log must be certified before completion of the job, both as to test value and date of test.
- H. Any faults in the work performed by the Contractor or in materials or equipment furnished by the Contractor must be corrected or replaced promptly by the Contractor at his own expense. Any faults in materials or equipment furnished by the Contractor which are the result of careless, incompetent or improper workmanship must be repaired and the work retested.

PART 4 METHOD OF MEASUREMENT

4.01 MARKER LIGHT BASES AND FIXTURES

- A. Lighting-Taxiway Type 1 Marker Light Base with L-861T – LED (L) Elevated Edge Light, Complete: The quantity of Type 1 marker light bases with FAA Spec. L-861T – LED (L) taxiway elevated light fixtures to be paid for will be the number complete, connected, tested, ready for operation, and accepted. This item includes an L-867 base can, excavation, conduit and drain hubs, drain pipe, ground rod, 20/25 watt isolation transformer, concrete, handhole frame and cover, hardware, and 7 W LED lamp for the fixture. Fixture to include arctic kit. Total load with arctic option per fixture is 25 watts. No separate measurement will be made for these individual items and accessories, but will be considered included in the unit price for this pay item. Fixtures shall be provided by CDA and installed by Contractor.

- B. Lighting-Taxiway L-861T – LED (L) Elevated Edge Light on Existing Type 1 Marker Light Base, Complete: The quantity of FAA Spec. L-861T – LED (L) taxiway elevated light fixtures to be paid for will be the number complete, connected, tested, ready for operation, and accepted. This item includes base can cover with appertance for fixture stem, 20/25 watt isolation transformer, 7 W LED lamp for the fixture, internal grounding conductor and hardware. Fixture to include arctic kit. Total load with arctic option per fixture is 25 watts. No separate measurement will be made for these individual items and accessories, but will be considered included in the unit price for this pay item. Fixtures shall be provided by CDA and installed by Contractor.
- C. Lighting-Taxiway, L-852T - LED (L) In-Pavement Edge Light on Existing in-pavement Lighting Base, Complete: The quantity of L-852T – LED (L) taxiway in-pavement light fixtures to be paid for will be the number complete, connected, tested, ready for operation, and accepted by the Commissioner. This item includes 30/45 watt isolation transformer, 5W LED lamp for the blue omni-directional fixture, internal grounding conductor and hardware. Fixture to include arctic kit. No separate measurement will be made for these individual items and accessories, but will be considered included in the unit price for this pay item. Fixtures shall be provided by CDA and installed by Contractor.
- D. Lighting-Taxiway L-861T – LED (L) Elevated Edge Light on Concrete Light Base -Special, Complete: The quantity of FAA Spec. L-861T – LED (L) taxiway elevated light fixtures to be paid for will be the number complete, connected, tested, ready for operation, and accepted. This item includes L-867 base can, excavation, conduit and drain hubs, drain pipe, ground rod, base can cover with appertance for fixture stem, 20/25 watt isolation transformer, 7 W LED lamp for the fixture, internal grounding conductor and hardware. Fixture to include arctic kit. Total load with arctic option per fixture is 25 watts. No separate measurement will be made for these individual items and accessories, but will be considered included in the unit price for this pay item. Fixtures shall be provided by CDA and installed by Contractor.
- E. Lighting-Taxiway L-861T – LED (L) Elevated Edge Light on Cored Concrete Light Base -Special, Complete: The quantity of FAA Spec. L-861T – LED (L) taxiway elevated light fixtures to be paid for will be the number complete, connected, tested, ready for operation, and accepted. This item includes L-867 base can, coring, excavation, conduit and drain hubs, drain pipe, ground rod, base can cover with appertance for fixture stem, 20/25 watt isolation transformer, 7 W LED lamp for the fixture, internal grounding conductor and hardware.

Fixture to include arctic kit. Total load with arctic option per fixture is 25 watts. No separate measurement will be made for these individual items and accessories, but will be considered included in the unit price for this pay item. Fixtures shall be provided by CDA and installed by Contractor

4.02 GUIDANCE SIGN AND BASE

- A. New L-858 Guidance Sign with New Base, 1 or 2 or 3 or 4 Module, Size 3, Complete: The quantity of guidance signs and bases to be paid for will be the number of each type guidance sign complete, connected, tested, ready for operations, and accepted. This Item consists of a concrete base, L-867 light base; a one, two, three, or four Module, Size 3 sign; transformer, ground rod, and hardware. No separate measurement will be made for excavation, drain pipe, ground rods, light fixtures, transformers, or any miscellaneous hardware, but will be considered included in the unit price for the guidance sign and base. Sign panels shall be provided by CDA and installed by Contractor.

4.03 DRAIN PIPES FOR LIGHT BASE CANS AND MARKER LIGHT BASES:

- A. The drain pipe or hub and French drain as applicable per details shown on the Drawings will not be measured separately, but shall be included in the line item unit price per each for marker light base, lighting fixture, and guidance sign in place, completed, and accepted.

PART 5 BASIS OF PAYMENT

5.01 BASES AND FIXTURES

- A. Payment will be made at the Contract unit price for each complete runway and taxiway light base with light fixtures, all installed in place by the Contractor and accepted by the Commissioner. The price will be full compensation for furnishing all materials; for all preparation, assembly and installation; and for labor, equipment, tools, accessories, light bases, and all work necessary to complete these units as required by these Specifications, and/or as shown on the Drawings.

5.02 GUIDANCE SIGNS AND BASES

- A. Payment will be made at the Contract unit price for each complete Remove Guidance Sign and Base, for each complete New Panels on Existing or Relocated Signs, for each Remove and Relocate Guidance Sign with New Base, and for each complete New Guidance Sign with New Base, 4 Module, installed in place by the Contractor and

accepted by the Commissioner. The prices will be full compensation for furnishing all materials; for all preparation, assembly and installation; and for labor, equipment, tools, accessories for light bases, and all work necessary to complete these units as required by these Specifications, and/or as shown on the Drawings.

5.03 DRAIN PIPES FOR LIGHT BASE CANS AND MARKER LIGHT BASES

- A. Payment for the furnishing and installation of drain pipes or hubs and French drains (materials and preparation, excavation, installation of drain pipe including clip-on drain covers and screens, backfilling; and for all labor, equipment, tools, and all work necessary to complete the item) will not be made separately, but will be included as included in the Contract unit price per each marker light base, lighting fixture, and guidance sign.

5.04 PAYMENT

- A. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
L-100-01	LIGHTING – TAXIWAY, TYPE 1 MARKER LIGHT BASE WITH L-861T LED (L) ELEVATED EDGE LIGHT, COMPLETE	EA
L-100-02	LIGHTING – TAXIWAY, L-861T LED (L) ELEVATED EDGE LIGHT ON EXISTING TYPE 1 MARKER LIGHT BASE, COMPLETE	EA
L-100-03	LIGHTING – TAXIWAY L-852T – LED (L) IN-PAVEMENT EDGE LIGHT ON EXISTING LIGHT BASE, COMPLETE	EA
L-100-04	LIGHTING SYSTEMS – NEW L-858 – LED (L) GUIDANCE SIGN WITH NEW BASE, 4 MODULE(S), SIZE 3, COMPLETE	EA
L-100-05	LIGHTING – TAXIWAY, L-861T LED (L) ELEVATED EDGE LIGHT ON CONCRETE LIGHT BASE – SPECIAL, COMPLETE	EA
L-100-06	LIGHTING – TAXIWAY, L-861T LED (L) ELEVATED EDGE LIGHT ON CORED CONCRETE LIGHT BASE – SPECIAL, COMPLETE	EA
L-100-07	LIGHTING – TAXIWAY, AMBER LENS REPLACEMENT ON ELEVATED EDGE LIGHT	EA

END OF SECTION L-100

INSTALLATION OF UNDERGROUND CABLE FOR AIRPORTS

SECTION L-108

PART 1 DESCRIPTION

1.01 GENERAL

- A. The work consists of furnishing and installing underground cable in accordance with these Specifications at the locations shown in the Drawings. This item includes the installation of airfield lighting and power cables. It includes cable connections, splicing, tagging, cable marking, and testing of the installation and all work necessary to place the cable in operating condition as a completed unit to the satisfaction of the Commissioner. The work under this Section is subject to the requirements of the Contract Documents.

PART 2 EQUIPMENT AND MATERIALS

2.01 GENERAL

- A. Airport underground cables covered by Federal Aviation Administration (FAA) Specifications must have the prior approval of the FAA, and are described in Advisory Circular (AC) 150/5345-7 (latest revision), "Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits" and must be listed in the latest issue of FAA Advisory Circular (AC) 150/5345-53 "Airport Lighting Equipment Certification Program", Appendix 3 and 4 Addendum.
- B. All other equipment and materials covered by other referenced Specifications will be subject to acceptance through manufacturer's certification of compliance with the applicable Specification, when requested by the Commissioner.
- C. All materials and equipment used to construct this item must be submitted to the Commissioner for approval prior to ordering the materials and equipment. Submittals consisting of marked catalog sheets or shop drawings must be provided. Submittal data must be presented in a clear, precise, and thorough manner. Manufacturer's certifications will not relieve the Contractor of his responsibility to provide materials in accordance with these Specifications and acceptable to the Commissioner. Materials supplied and/or installed that do not materially comply with these Specifications must be removed, when directed by the Commissioner, and replaced with materials that comply with these Specifications, at the sole cost of the Contractor.

- D. All equipment and materials furnished and installed under this Section must be guaranteed against defects in materials and workmanship for a period of at least 12 months from final acceptance by the Commissioner. The defective materials and/or equipment must be repaired or replaced, at the Commissioner's discretion at the sole cost of the Contractor. The Contractor must be responsible to maintain the required insulation resistance with isolation transformers connected in new circuits and new segments of existing circuits through the end of the Contract warranty period.

2.02 SERIES AIRFIELD LIGHTING CABLE, COUNTERPOISE, GUARD WIRE AND GROUNDING CONDUCTORS

- A. Runway and taxiway series lighting cables must be 5,000 volt (5KV) MV-90 cross-linked polyethylene (XLPE) insulated and must conform to the requirements of AC 150/5345-7 (latest revision), L-824 Type C, 5KV, size 6 AWG copper, 7 strand, single conductor cable and as indicated in the Contract Drawings. Cables must have a conductor stress relief shield, in accordance with Section 3 of the Insulated Cable Engineers Association Inc, ICEA S-96-659/NEMA WC71 as referenced in AC 150/5345-7 (latest revision). Acceptable manufacturer of this type of cable are Draka Cableteq USA; Prysmian Power Cables and Systems USA, LLC; South Wire Company; and Coleman Cable, Inc.; or other manufacturers approved by FAA and listed in the current AC150/5345-53 Appendix 3 Addendum.
- B. All CED electrical ductbanks must be provided with lightning protection, either with counterpoise conductor or FAA guard wire conductor, depending on the cables installed in the ductbank. Ductbanks containing FAA copper cables must be provided with FAA guard wire, all other ductbanks must be provided with counterpoise only.
- C. Airfield lighting counterpoise conductors installed underground must be soft drawn bare copper, size 6 AWG, solid, and must conform to the requirements of AC 150/5340-30 (latest revision), Chapter 12, Equipment and Material. Acceptable manufacturers of this type of wire are Draka Cableteq USA; Prysmian Power Cables and Systems USA, LLC; South Wire Company; and Coleman Cable, Inc.
- D. FAA airfield guard wire conductors installed underground must be soft drawn bare copper, 1/0 AWG, stranded, and must conform to the requirements of FAA standard-019e, Section 4.2.1.5 Equipment and Material. Acceptable manufacturers of this type of wire are Draka Cableteq USA; Prysmian Power Cables and Systems USA, LLC; South Wire Company; and Coleman Cable, Inc.

- E. Equipment grounding conductors installed within airfield lighting bases/ fixtures, grounding conductors installed underground in conduit or ductbank must be soft drawn copper, size 6 AWG, 7 strand, with a 45 mil minimum coating of Type XHHW green insulation for airfield lighting and shall conform to the requirements of AC 150/5340-30 (latest revision), Chapter 12, Equipment and Material. Acceptable manufacturers of this type of wire are Draka Cabletek USA; Prysmian Power Cables and Systems USA, LLC; South Wire Company; and Coleman Cable, Inc.;
- F. Equipment grounding conductors installed within manholes must be soft drawn copper, utilizing a grounding bus of 4/0 AWG bare stranded copper and size 2 AWG pigtails bare copper to bond all metal hardware within the structure. The equipment grounding conductor must be bonded to ¾" diameter, 10'-0" long stainless steel ground rod installed in each manhole. The Equipment Grounding System must conform to the requirements of AC 150/5370-10 (latest revision). Acceptable manufacturers of this type of wire are Draka Cabletek USA; Prysmian Power Cables and Systems USA, LLC; South Wire Company; and Coleman Cable, Inc. Ground bus, ground pigtails, and ground rods are included in the unit price of the L-115 electrical manhole pay items.
- G. Equipment grounding conductors installed within handholes must be soft drawn copper, utilizing a ground bus of 4/0 AWG stranded copper with 45 mil minimum coating of Type XHHW green insulation and size 2 AWG pigtails with a 45 mil minimum coating of Type XHHW green insulation to bond all metal hardware within the structure. The equipment grounding conductor must be bonded to ¾" diameter, 10'-0" long stainless steel ground rod installed in each handhole. The Equipment Grounding System must conform to the requirements of AC 150/5370-10 (latest revision). Acceptable manufacturers of this type of wire are Draka Cabletek USA; Prysmian Power Cables and Systems USA, LLC; South Wire Company; and Coleman Cable, Inc. Ground bus, ground pigtails, and ground rods are included in the unit price of the L-115 electrical handhole pay items.
- H. Samples and reports on the results of shop tests for all wire and cables and descriptive literature for cable connectors, splices and terminations must be submitted for review by the Commissioner prior to installation.
- I. The following wires and cables must be tested after installation but before final connections are made up: Service feeders, distribution feeders, branch circuit wiring and control wiring.

2.03 GROUND RODS

- A. Ground rods must be Type 304 solid stainless steel, ¾" diameter x 10'-0" long.

2.04 CABLE CONNECTIONS

- A. Cable connectors for series airfield lighting cables must be factory-molded or field attached plug-in connectors in accordance with the following. When the Plans or the proposal permit a choice of connection, the Contractor must indicate in the bid the type of connection that will be furnished.
 - 1. The Field-Attached Plug-in Splice: Figure 3 of AC 150/5345-26 (latest revision), "Specification for L-823 Plug and Receptacle, Cable Connectors," employing connector kits, is approved for field attachment to single conductor cables.
 - 2. The Factory-Molded Plug-in Splice: Specification for L-823 Connectors, Factory-Molded to individual conductors, is approved.
- B. Series circuit cable connectors for the connection of two single conductor wires to the secondary connector on the airfield lighting isolation transformer leads must be in accordance with FAA Specification L-823, Figure 2, of AC 150/5345-26 (latest revision).
- C. For CDA power circuit (non-airfield lighting 5 KV) cables at 600V – 7500V, splices and terminations must be made with compression type connectors and lugs that are U.L. listed and per the NEC. All lugs and connectors must be of the smooth conformable compression type suitable for use on 5 KV. Lugs must be two-hole, color-keyed for medium voltage requirements. Lug equipment and tools must be per the lug manufacturer's recommendations. All airfield splices must conform to appropriate FAA Advisory Circulars.
- D. For CDA power circuit cables at 0 - 600V, splices and terminations must be made with compression type connectors and lugs. Lugs must be 2 hole, color keyed. Lug bolting must include a flat washer, a Belleville washer, and a locknut. The lug manufacturer's recommended tools must be used. Indenter type compression fittings are not acceptable. All airfield splices must conform to appropriate FAA Advisory Circulars.
- E. Provide FAA approved electrical tape (Scotch Electrical Tape No. 88, 1 ½" wide; and Scotch 130C, 2" wide, as manufactured by Minnesota Mining and Company, or approved equivalent) and 16" of approved

heat shrink tubing over all primary cable splices in manholes, handholes and all light bases.

- F. Acceptable manufacturers of cable connectors are Amerace Ltd., Crouse-Hinds Molded products and Integro, LCC, and other manufacturers approved by FAA and listed in the current revision of FAA AC 150/5345-53C, Appendix 3.

2.05 SHRINKABLE CABLE CONNECTOR KITS

- A. Heat shrink tubing is to be designated for FAA Type L-823 plug and receptacle cable connectors. The heat shrink tubing is to be thick wall polyolefin, 16" full length, with a minimum shrink ratio of 3:1, designed for use with a heat gun or propane torch, and suitable for indoor or outdoor applications. Taping of connectors will not be permitted in lieu of heat shrink tubing. Connectors must be taped with a few turns of FAA approved vinyl tape prior to the installation of heat shrink tubing. Heat shrink tubing kits are to be installed in manholes, handholes and light bases. The secondary L-823 connectors from isolation transformers to airfield lighting/signage matching connectors must not have heat shrink tubing applied. These connectors are designed to be secured to the fixture and sign cover plates to provide an electrical disconnect at the frangible connector location, by break away action of the L-823 connectors.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

- A. The Contractor must install the specified cable at the approximate locations indicated in the Drawings.
- B. The work performed under this Section of these Specifications must conform to the requirements of the Chicago Electrical Code and the National Electric Code. The electrical systems must be complete with all necessary accessories to make them fully operational with the greatest assurance of protection to life and property.
- C. The Plans indicate the extent and general arrangement of the electrical work. If any departures from the Plans are deemed necessary by the Contractor, details of such departures and the reasons therefore must be submitted in writing as soon as practicable to the Commissioner for approval. No such departures must be made without the prior written approval of the Commissioner.

- D. Cable connections between lights will be permitted only at the light locations for connecting the underground cable to the primary leads of the individual isolation transformers. The Contractor must be responsible for providing cable in continuous lengths for home runs or other long cable runs without connections, unless otherwise authorized in writing by the Commissioner or shown in the Drawings.
- E. In addition to connectors being installed at individual isolation transformers, L-823 cable connectors for maintenance and test points must be installed at locations shown on the Drawings. Cable circuit identification markers must be installed on both sides of the L-823 connectors installed or at least once in each access point where L-823 connectors are not installed.
- F. Provide not less three feet of cable slack on each side of all connections, isolation transformers, light units, and at points where cable is connected to field equipment. Where provisions must be made for testing or for future above grade connections, provide enough slack to allow the cable to be extended at least one foot vertically above the top of the access structure. This requirement also applies where primary cable passes through empty base cans, junction and access structures to allow for future connections, or as designated by the Commissioner.

3.02 INSTALLATION IN CONDUIT

- A. This item includes the installation of the cable in duct or conduit as described below. The maximum number and voltage ratings of cables installed in each single duct or conduit, and the current-carrying capacity of each cable must be in accordance with the Chicago Electric Code.
- B. The Contractor must make no connections or joints of any kind in cables installed in conduits or ducts.
- C. The conduit must be installed as a separate item in accordance with Section L-110, Installation of Airport Underground Electrical Duct. The Contractor must run a mandrel through duct banks or conduit prior to installation of cable to insure that the conduit is open, continuous, and clear of debris. The Contractor must swab out all conduits/ducts and clean base can, manhole, etc., interiors immediately prior to pulling cable. Once cleaned and swabbed, the base cans and all accessible points of entry to the duct/conduit system must be kept closed except when installing cables. Cleaning of ducts, base cans, manholes, etc. is incidental to the pay item being cleaned. All raceway systems left open, after initial cleaning, for any reason, must be recleaned at the

Contractor's expense. All accessible points must be kept closed when not installing cable. The Contractor must verify existing ducts proposed for use in this project as clear and open. The Contractor must notify the Commissioner of any blockage in the existing ducts. The cable must be installed in a manner to prevent harmful stretching of the conductor, injury to the insulation, or damage to the outer protective covering. The ends of all cables must be sealed with moisture-seal tape before pulling into the conduit, and it must be left sealed until connections are made. Where more than one cable is to be installed in a conduit or duct under the same Contract, all cable must be pulled in the conduit or duct at the same time. The pulling of a cable through ducts or conduits may be accomplished by hand winch or power winch with the use of cable grips or pulling eyes. Installation of cable in ducts must be carried out by the use of nylon or polypropylene pull lines. Flat steel tapes or steel cables must not be used. Pulling tensions must be governed by recommended standard practices for straight pulls or bends and must not exceed manufacturer's recommendation. The Contractor must submit pulling tension values to the Commissioner prior to any cable installation. If required by the Commissioner, pulling tension values for cable pulls must be monitored by a dynamometer in the presence of the Commissioner. Cable pull tensions must be recorded by the Contractor and reviewed by the Commissioner. Cables exceeding the maximum allowable pulling tension values must be removed and replaced by the Contractor at Contractor's expense. A lubricant recommended for the type of cable being installed must be used where pulling lubricant is required. All cable must be installed directly from reels. Dragging the cable over the ground and across base can or manhole edges is not permitted. When cable must be coiled, lay cable out on a canvas tarp or utilize other appropriate means to prevent abrasion to the cable jacket.

- D. Cable installation, handling, and storage must be per manufacturer's recommendations. During cold weather, particular attention must be paid to the manufacturer's minimum installation temperature. At the Contractor's option, the Contractor may submit a plan, for review by the Commissioner, for heated storage of the cable and maintenance of an acceptable cable temperature during installation when temperatures are below the manufacturer's minimum cable installation temperature.

3.03 SPLICING

- A. For 5KV series circuit airfield lighting, the connections of the type required in the Plans must be made by experienced personnel

regularly engaged in this type of work and must be completed in accordance with the following:

1. Field-attached or Plug-in Splices. (5KV Splices) These must be assembled in accordance with the National Electrical Code and manufacturer's recommendations. These splices must be made with compression type connectors or lugs plugging directly into mating connectors. In all cases the joint where the connectors come together must be cleaned, taped and encased with heat shrink tubing. Indenter type compression fittings are not acceptable. Provide tape and heat shrink tubing over all cable splices in manholes, handholes, and light bases.
 2. For splicing cables with L-823 plug and receptacle cable connectors, see Paragraphs 2.04A, 2.04B, and 2.05 above.
 3. Every splice must be housed in a light base, handhole, or manhole. In a light base, leave at least 6 feet of slack cable on each side of the splice. In a handhole or manhole, the cable must make one loop around the handhole or manhole and the splice must be located near the center of the loop.
- B. For power cable splicing above 600 Volt, splices and terminations will not be permitted except in junction boxes, manholes and handholes. These must be assembled in accordance with the National Electrical Code and manufacturer's recommendations. Splices and terminations must be made with compression type connectors and lugs for medium voltage use. Splices must only be made where necessary when pulling tensions exceed manufacturer's recommendations. Lugs will only be allowed in above ground enclosures or junction boxes. Lugs must be 2-hole, color keyed only and installed with tools as required by the lug manufacturer. Lug bolting and solderless lug terminations must be per manufacturer's recommendation for medium voltage.
- C. For 600 Volt and lower cables, splices and terminations will not be permitted except in junction boxes, pad-mounted transformers, manholes, and handholes. These must be assembled in accordance with the National Electrical Code and manufacturer's recommendations. Splices and terminations must be made with compression type connectors and lugs. Splices must only be made where necessary at branches or where pulling tensions exceed manufacturer's' recommendations. The lug manufacturer's recommended tools must be used. Indenter type compression fittings are not acceptable. Lugs must be 2 hole, color keyed. Lug bolting must include a flat washer, a Belleville washer and a locknut. All stranded wire must be terminated with solderless lugs.

D. The Contractor must splice underground signal (control, telephone) cables as follows:

1. Kit and Resin: The splices must consist of a rigid polypropylene mold body with a built-in spacer web to provide cable centering and proper compound coverage. The mold body must be filled with a flexible polyurethane electrical compound capable of continuous operation at 90 degrees C, with an emergency overload temperature rating of 130 degrees C. Splices must have provisions for inline splicing of shielded or non-shielded plastic or rubber-jacketed control (telephone) cables. The splices must be rated for direct burial applications. For control cables with outside diameters between 0.25 inches and 3.25 inches, 3M Scotchcast Signal and Control Cable In-line Splicing kits of the 72N series meet these Specifications, and are acceptable.
2. Connectors: Control cable splice connectors must be in-line type, in which two conductors are spliced by laying one conductor in each end of the connector and crimping the connector with a special tool selected to match the connector type and size. Before crimping, the connector is open on one side of its length. After crimping, the connector is closed all around its length. The connector bodies must be made with a tin-plated phosphor bronze piece on the inside, to contact the cable conductors, and bonded polyester insulation on the outside to insulate the connection. The insulation must be color coded to denote wire size range. The cable splice connectors and tools must incorporate the insulation displacement termination technique which uses a slotted, tin-plated contact to displace the conductor insulation, thus providing four redundant electrical contact points. Connectors which require prestripping the conductor must not be used. Tyco Amp, Inc (Harrisburg, PA) Picabond connectors sized for conductor size and matching AMP tooling, meet these Specifications and are acceptable or an approved equal.

3.04 COUNTERPOISE OR FAA GUARD WIRE INSTALLATION FOR LIGHTNING PROTECTION

- A. Counterpoise or FAA guard wire must be installed for lightning protection of the underground cables. Counterpoise or FAA guard wire must be installed in the same trench for the entire length of buried cable, conduits and duct banks that are installed to contain airfield lighting cables and/or FAA copper conductors. In trenches counterpoise or FAA guard wire must be installed continuously a minimum of 4 inches above the cable, conduit or duct bank, or as

shown on the Drawings if greater. Additionally, counterpoise or FAA guard wire must be installed at least 8 inches below the top of subgrade in paved areas or 10 inches below finished grade in unpaved areas. This dimension may be less than 4 inches where conduit is to be embedded in existing pavement. Counterpoise or FAA guard wire must not be installed in conduit. Refer to paragraph 2.02B as to where counterpoise wire or FAA guard wire is required. The counterpoise wire must be exothermically welded to ground rods spaced a maximum of 500 feet apart around the entire circuit. The FAA guard wire must be exothermically welded to ground rods spaced a maximum of 90 feet apart around the entire circuit. Refer to paragraphs 2.02C and 2.02D for airfield lighting counterpoise size and FAA guard wire size, respectively.

- B. The counterpoise or FAA guard wire must be routed around each edge light fixture base, handhole and manhole. Connection is not made to light fixture base can (edge light), handhold or manhole. The requirements for counterpoise must conform to the FAA Advisory Circular AC 150/5340-30 (latest revision), Chapter 12, paragraph 12.5 "Counterpoise" (Lightning Protection). The counterpoise or FAA guard wire must also be exothermically welded to ground rods installed as per these Specifications.
- C. For in-pavement runway touchdown zone lights, runway centerline lights and taxiway centerline lights installed in rigid pavement the counterpoise connections are made to the exterior ground lug on fixture bases and bonded to the rebar cage around the fixture base. The counterpoise wire must also be exothermically welded to ground rods installed as shown on the Drawings, but not more than 500 feet (150 m) apart around the entire circuit.

3.05 SAFETY (EQUIPMENT) GROUND

- A. A separate safety (equipment) ground system must be provided in addition to the counterpoise wire. The requirements for safety ground must conform to the FAA Advisory Circular AC 150/5340-30 (latest revision), Chapter 12, Paragraph 12.6 "Light base Ground" and as shown in the Drawings. The equipment ground must not run in conduit between fixture bases.
 - 1. A ground rod must be installed at and securely attached with a size 6 AWG bare jumper to each airfield in-pavement light fixture base can.
 - 2. For each electrical manhole, bond all metal surfaces to the 4/0 AWG bare stranded copper ground bus utilizing size 2 AWG pigtail bare copper cables.

3. For each electrical handhole, bond all metal surfaces to the 4/0 AWG stranded copper insulated ground bus utilizing size 2 AWG pigtail insulated cables. Insulation must be green, Type XHHW.
4. For each Type 1 marker base handhole, bond all metal surfaces to the ground rod in the handhole using size 6 AWG green insulated wire.

3.06 COUNTERPOISE OR FAA GUARD WIRE INSTALLATION ABOVE MULTIPLE CONDUITS AND DUCT BANKS

- A. Counterpoise or FAA guard wires must be installed above multiple conduits/duct banks for airfield lighting or FAA copper cables, to provide a complete cone of protection over the cables. When multiple conduits and/or duct banks are installed in the same trench, the number and location of counterpoise or FAA guard wires above the conduits must be adequate to provide a complete cone of protection measured 22 ½ degrees each side of vertical. For ductbank of extra width, multiple counterpoise or FAA guard wires may be required.
- B. Where duct banks pass under pavement to be constructed in the Project, the counterpoise or FAA guard wire must be placed above the duct bank.

3.07 COUNTERPOISE OR FAA GUARD WIRE INSTALLATION AT EXISTING DUCT BANKS

- A. Where new ductbank is to connect to an existing ductbank and counterpoise/guard wire system, the new counterpoise or FAA guard wiring must be terminated at ground rods at the end of the existing duct bank. The new counterpoise or FAA guard wire must be bonded to the existing counterpoise or FAA guard wire system in accordance with these Specifications.

3.08 EXOTHERMIC BONDING FOR COUNTERPOISE, FAA GUARD WIRE, AND GROUNDING CONDUCTORS

- A. Bonding of counterpoise or FAA guard wire must be by the exothermic welding process. Only personnel experienced in and regularly engaged in this type of work must make these connections.
- B. Contractor must demonstrate to the satisfaction of the Commissioner, the welding kits, materials and procedures to be used for welded connections prior to any installations in the field. The installations must comply with the manufacturer's recommendations and the following:

1. All slag must be removed from welds.
2. For welds at light fixture base cans, all coated surface areas and "melt" areas, both inside and outside of base cans, damaged by exothermic bond process must be restored by coating with a compound conforming to the base can manufacturer's recommendations.
3. All buried stainless steel, copper, and weld materials at weld connections must be thoroughly coated with 6 mil of 3M "Scotchkote", or approved equivalent, or coated with coal tar bitumastic material to prevent surface exposure to corrosive soil or moisture.

3.09 INTERFERENCE WITH AIRPORT OPERATION

- A. The normal operating functions of the Drawings will be continued and the work in some areas will be permitted only at specified times and during suitable weather conditions. The installation of equipment and the opening of vital circuits must be done only for minimum intervals at such times and with such restrictions as approved and agreed upon by the Commissioner and may be required during non-regular working hours. The installation of temporary wiring may also be required to permit operations and work in certain areas and will be required to maintain operation of all lighting.

3.10 TESTING REQUIREMENTS

- A. The Contractor must furnish all necessary equipment and appliances for testing the underground cable circuits after installation. The Contractor must test and demonstrate in the presence of and to the satisfaction of the Commissioner the following:
 1. That all lighting power and control circuits are continuous and free from short circuits. This task includes a megger test at the respective Airfield Lighting Vault.
 2. That all circuits are free from unspecified grounds.
 3. That the insulation resistance to ground of all nongrounded series circuits and all nongrounded conductors of multiple circuits is not less than 100 megohms at the Airfield Lighting Vault.
 4. That all circuits are properly connected in accordance with applicable wiring diagrams.
 5. That all circuits are operable. Tests must be conducted that include operating each control not less than 10 times and the

continuous operation of each lighting and power circuit for not less than 1/2 hour at each intensity.

6. That for airfield ground testing other than FAA installations, the impedance to ground of each ground rod does not exceed 25 ohms prior to establishing connections to other ground electrodes. The fall-of-potential ground impedance test must be utilized, as described by ANSI/IEEE Standard 81, to verify this requirement.
7. That for all FAA guard wire/FAA ground electrodes, the impedance to ground for each ground rod or connected system for ground electrodes must meet the requirement of FAA-STD-019e, *"Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment"* and FAA-GL-918 (latest revision) *"FAA Great Lakes Region Specification for Construction of Terminal Navigational Aid Facilities"*. Ground resistance requirements related to FAA-ALSF-2 systems is outlined in FAA Specification Number FAA-C-2722, *"Construction of a High Intensity Approach Lighting System With Sequenced Flashing Lights for Category II (ALSF-2) Runways"*.
8. All tests and measurements must be documented in writing for future reference. A log must be maintained for all tests. This log must be certified before completion of the work both as to test value and date of test. The log and all test results must be submitted to the Commissioner.
9. All cables must be factory-tested and certified before shipping. The test reports must be submitted and approved by the Commissioner before shipping.
10. Tests must be coordinated with the field schedule and field conditions.
11. Before testing, all necessary precautions must be taken to ensure the safety of personnel and equipment. All enclosures for conductors and equipment must be properly grounded.
12. Any faults in the work performed by this Contractor or in materials furnished by this Contractor must be corrected or replaced promptly by this Contractor at his own expense. Any faults in materials furnished by the Contractor which are the result of careless, incompetent or improper workmanship must be repaired and the work retested.

3.11 TESTING PROCEDURES

- A. After home-run cable installation operations have been completed, including splices and terminations, the individual conductors of all cables must have all test requirements listed in Section 3.10.
- B. On all new airfield lighting circuits comprised of all new size 6 AWG-5 KV series circuit conductors, megger testing between fixtures will not be required provided that the 100 megohms requirement is met at the appropriate North or South Airfield Lighting Control Vault per 3.10.A.1, 2, 3.

With reference to new portions or extensions of size 6 AWG-5 KV cable that have been added to existing 5 KV cabling circuit, the megger testing must conform to Paragraph 3.11.G of this Specification and the 100 megohms requirement at the vault per Paragraph 3.10.A.1, 2, 3. Megger testing between fixtures will be required to check for improper grounds if the vault testing with adjusted values for testing based on Paragraph 3.11.G cannot be met.

- C. Any cable which fails to meet any specified tests must be removed and replaced by the Contractor, without added expense to the Contract. Any splice or termination which fails must be repaired or replaced as determined by the Commissioner.
- D. All new cables provided due to failures during the warranty or the above specified tests must be tested in the same manner and at the same times as the original new cables provided by this Contract.
- E. The Contractor must maintain a readily available supply of replacement cables so that in the case of a cable failure no delays shall occur in the prompt replacement or repair of the faulty cable.
- F. Tests must be performed in accordance with ICEA and AEIC recommended procedures. The Contractor must notify the Commissioner two weeks prior to each test that these tests can be witnessed by the Commissioner. Certified copies of all tests must be delivered to the Commissioner upon completion of all tests.
- G. Whenever the new 5KV cables are spliced or otherwise connected to existing cables which are older, have a lower insulation level or have a different construction, the test voltage and time duration applied to this combination must not exceed the lower of the specified values for the different types of cable. It must be the Contractor's sole responsibility to check the conditions and to establish these test values before setting up the tests.

- H. Tests must be coordinated with the field schedule and field conditions. Before testing, all necessary precautions must be taken to ensure the safety of personnel and equipment. All enclosures for conductors and equipment must be properly grounded.

3.12 IDENTIFICATION OF CONDUCTORS

- A. Where conductors pass through handholes, manholes and at each side of an L-823 Connector they must be identified with phenolic engraved tags. Each conductor must be tagged at each end of each handhole, manhole, and light base. For the North Airfield (supplied from the North Airfield Lighting Control Vault) the tags must be yellow with black one-quarter inch high lettering and attached with nylon locking ties at each end of the tag. For the South Airfield (supplied from the South Airfield Lighting Control Vault) the tags must be white with black one-quarter inch high lettering and attached with nylon locking ties at each end of the tag. The cable must be thoroughly cleaned before applying the tags. At splices, conductors on each side of the splice shall be tagged. The circuit identification must be as shown on the Contract Drawings and in accordance with Airfield Circuit Identification System.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Cable and counterpoise/guard wire installed must be measured by the number of lineal feet measured in place, completed, ready for operation, and accepted as satisfactory.
- B. Separate measurement must be made for each cable or counterpoise/guard wire installed. The footage of wire or cable will be lineal measurement plus two percent for slack of wire or cable. Measurement will be from center to center of manholes, handholes and bases. Additional length for connection of isolation transformers, in handholes, etc. will be included in the appropriate items of this Contract. Connector kits, cable tagging, and electrical testing will not be paid for separately; but, will be included in the unit price for the pay item for wire and/or cable installed. Ground rods and exothermic welding for counterpoise wire and guard wire will not be measured and paid for separately, but are included in the unit price of the pay items in this Specification requiring their installation.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment will be made at the Contract unit price for wire and cable installed by the Contractor and accepted by the Commissioner. This price includes full compensation for furnishing all materials and for all preparation and installation of these materials, and for all labor, equipment, tools, and all work necessary to complete this item.
- B. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
L-108-01	POWER CABLE – L-824, TYPE C 5KV, 1/C, SIZE 6 AWG	LF
L-108-02	COUNTERPOISE WIRE – 1/C, SIZE 6 AWG, 600 V, BARE COPPER	LF

END OF SECTION L-108

INSTALLATION OF AIRPORT UNDERGROUND ELECTRICAL DUCT

SECTION L-110

PART 1 DESCRIPTION

1.01 GENERAL

- A. The work consists of underground electrical conduit and ducts installed in accordance with this Specification at the locations and in accordance with the dimensions, designs, and details shown in the Drawings. The work includes the installation of all underground electrical ducts or underground conduits. It includes the connection of the ducts and conduit into the existing underground electrical system, including all trenching, jacking steel casing where shown on the Plans, backfilling, removal, restoration of any paved areas, connection to new or existing manholes and handholes, concrete encasement, installation of innerducts, mandreling and installation of nylon or polypropylene rope, capping and the testing of the installation as a completed duct system ready for installation of cables, to the satisfaction of the Commissioner. The work under this Section is subject to the requirements of the Contract Documents.
- B. Special Requirements for ComEd Utility Ductbanks – Unless otherwise indicated on the Contract Plans, all ComEd ductbank materials, installation, ductbank run formations, curve layouts, transposition and connection to ComEd manholes must be in accordance with the ComEd Standards. Refer to CE-100, *Commentary on ComEd Standards for Utility Manholes, Ductbanks, and Equipment Foundations at the CDA/OMP*.

1.02 RELATED WORK

- A. Section P-157 – Trench Backfilling
- B. Section P-610 – Structural Portland Cement Concrete

PART 2 EQUIPMENT AND MATERIALS

2.01 GENERAL

- A. Equipment and materials covered by referenced Specifications must be subject to acceptance through manufacturer's certification of compliance with the applicable Specification when so requested by the Commissioner.

2.02 POLYVINYLCHLORIDE (PVC) CONDUIT

- A. Non-metallic conduit must be PVC Schedule 40 or Schedule 80 concrete encased as indicated on the Drawings.
- B. PVC conduit, including elbows and couplings, must meet the requirements of NEMA standards TC2 (latest edition), UL Standard 651, Federal Specifications WC-1094A, and must be UL rated and listed for use with 90 degrees C-rated conductors in compliance with Article 352 of the NEC.
- C. The conduit must be manufactured from PVC compound that meets the applicable requirements of ASTM No. D 1784.
- D. PVC conduit fittings must meet with the requirements of NEMA Standard TC3 (latest edition), UL Standard 514 supplement, and Federal Specifications WC-1094A.
- E. All PVC conduit and fittings for communication conduits that will carry fiber optic cables must utilize sweeping bends. The bend must allow for the minimum bending (radius) requirements of the innerduct manufacturer and installer.
- F. Standard PVC fittings and PVC cement adhesive must be compatible with the conduits and must be obtained from the same conduit manufacturers.
- G. Acceptable PVC conduit manufacturers are National Pipe, Carlon (Lamson and Sessions), Cantex, and IPEX.
- H. Industry produced short radius PVC bends will not be allowed.

2.03 PVC-COATED GALVANIZED RIGID STEEL (GRS) CONDUIT

- A. A Polyvinyl Chloride (PVC) coating nominal thickness 0.04 inches (40 mil), will be bonded to the exterior of the conduit. The bond between the coating and the conduit must be greater than the tensile strength of the plastic.
- B. Fittings must be coated in the same manner as the conduit. Fittings must have a PVC sealing sleeve extending from the ends. The sleeve length must be approximately equal to the outside diameter of the conduit or 1-1/2 inches, whichever is smaller.
- C. The PVC coated galvanized rigid conduit must be U.L. listed /labeled. The Manufacturer must submit certified test results from a recognized independent testing company validating that their product meets or

exceeds the requirements of ASTM D870-02 Testing Water Resistance of PVC Coating Using Water Immersion and ASTM D2247-02 Testing Water Resistance of PVC Coating in 100% Relative Humidity, to signify compliance to the adhesion performance standards.

- D. A urethane chemical coating must be uniformly and consistently applied to the interior of the conduit and fittings. The internal coating must be applied at a minimum thickness of 2 mils.
- E. Provide solvent cement and patching compound as recommended by the manufacturer for sealing joints and repairing gouges and cuts.
- F. Provide PVC coating cement and patching compound as recommended by the PVC coated conduit and fitting manufacturer.
- G. PVC coated conduit and fittings must be 1 inch trade size or larger.
- H. Galvanized rigid steel conduit heavy wall must be milled steel, hot-dip galvanized conduit, complying with ANSI C80.1 and Federal Specification WWC-581 and must be U.L. listed.
- I. Elbows, bends, and fittings must be made of full weight materials and must comply with the above and threaded the same as conduit.
- J. Threads for conduit, couplings and fittings must be full depth and clean cut. Field cut threads must be coated with Coppercoat or in accordance with manufacturer's instruction.

2.04 CONCRETE

- A. Concrete used to form duct banks with conduit must be as specified in Section P-610 Structural Portland Cement Concrete. Reinforcing bars where required will be as shown on the Drawings and in accordance with P-610.

2.05 INNERDUCT

- A. Materials for innerducts for airfield communication cables will be subject to acceptance through manufacturer's certification of compliance with applicable Specifications.
 - 1. All innerduct must be provided with a pull rope.
 - 2. Footage label must be sequentially marked on the innerduct.
- B. Outdoor Installations

1. Innerduct that is to be installed outside, as indicated in the Contract Drawings, must meet the following requirements:
 - a. The innerduct must meet or exceed the minimum standards of PE334470E/C as defined in ASTM D3350.
 - b. The innerduct must conform to ASTM F2160.
 - c. As indicated on the Contract Drawings, provide 1.00-inch for FAA or 1.25-inch for CDA innerduct for outdoor applications. The innerduct must meet the following Specifications.

(1)	Type	Solidwall
(2)	Wall Construction	SDR 11
(3)	Material	High Density Polyethylene
(4)	Color	Yellow for FAA single mode fiber; grey for FAA copper control cable; orange for all other applications.
 - d. All solid wall innerduct, after final length trimming in manholes or building entrances, and prior to any cable installations within the innerduct must be reamed at the inside diameter edge at both ends of the innerduct to provide a smooth, rounded edge for protection to all copper and fiber optic cables and cable jacketing.

C. Indoor Installations

1. Innerduct that is installed indoors, as indicated in the Contract Drawings, must meet the following requirements.
 - a. The plenum rated innerduct must be recognized per NEC Articles, 770 and 800 for Plenum, Riser and General Purpose Raceway for optical fiber and telecommunications cables.
 - b. The riser rated innerduct must be recognized per NEC Articles, 770 and 800 for Riser and General Purpose Raceway for optical fiber and telecommunications cables.
 - c. The innerduct must conform to UL 2024.
 - d. As indicated on the Contract Drawings, provide 1.00-inch plenum or riser rated innerduct for FAA indoor applications. The innerduct for indoor applications must meet the following Specifications.

(1)	Type	Corrugated
(2)	Material	PVC (Riser Rated) PVDF Resin (Plenum Rated)
(3)	Inner Diameter	1.05 inches (+0.010 inch, -0.020 inch)

- (4) Outside Diameter 1.31 inches (+0.010 inch, -0.020 inch)
- e. As indicated on the Contract Drawings, provide 1.25-inch plenum or riser rated innerduct for CDA indoor applications. The innerduct for indoor applications must meet the following Specifications.
 - (1) Type Corrugated
 - (2) Material PVC (Riser Rated)
PVDF Resin (Plenum Rated)
 - (3) Inner Diameter 1.38 inches (+0.010 inch, -0.020 inch)
 - (4) Outside Diameter 1.65 inches (+0.010 inch, -0.020 inch)
- f. Innerduct color must be yellow for FAA single mode fiber, grey for FAA copper control cable, and must be orange for all other applications.

D. Pull Rope

- 1. Provide pull rope in all innerduct with minimum pull strength of 1250 pounds for outdoor applications and 900 pounds for indoor applications. The pull rope must extend 6 feet beyond the termination at each end.

E. Duct Plugs and Conduit Seals

- 1. Duct plugs and conduit/innerduct seals must be constructed of high impact plastic and fully corrosion resistant. Where fasteners are required they must be stainless steel. The duct plugs and conduit/innerduct seals must provide a water tight and gas tight installation. The devices must be easily installed or removed. The design must be of a split type configuration for retrofitting without any disassembly of existing conduits, innerducts, or cables. The compressible gaskets must be elastic, expandable, and durable for a permanent or temporary installation. Where conduits or innerducts contain pull ropes or cords the plug devices must have internal fastening loops to secure the rope or cord with slack within the conduit or innerduct for access at a later date during cable installations.
 - a. Blank Duct Plugs – Compression type mechanical plugs must be installed to seal spare conduits and spare innerducts of various sizes at all building/facility entrances and at the first manhole or handhole outside of the building/facility entrance. Plugs are to be sized per conduit inside diameters as required.
 - b. Innerduct Seals – Compression type mechanical seals

must be provided to seal annular space around innerducts within conduits at all building entrances and at the first manhole or handhole outside of the building/facility entrance. Seals must be split type that can be installed around existing innerducts that are in place with or without cable.

- c. Cable Seals – Compression type mechanical seals must be provided to seal all cable entrances in conduits and all cable entrances in innerduct at all building entrances and at the first manhole or handhole outside of the building/facility entrance. Fiber optic cable are installed individually, one cable of various diameter within one innerduct. 5KV or 600 volt power cables must have seals selected per total number of cables, diameter of cables, and conduit sizes as required.

F. Pulling Lubricant

- 1. A water based propylene glycol solution must be used when placing innerduct into duct banks as well as placing cable into innerduct.
- 2. The lubricant must have characteristics intended for the pulling of MDPE and HDPE fiber sheaths through PVC innerduct.

G. Provide all fittings, terminations, connectors, etc. for a complete integrated raceway system.

H. Acceptable innerduct manufacturers are Carlon, EW&C and Innerduct.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

- A. The Contractor must install underground duct banks at the locations and grades as indicated in the Drawings. Conduits must be of the size, material, and type indicated in the Plans or Specifications. Where no size is indicated in the Drawings or Specifications, the conduits must not be less than 3 inches inside diameter. All duct banks must be laid to pitch toward structures for drainage as shown on the Drawings. Pockets or traps where moisture may accumulate are not acceptable unless pre-existing underground field conditions prohibit ductbank pitch to structure.
- B. The Contractor must mandrel each conduit. After completion of construction, each conduit must first be thoroughly cleaned before being mandrelled. Cleaning can be accomplished by drawing a wire

duct brush, a flexible mandrel or power water rodding/jetting through each conduit to make sure that no foreign materials are left in the conduits after construction. When cleaning is completed, each conduit must be mandrelled with a non-flexible, durable, wood or metal conduit mandrel made specifically for this purpose. The diameter of the mandrel must not be more than ¼ inch smaller in diameter of the bore of the conduit and the length of the mandrel must be at least 1 inch longer than the diameter of the bore.

- C. Conduit installed must be provided with a nylon or polypropylene rope for pulling the permanent wiring. Sufficient length must be left in handholes and secured to prevent it from slipping back into the conduit.
- D. Conduit must be securely fastened in place during construction and progress of the work and must be plugged to prevent seepage or grout, water, or dirt. Conduits must be placed on supports/spacers designed and manufactured for this specific purpose. When not being worked, conduits must be capped using metal or plastic caps designed for this purpose. The use of materials such as rags, paper, plastic bags or tape is forbidden. Any duct bank having a defective joint must not be installed.
- E. Conduit must be encased in concrete, with a 3 inch minimum concrete envelope poured around all conduit.
- F. Where turf is well established and the sod can be removed, it must be carefully stripped and properly stored and replaced after backfilling in accordance with Section 3.06, as directed by the Commissioner.
- G. Trenches for conduit and ducts may be excavated manually or with mechanical trenching equipment. Walls of trenches must be essentially vertical so that a minimum of base material or soil is disturbed.
- H. Dozers, wheel loaders, or motor graders must not be used to excavate the trench. The Contractor must ascertain the type of soil or rock to be excavated before bidding. All excavation material will be unclassified. Work shall be performed in accordance with Section 3.08-Unclassified Excavation.
- I. Conduit must be provided with slip couplings where it crosses through or under transverse construction joints in Portland cement concrete pavement.

- J. Conduit must be provided with approved expansion and deflection couplings where it crosses through expansion joints.
- K. PVC-Coated Galvanized Rigid Steel Conduit must be provided with grounding bushings to insure continuity of ground for the underground electrical system. The grounding bushings must be threaded onto the conduit.
- L. The Contractor must connect into the electrical duct bank system at the location indicated on the Plans by core drilling into structures, by connecting to existing conduit or ducts, or as directed by the Commissioner.

3.02 CONDUIT ENCASED IN CONCRETE

- A. Unless otherwise shown in the Plans, concrete-encased conduit must be installed so that the top of the concrete envelope is not less than 30 inches below the finished subgrade where installed under runways, taxiways, aprons, or roads, and not less than 30 inches below finished grade where installed in unpaved areas. Ducts under paved areas must extend at least 5 feet beyond the edges of the pavement or 5 feet beyond any underdrains which may be installed alongside the paved area. Trenches for concrete encased conduit must be opened the complete length before concrete is laid, so that if any obstructions are encountered, proper provisions can be made to avoid them. Concrete for the duct must be placed to form a single unit, not incrementally. The concrete cover thickness must be a minimum of three inches on all sides. Where two or more conduits are encased in concrete, the Contractor must space them not less than 2 inches apart (measured from outside wall to outside wall) using spacers applicable to the type of conduit. End bells or end couplings must be installed flush with the end of the concrete encasement where required.

- B. Tracing FAA and Common Electric Ductbank (CED) Containing FAA Fiber

Tracer wire is required by the FAA to trace and locate concrete encased ductbank containing FAA fiber optic cable. Tracer wire will allow traceability of a fiber optic cable segment into and out of all facilities along the path of the specific fiber optic cable FOTS loop for every facility with FAA fiber optic equipment connected to the cable being traced.

Because the routing of FAA fiber optic cable for Communication FOTS loops and NAVAID (ILS) FOTS loops often follow the same ductbank route, the number of tracer wires in a given ductbank will vary as

required to achieve traceability of each segment on a whole fiber optic loop. Most ductbanks will require only a single tracer wire, however other short facility branch ductbanks from the main would require multiple tracer wires when fiber optic cable segments overlap. When in the case of a NAVAID fiber optic cable loop which can double back on itself, at a facility that uses a single ductbank branch to access both of the cable segments serving it by ductbank with multiple segment entrances, 2 or 3 tracer wires would be required within that short ductbank branch to the FAA site/shelter. Where tracer wires converge at the lower level, Concourse "E" and "G" entrances of the main terminal, and the south entrance to the SATCT three (3) tracer wires within a common ductbank would be needed.

All new fiber installations and tracer wire routings for design packages must be coordinated with the CDA/OMP/FAA to conform with the overall or master Airport FAA fiber routing plan developed by FAA.

1. Provide and install 6" wide red plastic warning tape above all ductbanks and #14 AWG insulated copper tracer wire within all FAA dedicated ductbanks, handholes and manholes; all Common Electrical Ductbanks (CED), handholes and manholes containing FAA fiber optical cable; and existing ductbanks, handholes and manholes when used to route FAA fiber. (These requirements apply to both single-mode FAA fiber and multi-mode FAA fiber installations).
2. Tracer wire must be placed by the contractor installing FAA fiber optic cable to follow the entire fiber segment route between FAA buildings and facilities through new infrastructure and existing infrastructure. It is the contractor's responsibility to coordinate all fiber tracer wire requirements with the OMP/FAA for all new FAA fiber work or expansion of existing fiber/tracer wire work.
3. The tracer wire must be #14 AWG insulated solid copper wire. The insulation color must be orange for multi-mode fiber or yellow for single-mode fiber. The tracer wire must be placed with the installation of innerduct within a conduit in conjunction with the later installation of FAA fiber cable in that contract. The tracer wire should optimally be pulled in with the innerduct, in the conduit void between innerducts or in a FAA spare innerduct with the FAA's approval and is run continuously from FAA facility/shelter to FAA facility/shelter without splices. Within manholes or handholes the tracer wire must be fastened to the cable racks and tagged "FAA Fiber Optic Tracer Wire".
4. The tracer wire must follow the entire run of FAA fiber optic cable segments from Airport Traffic Control Tower or

Concourse lower level duct entrances into and out of each of the respective FAA NAVAID and Communication / Radar facility to accommodate the tracing of each fiber segment. Tracer wire is not required beyond the Concourse ductbank entrances, in the lower level Concourse tunnels or to the ATCT. A separate tracer run in general follows each fiber segment from building to building and will not be shared nor spliced / tied together.

5. When the tracer wire is brought into a facility it will not be terminated. The tracer wire must be coiled in an interior mounted fiber optic junction box. The contractor must provide ten (10) feet of cable, coiled and tagged "FAA Fiber Optic Tracer Wire". The junction box must also be tagged "FAA Fiber Optic Tracer Wire".
6. Tracer wire continuity between facilities along each fiber optic cable segment must be demonstrated by the contractor to the FAA for acceptance.
7. When a field manhole tracer wire splice is required due only to the cable spool limitations the splice must be made with approved mechanical type connectors, Pro-Trace TW Connector, as directed by the Director and the FAA. The connection must also be wrapped with an overlapping layer of 3M Super 88 Electrical tape and an overlapping layer of 3M Super 33+ Electrical tape
8. In the event tracer wire is damaged or rendered inoperable during the course of construction activities, the contractor will be responsible to re-establish or install new tracer wire between facilities.

C. ComEd Ductbank, Common Electrical Ductbank (CED) Warning Tape

1. Unless the ComEd Ductbank or Common Electrical Ductbank is being jacked in place, or the Plans indicated otherwise, a 6 inch wide red plastic warning tape must be placed 12 inches below grade directly over the entire length of a proposed ComEd Ductbank or Common Electrical Ductbank. The CED ductbanks contain as part of the CDA/OMP both electrical power and communications assigned cells.
2. The plastic warning must be colorfast and chemically inert. Clips for bonding tears and completing end-of-roll splices must be provided and installed per manufacturers' recommendations.

3.03 INNERDUCT INSTALLATION

A. Equipment

1. Cable tuggers, tension metering equipment, break-away swivels, sheaves, quadrant blocks, hooked hanger sheaves, cable feeding sheaves, corner cable guides, reel trailers, reel trucks and continuous lubricating equipment are the most suitable types of equipment for this Project; however, the Contractor must make its own determination and selection of the equipment to use to install the innerduct.
2. Use pulling means, including fish tape, cable rope and basket weave innerduct grips that will not damage the innerduct media or raceway. Pull innerducts simultaneously in the same raceway as shown on the Drawings with equipment to equalize pulling tensions on each innerduct. A reliable non-freezing type of swivel must be inserted between the pulling line and the innerduct grips to prevent twisting under strain. The swivel must be equipped with shear to tension pins with a breaking strength recommended by the innerduct manufacturer. Pulling equipment must be equipped with a hydraulic bypass which must be set so that a maximum tension (recommended by the innerduct manufacturer) is not exceeded.
3. Prior to being installed, multiple innerducts must be bundled and secured with lashing ties per the manufacturers recommendations. The lashing ties must be installed every two (2) meters.

B. Joints and Breaks

- C. Innerducts must be installed continuous in the ductbank. No joints or breaks of any kind will be allowed in any of the innerduct segments. Innerduct breaks are allowed only in manholes/handholes/pullboxes and at Panel locations.**

- Placing Innerduct In Segments**
1. Contractor must utilize secured sheaves and quadrant blocks to guide the innerduct from reels above the manhole or from buildings into the manhole chamber and into the 4 inch conduit. Contractor must maintain tension on the innerduct from the supply reel to the 4 inch conduit.
 2. Contractor must lubricate the innerduct at the point that it enters the conduit. Use pulling compound or lubricant as recommended by the innerduct manufacturer. Contractor must use a lubricant application system to minimize lubricant loss and spillage in the manhole and/or immediate work surface area. All spilled lubricant must be cleaned completely from the surfaces of the manhole and work surface area.

D. Manhole Terminations

1. The innerduct must enter the manholes through conduit fittings cast into the side of the manholes.
2. To compensate for innerduct elongation due to installation pulling stress and installation temperature, the Contractor must pull the multiple innerducts past the conduit system and/or manholes to allow the innerduct to recover to its original length. The amount of innerduct left after the initial cutting in manholes must be coordinated with the innerduct manufacturer. This coordination must take into account allowable pulling tension, pulling techniques/equipment, conduit conditions, length of innerduct pulls, size/quantity of innerducts per conduit, and installation temperature. The time needed for innerduct recovery must be per innerduct manufacturer's requirements prior to the final innerduct trimming to 6 inches extending out of the interior side of the manhole wall. Any innerduct improperly trimmed or compensated for elongation, that contracts into the conduit after relaxation must be removed and replaced at the Contractor's expense.

E. Building Terminations

1. The innerduct must enter the buildings through 4 inch conduit fittings. Mechanical compression type seals are to be installed based on quantity and size of innerducts to provide a water and gas tight seal.
2. After installation of innerduct seals, Contractor must cut all HDPE innerduct per manufacturer's requirements as described in Paragraph 3.03.G. If the Contract Drawings call for the innerduct to continue from the building wall, an innerduct transition piece must be installed and plenum rated innerduct is to be connected to it and extended into the building.
3. Contractor must provide an innerduct connector on all innerduct that is to be terminated onto an enclosure. The connector is to be securely fastened on the innerduct and enclosure. The 4 inch openings in buildings that are not used for innerduct entry must be plugged with a 4 inch blank compression type conduit plug.

F. Innerduct Support

1. Exposed innerduct must be supported in an approved manner. Innerducts must not be fastened to or come in contact with any mechanical system pipes, ducts or equipment of other trades, except as approved by the Commissioner. In all innerduct work including vertical runs, acceptable electrical support devices

including hangers, racks, ties or a combination thereof must be used as supports.

G. Innerduct and Conduit Mechanical Seals

1. The conduit and innerduct must be sealed with compression type mechanical seals at building penetrations and at the first manhole/handhole to building only.
2. Corrosion resistant compression type mechanical cable seals must be used to terminate the various cables at building entrance conduits and innerducts at buildings.
3. Duct tape must be used to temporarily seal all innerduct segments during the course of construction.
4. Immediately upon installation of an innerduct segment, the Contractor must place duct tape temporarily at both ends of each innerduct in the segment. Contractor must attach the pulling rope to the exterior of the innerduct with duct tape temporarily.
5. At the close of each workday, all innerduct installed as of the end of the workday is to be taped with duct tape to ensure that innerducts remain free of liquids and particles.

H. Prior to installing new innerducts inside existing underground ductbanks, the existing ducts must be cleared and cleaned. Clearing and cleaning by mandrelling, power rodding, power washing or other means necessary for the installation of the new innerducts will be included in the unit price for the Innerduct Pay Item.

3.04 DUCTBANK END DELINEATION

- A. In locations where ductbank ends; but, will be extended at a later date, the ductbank ends will be bulkheaded or stubbed and capped below grade. The ends of these ductbanks must be surveyed by the Contractor for their exact locations based on O'Hare Survey Control Monuments (easting and northing of each corner referred to the IL State Plane Coordinates NAD 1983 and the vertical elevation of the top of each corner referred to NAVD 1988). This survey information must be provided and indicated by the Contractor on the As-built Drawings for reference.

3.05 BACKFILLING

- A. After concrete-encased conduits have been properly installed and the concrete has set, the trench must be backfilled in accordance with Specification P-157, Trench Backfilling.

- B. Trenches must not be excessively wet and must not contain pools of water during backfilling operations.
- C. Excess excavated material must be removed and disposed of in accordance with instructions issued by the Commissioner.
- D. Material to be used in backfilling under and adjacent to the paved areas must conform to the requirements of Trench Backfill, but the cost of furnishing and placing such backfill must be included in the Contract unit price for the items listed under installation of underground electrical duct.

3.06 RESTORATION

- A. After the backfill is completed, the Contractor must dispose of all surplus material and rubbish off site. Excess dirt and excavated material must be embanked within the project embankment limits in accordance with section P-152 Excavation and Embankment, and will be considered incidental to the work. The Contractor must restore all disturbed areas to their original condition. Where the original condition is grass, topsoil and sod or permanent seeding must be used for restorations, as shown on the drawings. All costs for restoration will be included in the Contract unit price. Any future settlement of trenches must be restored at the Contractor's expense.

3.07 UNCLASSIFIED EXCAVATION

- A. Provide all excavation for ductbank to the lines and grades for elevations, shown on the Drawings or as stated by the Commissioner. The excavation is to be of sufficient size to permit the placing of the full width and length of the ductbank shown. Excavated material is to be stockpiled where directed by the Commissioner. The elevations, as shown on the Drawings, are to be considered as approximate only; and the Commissioner may order, in writing, changes in dimensions or elevations necessary to secure a satisfactory installation.
- B. Boulders, logs, or other objectionable materials encountered in excavation are to be removed. All rock or other hard foundation material is to be cleaned of all loose material and cut to a firm surface either level, stepped or serrated, as directed by the Commissioner. All seams or crevices are to be cleaned out and grouted. Remove all loose and disintegrated rock and thin strata. When concrete is to rest on a surface other than rock, special care is to be taken not to disturb the bottom of the excavation, and excavation to final grade is not to be made until just before the concrete or reinforcing is to be placed.

- C. Provide all bracing, sheathing or shoring necessary to implement and protect the excavation and the ductbank, as well as protect existing adjacent structures located above or below grade as required, as required for safety or conformance to governing laws. The cost of bracing, sheathing or shoring is to be included in the unit price for the ductbank.
- D. Unless otherwise provided, bracing, sheathing, or shoring involved in the construction of this item is to be removed by the Contractor after the completion of the structure. Removal is to be effected in a manner which will not disturb or mar finish masonry. The cost of removal is to be included in the unit price bid for the structure. The Contractor is to notify the Commissioner to the effect; and concrete or reinforcing steel is to be placed after the Commissioner has approved the depth of the excavation and the character of the foundation material.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Underground duct bank, including innerduct for fiber optic cables where shown on the plans, will be measured by the lineal feet of duct bank installed, measured in place, completed, and accepted. Measurement will be made from the centroid of manhole and handhole clusters or connecting structures. No separate measurement will be made for the various types and sizes, or the individual ductbank fingers that enter into each manhole, handhole, or connecting structure. No separate measurement will be made for steel casing, ductbank warning and fiber optic tracer wires, innerduct and conduit mechanical seals, excavation, backfilling, miscellaneous materials or connections to the existing underground ductbank system including removal of standard duct banks and appurtenances within limits of the ductbank trench and layout, and clearing of existing underground ductbank necessary for the installation of new innerducts.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment will be made at the Contract unit price for each type and size of duct bank, including innerduct for fiber optic cable where shown on the plans, completed by the Contractor and accepted by the Commissioner. This price includes full compensation for furnishing all materials; for all preparation, assembly, and installation of these materials; for all trenching and backfilling necessary; for all restoration of disturbed areas; for clearing existing underground ductbank for new

innerduct installations, ductbank warning and fiber optic tracer wires, innerduct and conduit mechanical seals; and for all labor, equipment, tools, and all work necessary to complete this item as required by these Specifications and as detailed on the Contract Drawings

B. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
L-110-01	CONCRETE ENCASED DUCTS, 1-WAY 2" PVC	LF
L-110-02	CONCRETE ENCASED DUCTS, 2-WAY 3" PVC	LF
L-110-03	CONCRETE ENCASED DUCTS, 6-WAY 2" PVC	LF
L-110-04	COMMON ELECTRIC DUCBANK, 4-WAY, 4" PVC CONDUIT, CONCRETE ENCASED, REINFORCED	LF
L-110-05	COMMON ELECTRIC DUCBANK, 6-WAY, 4" PVC CONDUIT, CONCRETE ENCASED, NON-REINFORCED	LF
L-110-06	SAW KERF CONCRETE ENCASED DUCTS, 1-WAY, 3" PVC CONDUIT	LF

END OF SECTION L-110

ELECTRICAL MANHOLES AND HANDHOLES

SECTION L-115

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item consists of the furnishing of all labor, equipment, and material, and of performing all operations in connection with furnishing and installation of new electrical manholes and handholes and with the adjustment of existing electrical manholes and handholes. The work under this section is subject to the requirements of the Contract documents.
- B. Electric utility company manholes must be in conformance with Commonwealth Edison (ComEd) Standard details as indicated on the Drawings and specified by ComEd. Refer to CE-100 – *Commentary on ComEd Standards for Utility Manholes, Ductbanks, and Equipment Foundations at the CDA/OMP* and CE-101 – *CDA/OMP Advisory on Shop Drawings for Commonwealth Edison (ComEd) Manholes*.

PART 2 EQUIPMENT AND MATERIALS

1.02 GENERAL

- A. Airport equipment and materials covered by Federal Aviation Administration (FAA) specifications are to have the prior approval of the Office of Airport Safety and Standards, Attention: AAS-200, FAA, Washington, D.C. 20591, and are to be listed by FAA's Advisory Circular No. 150/5345-53 (latest edition), "Airport Lighting Equipment Certification Program."
- B. All other Airport equipment and materials covered by other referenced specifications will be subject to acceptance through manufacturer's certification of compliance with the applicable specifications, when so requested by the Commissioner.
- C. All ComEd electric utility company manhole materials and products must be in conformance with ComEd Standards as indicated on the Drawings and specified by ComEd. Refer to CE-100 - *Commentary on ComEd Standards for Utility Manholes, Ductbanks, and Equipment Foundations at the CDA/OMP*; and CE-101 – *CDA/OMP Advisory on Shop Drawings for Commonwealth Edison (ComEd) Manholes*.
- D. ComEd precast manholes can only be ordered and furnished from an approved ComEd vendor.

1.03 REINFORCING STEEL

- A. Reinforcing steel is to comply with Section P-610 Structural Portland Cement Concrete of these specifications.
- B. All existing reinforcing steel exposed during the adjustment of electrical manholes is to be reincorporated into the adjusted structure. Care must be taken not to damage the existing reinforcing steel during concrete removal. The exposed reinforcing steel is to be cleaned of all concrete. Any reinforcing steel rusted, damaged or deemed not retainable by the Commissioner is to be replaced with bars of the same size and length meeting the requirements of ASTM A615 Grade 60.

1.04 CONCRETE

- A. Cast-in-place concrete required for the construction of manholes and handholes, and for the adjustment of manholes and handholes is to comply with all the requirements of Section P-610 Structural Portland Cement Concrete.
- B. All manhole and handhole structures that are located within the runway safety area (RSA) or taxiway safety area (TSA) or designated as aircraft load rated in the contract documents must be designed by a structural engineer to support aircraft loading in accordance with FAA AC 150/5320-6D Appendix 3, Design of Structures for Heavy Aircraft. The structural engineer sealed drawings shall be the responsibility of the contractor and included in the structure submittals.
- C. Proposed precast concrete mix designs including all ingredients and certified concrete strength test results must be submitted by the Contractor/Precaster prior to manufacturing, for review by the Commissioner.

1.05 GROUND RODS

- A. Ground rods are to be $\frac{3}{4}$ inch diameter type 304 stainless steel, 10-feet long minimum.

1.06 FRAMES AND COVER

- A. New frames and covers are to be installed on all electrical manholes and handholes, except where the Drawings indicate otherwise.
- B. The castings must conform to one of the following requirements:
 - 1. Gray iron castings: ASTM A48, Class 30B and 35B

2. Malleable iron castings: ASTM A47
 3. Steel castings: ASTM A27
 4. Structural steel for grates and frames: ASTM A283, Grade D
 5. Ductile iron castings are to meet the requirements of ASTM A536
 6. Austempered ductile iron castings: ASTM A897
- C. All castings or structural steel units are to conform to the dimensions and requirements shown on the Drawings and are to be designed to support the loading specified.
- D. Each frame and cover unit is to be provided with stainless steel locking bolts to prevent it from being dislodged but which will allow easy removal for access to the structure.
- E. Each cover must be provided with a latch device that is integral to the cover casting. The latch must be of a spring catch or quarter turn design that is operable with a tool supplied with the casting. Tool quantity to be supplied with the order as indicated on the drawings. The latching device must secure the cover in a closed position when the hold down stainless steel locking bolts (item 'D' above) are being removed or reinstalled. The cover must be secured by both bolts and latches.
- F. The frames of all electrical and communications manholes and handholes are to be grounded as shown on the Drawings.
- G. All frames and covers installed within the Aircraft Operation Area (AOA) will be aircraft rated for 100,000 lbs. Spring assist frame to be cast into roof or riser section of structure.
- H. Airside Electrical Handhole/Manhole Frame and Cover Schedule

Structure Use	Cover Size and Type	Cover Legend	Notes
ComEd Manholes	<p>Per ComEd Standards (Drawings and Specifications)</p> <p>For new ComEd manholes - Use 38" dia. frame for 32" dia. cover</p> <p>For retrofit installation - Use 42" x 46" frame for 36" dia. cover</p>	Per ComEd Standards (Drawings and Specifications)	<p>Must meet CDA/OMP Aircraft loading requirements within the AOA.</p> <p>Refer to Section CE-100 and CE-101</p>

Structure Use	Cover Size and Type	Cover Legend	Notes
Common Electrical Duct (CED) Handholes Design Standard Detail Nos. 6-06-03R through 6-06-05R.	30" x 30" Opening spring assist, hinged w/bolt down, ductile iron lid		Must meet CDA/OMP Aircraft loading of 100,000 lbs within the AOA.
		<u>Common Installations:</u> 600V-7500V R/W AIRFIELD LIGHTING or 600V-7500V T/W AIRFIELD LIGHTING or COMMUNICATIONS	
		<u>Less Common Installations:</u> 0V-600V ELECTRIC or 600V-7500V ELECTRIC	Low voltage for FAA PAPI feed, hot boxes, pump, security or other similar function High voltage for FAA Secondary or City Electric
		<u>Use Only Upon Approval from CDA/OMP for Limited Cases:</u> 600V-7500V AIRFIELD LIGHTING	

Structure Use	Cover Size and Type	Cover Legend	Notes
Common Electrical (CED) Manholes Design Standard Detail Nos. 6-06-09R through 6-06-22	30" x 30" Opening spring assist, hinged w/bolt down, ductile iron lid		Must meet CDA/OMP Aircraft loading of 100,000 lbs within the AOA.
		<u>Common Installations:</u> 600V-7500V R/W AIRFIELD LIGHTING or 600V-7500V T/W AIRFIELD LIGHTING or COMMUNICATIONS	
		<u>Less Common Installations:</u> 0V-600V ELECTRIC or 600V-7500V ELECTRIC	Low voltage for FAA PAPI feed, hot boxes, pump, security or other similar function High voltage for FAA Secondary or City Electric
		<u>Use Only Upon Approval from CDA/OMP for Limited Cases:</u> 600V-7500V AIRFIELD LIGHTING	
FAA Handholes FAA Standard Details Example – GL-D-5693- 10-6	Per FAA Standards (Drawings and specifications)	Per FAA Standards (Drawings and specifications) (See FAA-C-1391b) “FAA Communications” legend on lids are exclusive to FAA NAVAID, FAA Communications, and ALSF sites <u>only</u> . For locations outside FAA facilities/sites and all other locations, the legend on lids must be per CED requirements.	Handhole type, Cover Size and Legend to be Coordinated with the FAA

Structure Use	Cover Size and Type	Cover Legend	Notes
Type 1 Marker Light Bases	18" x 18" Opening w/bolt down, ductile iron lid	AIRFIELD LIGHTING	Must meet CDA/OMP Aircraft loading of 100,000 lbs within the AOA.

- I. Acceptable manufactures include:
 1. Neenah Foundry Company
 2. East Jordan Iron Works, Inc.
 3. Campbell Foundry

1.07 NON-METALLIC CABLE SUPPORT RACKS

- A. Manhole and handhole cable racks must be heavy duty, molded, acceptable agency listed, standard yellow fiberglass reinforced nylon with adjustable arms. Length of rack arm must be 14 inches for CED manholes and 6 inches for handholes, respectively. Install cable racks as shown on the Drawings. Secure all cable to the rack arm with separate nylon tie wrap. Acceptable manufacturers of non-metallic cable support racks are Underground Devices, Inc., Northbrook, IL and StrutTech/Axium Composites, Inc., Redmond, WA and Eaton Inc., Highland, IL. Acceptance is subject to manufacturer's certification of compliance with applicable specifications. ComEd furnishes and installs its own cable support racks.

1.08 PULLING IRONS

- A. Provide all pulling-in irons, hooks and all other appurtenances as indicated on the Drawings and as required for a complete operational manhole or handhole. Pulling-irons to be manufactured with 7/8-inch diameter hot-dipped galvanized steel.

1.09 EPOXY CONCRETE ADHESIVE

- A. The epoxy concrete adhesive must conform to the requirements of Section 1025.01 of IDOT's Standard Specifications for Road and Bridge Construction (latest edition), and meet the approval of the Commissioner.

PART 3 CONSTRUCTION METHODS

1.10 UNCLASSIFIED EXCAVATION

- A. Provide all excavation for structures to the lines and grades for elevations, shown on the Drawings or as directed by the Commissioner. The excavation is to be of sufficient size to permit the

placing of the full width and length of the structure shown. Excavated material is to be stockpiled where directed by the Commissioner. The elevations, as shown on the Drawings, are to be considered as approximate only; and the Commissioner may order, in writing, changes in dimensions or elevations necessary to secure a satisfactory installation.

- B. Boulders, logs, or other objectionable materials encountered in excavation are to be removed. All rock or other hard foundation material is to be cleaned of all loose material and cut to a firm surface either level, stepped or serrated, as directed by the Commissioner. All seams or crevices are to be cleaned out and grouted. Remove all loose and disintegrated rock and thin strata. When concrete is to rest on a surface other than rock, special care is to be taken not to disturb the bottom of the excavation, and excavation to final grade is not to be made until just before the concrete or reinforcing is to be placed.
- C. Provide all bracing, sheathing or shoring necessary to implement and protect the excavation and the structure, as well as protect existing adjacent structures located above or below grade as required, as required for safety or conformance to governing laws. The cost of bracing, sheathing or shoring is to be included in the unit price for the structure.
- D. Unless otherwise provided, bracing, sheathing, or shoring involved in the construction of this item is to be removed by the Contractor after the completion of the structure. Removal is to be effected in a manner which will not disturb or mar finish masonry. The cost of removal is to be included in the unit price bid for the structure. The Contractor is to notify the Commissioner to the effect; and concrete or reinforcing steel is to be placed after the Commissioner has approved the depth of the excavation and the character of the foundation material.

1.11 CONCRETE STRUCTURES

- A. Concrete structures are to be built on prepared foundations, conforming to the dimensions and form indicated on the Drawings. Any reinforcement required, is to be placed as indicated on the Drawings and is to be approved by the Commissioner before the concrete is poured. Precast manholes and handholes are allowed as long as they meet all requirements of this specification. Precast units to be installed plumb and true. Joints to be made watertight by use of sealant at each key joint and at roof joint.

- B. The interior bottom is to be sloped downward toward the floor drain or outlet. Provide French Drain Sump or piped drain connection to manholes and handholes as shown or indicated on the Drawings.

1.12 PLACEMENT AND TREATMENT OF CASTINGS, FRAMES AND FITTINGS

- A. All castings, frames and fittings are to be placed in the positions indicated on the Drawings or as directed by the Commissioner, and must be set true to line and to correct elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts are to be in place and position before the concrete or mortar is placed. The unit is not to be disturbed until the mortar or concrete has set.
- B. After the frames or fittings have been set in final position and the concrete or mortar has been allowed to harden for seven (7) days, the grates or covers are to be placed and fastened down.

1.13 COMMONWEALTH EDISON (ComEd) MANHOLE INSTALLATION

- A. Construction and installation of ComEd utility manholes must be in accordance with the ComEd Standards. Refer to CE-100 - *Commentary on ComEd Standards for Utility Manholes, Ductbanks, and Equipment Foundations at the CDA/OMP and CE-101 – CDA/OMP Advisory on Shop Drawings for Commonwealth Edison (ComEd) Manholes.*

1.14 BACKFILLING

- A. After a structure has been completed, the area around it is to be backfilled in horizontal layers all around the structure not to exceed 8 inches in loose depth, and compacted. The top of the fill is to meet the elevation shown on the Drawings or as directed by the Commissioner.
- B. All excavations must be backfilled within a reasonable time after the structures are installed, unless other required protection of the structure is directed. Backfill materials and compaction procedures must be acceptable to the Commissioner. In all backfilling, any compressible or destructible rubbish and refuse must be removed from the excavated space before backfilling is started, except that sheeting and bracing must be left in place or removed as the work progresses as specified or directed.
- C. The backfill material must be brought up evenly on each side of the structure to proposed grade. If under pavement, or within 2 feet of the proposed, future or existing pavement edge, fine aggregate backfill must be placed and compacted until the top of subgrade is reached. If

the trench is not under, or adjacent to, existing, proposed or future pavement, then acceptable fill must be placed and compacted to proposed grade.

- D. Structures excavated with sloped or bench walls must be backfilled for the full width of the excavation, as herein specified.
- E. The backfill material for fine aggregate must consist of natural sand or washed crushed limestone having a FA-6 gradation conforming to Section 1003 of the Standard Specifications for Road and Bridge Construction, Illinois Department of Transportation, latest edition. Acceptable fill for backfill is defined as suitable unclassified excavation material that is non-organic, non-decayable, and non-rubble material having a maximum dry density of not less than 98 pounds per cubic foot. It will contain no rocks, stones, or broken concrete greater than 3 inches in the largest dimension. The material must be easily compactable to the required density and approved by the Commissioner.
- F. Finish grading must be performed in accordance with the completed contour elevations and grades shown and must be made to blend into the existing or plan ground surfaces. All finished grading surfaces must be left smooth and free to drain. Finish grades must be brought to elevations within plus or minus 0.10 foot of elevations or contours shown.
- G. Fine aggregate backfill must be placed in uniform layers not greater than 8 inches in loose thickness and thoroughly compacted in place with suitable vibratory equipment to not less than 95% of the maximum density determined by ASTM D 1557. Each lift of fill must be within +/- 2% of optimum moisture content before the succeeding lift is placed. If the backfill is acceptable fill it must be placed in uniform layers not greater than 12 inches in loose thickness and each layer compacted to 85% of maximum density as determined by ASTM D 1557.
- H. Backfill compaction must be tested and monitored by the Contractor. All material and backfill operations may be subjected to testing by the Commissioner with the assistance of the Contractor.
- I. Backfilling is not to be placed against any structure until permission is given by the Commissioner. In the case of concrete, such permission will not be given until the concrete has been in place a minimum of seven (7) days, or until tests made by the Contractor's QC organization and tested by the Contractor's approved laboratory, subject to the verification by the laboratory under supervision of the Commissioner establish that the concrete has attained sufficient

strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it.

- J. The suitability of compacting equipment must be acceptable to the Commissioner. Tamping rollers (generally referred to as Sheepsfoot Rollers) will be considered the proper type of equipment for compaction of cohesive soils and vibratory/mechanical tamping equipment will be applicable for compacting granular soils. In all cases, the adequacy of the equipment will be determined by the Commissioner.
- K. Any depression which may develop from settlement in backfilled areas within 1 year after the work is fully completed and accepted must be the responsibility of the Contractor. The Contractor must provide as needed, at his own expense, additional backfill material, pavement, base replacement, permanent pavement repairs on replacement and must perform the necessary reconditioning and restoration work to bring such depressed areas to proper grade as acceptable to the Commissioner.

1.15 HEIGHT ADJUSTMENT OF ELECTRICAL MANHOLES AND HANDHOLES

- A. Where indicated on the Drawings and as directed by the Commissioner, existing manholes and handholes are to be adjusted to meet new finish grade elevations in accordance with the typical sections as detailed on the Plans. New grade elevations for existing manhole and handholes must match the proposed pavement and/or finish grade elevation at the specified location.
- B. When frames or fittings are to be placed upon previously constructed manholes, handholes, and structures, the bearing surfaces are to be brought true to line and grade. The unit is to be set in mortar beds and anchored to the existing manhole or handhole as indicated on the Drawings and as directed and the Commissioner. All units are to be set firm and secure.
- C. When frames and covers on existing ComEd manhole structures are required, the existing square covers and frames must be removed and the manhole entrance rebuilt to accommodate ComEd Retrofit 42"x46" frame and ComEd 36" diameter cover.
- D. Areas around electrical manholes and handholes that have been disturbed or removed during construction must be restored to meet original conditions as outlined in Paragraph 3.08. Restoration work will

not be measured and paid for separately. This work is to be included in the unit price for electrical manhole adjustment.

1.16 APPLICATION OF EPOXY CONCRETE BONDING ADHESIVE

- A. Where shown on the detail the epoxy concrete bonding adhesive is to be uniformly applied to coat the entire surface of the concrete remaining in place.

1.17 CLEANING AND RESTORATION OF SITE

- A. After the backfill is completed, the Contractor must dispose of all surplus material and rubbish off site. Excess dirt and excavated material must be embanked within the project embankment limits in accordance with section P-152 Excavation and Embankment, and will be considered incidental to the work. The Contractor must restore all disturbed areas to their original condition. Where the original condition is grass, topsoil and sod or permanent seeding must be used for restorations, as shown on the drawings. All costs for restoration will be included in the Contract unit price. Any future settlement of trenches must be restored at the Contractor's expense.

1.18 GROUNDING

- A. All non-current-carrying metallic parts of equipment and exposed metal in electrical handholes and manholes must be securely grounded to the grounding conductor. New conductors must be installed in a neat and workmanlike manner and must be securely held in place by means of straps spaced at proper intervals. Exothermic welds must be used to make connections to grounding systems. The grounding requirement is 5 ohms.
- B. A ground rod must be installed in the floor of all concrete structures so that the top of the rod extends 6 inches (154 mm) above the floor. The ground rod must be installed within 1 foot of a corner of the concrete structure. Ground rods must be installed prior to casting the bottom slab. Where the soil condition does not permit driving the ground rod into the earth without damage to the ground rod, the Contractor must drill a 4-inch diameter hole into the earth to receive the ground rod. The hole around the ground rod must be filled throughout its length, below slab, with Portland cement grout. Ground rods must be installed in precast bottom slab of structures by drilling a hole through the bottom slab and installing the ground rod. Bottom slab penetration must be sealed watertight with Portland cement grout around the ground rod.

- C. For manholes and handholes, a grounding bus of 4/0 AWG bare stranded copper must be looped around the concrete structure walls and exothermically bonded to the ground rod. The ground bus must be a minimum of 1 foot above the floor of the structure and separate from other cables. Size 2 AWG bare copper pigtails must bond the grounding bus to all metal hardware within the concrete structure. Connections to the ground bus must be by exothermic welding.
- D. Grounding for ComEd manholes must be in accordance with ComEd Standard C0724.

1.19 INTERFERENCE WITH OPERATION

- A. The normal operating functions of the Airport will be continued while the work under the Contract is being accomplished. Operations and work in some areas will be permitted only at specific times and suitable weather conditions. The installation of equipment and the opening of vital circuits must be done only for minimum intervals at such times and with such restrictions as accepted and agreed upon by the Commissioner and may be required during non-regular working hours. The installation of temporary wiring may also be required to permit operations and work in certain areas.

PART 4 METHOD OF MEASUREMENT

1.20 MEASUREMENT

- A. Manholes and handholes must be measured by the number of units installed or per cluster as identified in the bid item, measured in place, completed, and accepted.

PART 5 BASIS OF PAYMENT

1.21 PAYMENT

- A. Payment will be made at the Contract unit price for each type of manhole and handhole completed and accepted by the Commissioner. This price includes full compensation for furnishing all materials; for all preparation, assembly, and installation of these materials; for all dewatering, temporary earth retention system, excavation and backfilling, for all restoration of disturbed areas and for all labor, equipment, tools, and accessories including frame and cover, cable support rack and inserts, ground rod and grounding, ladders and rungs, cable pull irons, other embeds, French Drain Sump or piped drain connection necessary to complete this item as required by these Specifications and as detailed on the Contract Drawings.

B. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
L-115-01	COMMON ELECTRICAL DUCTBANK HANDHOLE [TWO CLUSTER], NON-AIRCRAFT RATED, PRECAST	EA
L-115-02	COMMON ELECTRICAL DUCTBANK MANHOLE, AIRCRAFT RATED, PRECAST	EA
L-115-03	ELECTRICAL HANDHOLE	EA
L-115-04	COMED VEHICLE BARRIER (TRAFFIC PROTECTION)	EA

END OF SECTION L-115

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CED/FAA COMMUNICATION MH/HH AS-BUILT CHECKLIST

SECTION L-118

PART 1 DESCRIPTION

1.01 GENERAL

- A. The scope of this As-built Checklist covers CED and FAA Communication Manholes/Handholes and infrastructures only.
 - 1. The primary purpose of butterfly mapping the CED/FAA Communication MHs/HHs is to establish and provide a continuous and clear route or path for new FAA fiber optic cables from an FAA facility to another FAA facility or to the Air Traffic Control Tower. Where specified elsewhere in the contract documents, the scope of work may include the clearing and cleaning of existing ducts including removal and pulling out of abandoned cables/wires, power washing and mandrelling of existing ducts, and rehabilitation of existing ducts to provide clear paths for new innerducts and fiber optic cables.
 - 2. The secondary purpose of the MH/HH mapping and documentation is to determine, identify, and establish the remaining conduits/ducts available for future use and to verify their clear path from structure to structure as called for on the Drawings.
- B. The Contractor must prepare a CED/FAA Communication Structure Checklist for each CED/FAA communication structure constructed or existing communication structure altered. The Contractor is the prime responsible group to coordinate, verify, document, and maintain the as-built checklists until transmitted to CDA/OMP and FAA. Work requiring the checklist includes, but is not limited to:
 - 1. Installation of communication manholes or handholes (structures),
 - 2. Construction of duct bank entrances to such structures,
 - 3. Installation of communication innerducts in such structures,
 - 4. Installation of copper, fiber optic communication cables and tracer wire (tracer wire installed per Section L-110 Installation of Underground Electrical Duct) in such structures.

5. Items 2-4 above as related to existing communication structures altered.
 6. The CDA/OMP structure identification and label (per CDA/OMP naming convention) must be included and used on the form with the structure location (latitude/longitude in NAD 83 format).
- C. The checklist will document and record construction items related to a contract's communication scope of work. If a contract is installing only empty infrastructure then the checklist will document only those items installed (frames and lids, pulling eyes, ground bus, ground rod, cover ground pig tail, duct entrances, duct size and configuration, etc.). Any future work, by other contracts, such as innerduct installation, innerduct reaming, copper or fiber optic cable installations, tracer wire installations, cable tagging, cable coiling would produce a separate or updated CED/FAA Communication Manhole/Handhole Checklist documenting those items within the contract's communication scope of work and noting any other existing installations.
- D. The manhole/handhole checklist form includes a section where the Contractor will sketch the butterfly mapping of the structure with wall faces A, B, C, and D references to true duct bank entrance compass configuration. Depending on the project scope, the mapping will record number, size, configuration of cells per wall, the number, size, location of innerducts per cell, tracer wire and location, fiber optic designations, and cable tagging. The form utilizes a small standard duct bank illustration for each wall and requires larger separate sketches to be prepared and attached, if necessary, to clearly document the duct bank configuration for each wall of the structure. The Contractor should indicate and label existing cables to the extent that he sees them and cable tags that exist; the Contractor is not responsible for labeling any existing cables that don't have cable tags or tracing cables to determine what they are or verifying the accuracy of existing cable tags (unless the Contractors' scope of work specifically includes this additional labeling verification or coordination with FAA or CDA agencies).
- E. To determine a clear path, the Contractor must investigate spare ducts within a structure to allow the communications cabling to route through the structure. Depending on communication system being installed, the Contractor must designate if existing spare innerducts in that system exist, and, if so, are the spare innerducts usable to achieve the systems clear path required. Where no spare ducts or innerducts exist, the Contractor must identify any cables that are tagged as abandoned that may be cleared to provide a spare duct for establishing a clear path. When a clear path has been established by

cleaning and mandrelling or by cable removal operations, that duct must be left with a pull cord with tag indicating the clear path duct established. Clear path ducts must be indicated on the manhole/handhole checklist. The tag must alert that the identified duct(s) are dedicated to a specific agency and unauthorized use by others is prohibited.

1.02 SUBMITTALS

- A. Duly accomplished CED/FAA Communication MH/HH As-built Checklist (pages 1 and 2) – Refer to attachment.
- B. Pictures or photographs of the manholes/handholes, as required by the Commissioner.

1.03 RELATED WORK

- A. As specified in the following Sections:
 - 1. Section L-110 – Installation of Airport Underground Electrical Duct
 - 2. Section L-115 – Electrical Manholes and Handholes

PART 2 MATERIALS [NOT USED]

PART 3 EXECUTION

3.01 GENERAL

- A. The CED/FAA Communication Manhole/Handhole Checklist forms must be incorporated into the projects As-built document submittal. The documentation must also include a tabulation sheet that numbers each cell per wall; listing work per cell installed will be compiled by the CDA/OMP as new contracts and new cabling populate the CED/FAA communication duct/structure system. As a revision block is to a drawing for recording all changes, the checklist will record and document all cabling work and structure build out within a respective CED/FAA communication structure. The checklist will be used as a tool to manage cable installations and plan for future use and expansions. The Contractor will be responsible for labeling and signing off as accurate, as part of the checklist, any cables, tracer wires, or other work the Contractor installed or performed as part of the construction contract.
- B. As-built checklists prepared by the Contractor and verified as performed by the CM must be provided to CDA/OMP/FAA upon substantial completion of individual component/phase of work when

there is a transfer of building/infrastructure occupancy, and not after the completion of the entire project. Prior to pulling fiber optic cables through a loop by the FAA or other Contractor, the MH/HH as-built checklists for that entire loop must be submitted to CDA/OMP and FAA.

- C. The Contractor is required to provide redlined .pdf files prior to the Building Occupancy Date (BOD). Computer Assisted Drawing (CAD) .dgn files of pertinent as-built FAA drawings will be prepared by the CDA/OMP's Engineer of Record or other provider of Construction Phase Services within 90 days of BOD for limited segments of work associated specifically with the BOD deliverable, based upon the .pdf files.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. All work associated with the preparation, mapping, tagging, and documentation of the CED/FAA Communication MH/HH As-built Checklist will not be measured separately, but will be considered incidental to the overall contract.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. All costs associated with the preparation, mapping, tagging, and documentation of the CED/FAA Communication MH/HH As-built Checklist as described in this Section, will not be paid for separately but will be considered incidental to the overall contract.

END OF SECTION L-118

L-118 CED/FAA COMMUNICATION MH/HH AS-BUILT CHECKLIST (Page 1 of 2)
(To be submitted as Electrical As-built)

Project Name: _____

Date: _____

OMP Project No: _____

Contractor: _____

Electrical MH/HH No.: _____

Location: _____

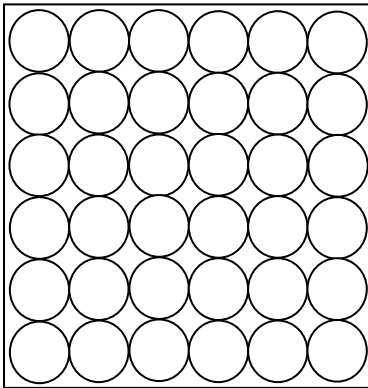
Electrical MH/HH Lid Label: _____

(Lat./Long. In NAD 83 Format)

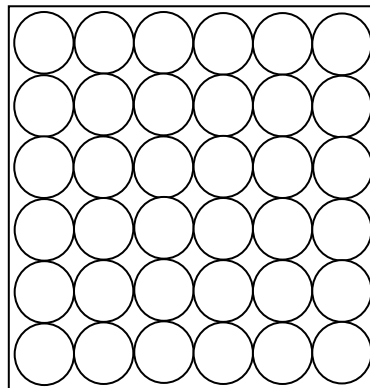
*Draw innerduct location in conduit & indicate labeling. Use page 2 of 2 if necessary

KEY PLAN OF MH/HH

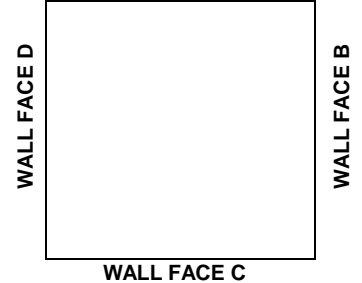
WALL FACE A



WALL FACE B

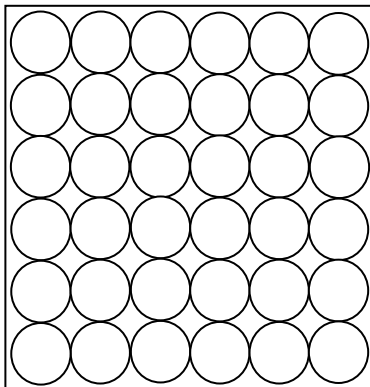


WALL FACE A

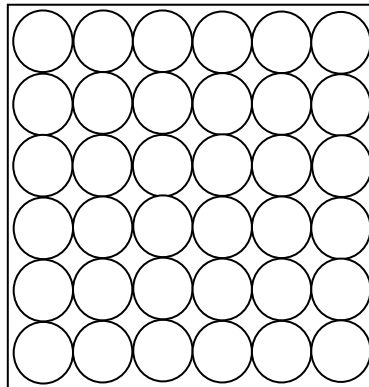


Note: Indicate in the Box, the Direction of the True North for Reference.

WALL FACE C



WALL FACE D



NOTES:

Y	N	N/A	MHs and HHs
<input type="checkbox"/>	<input type="checkbox"/>		Existing MH / HH
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Fiber Loop per FAA detail
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Security Fiber looped per FAA detail
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	FAA FOTS Loop Tags present
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Tracer wire in place per plan
<input type="checkbox"/>	<input type="checkbox"/>		Uniduct for tracer wire identified in Grey
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Saddle Racks / Rack Arms Installed
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Ground Rod Installed
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Pulling Eyes Grounded
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Frame Grounded
<input type="checkbox"/>	<input type="checkbox"/>		Ground Bus Installed
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Mech Seal Installed in used Innerduct
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Tuckpoint Conduits
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	MH / HH Cleaned (New installation only)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Pull strings installed (New MH & HH Only)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Conduit Mandrelled
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Document cell used
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Innerduct installed / color (circle below)
			Yellow Grey Orange

Ductbank Legend
 (to be filled in per Project)

 Name of Contractor F.M. Signature Date

 Name of OMP Inspector Signature Date

 Name of FAA Inspector Signature Date

L-118 CED/FAA COMMUNICATION MH/HH AS-BUILT CHECKLIST (Page 2 of 2)

(To be submitted as Electrical As-built)

Project Name: _____ Date: _____

OMP Project No: _____

Contractor: _____

Electrical MH/HH No.: _____

Location: _____

Electrical MH/HH Lid Label: _____

(Lat./Long. In NAD 83 Format)

	A	B	C	D	E	F	G	H	I	J	K	L
Wall Face A <input type="checkbox"/> B <input type="checkbox"/>	1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
C <input type="checkbox"/> D <input type="checkbox"/>	3	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	4	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
(Identify Cells as A1, B1, ...K6, L6, ...)	5	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	6	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

CELL No. _____

Contents Description: _____

CELL No. _____

Contents Description: _____

CELL No. _____

Contents Description: _____

CELL No. _____

Contents Description: _____

CELL No. _____

Contents Description: _____

CELL No. _____

Contents Description: _____

Name of Contractor F.M.

Signature

Date

Name of OMP Inspector

Signature

Date

Name of FAA Inspector

Signature

Date

MOBILIZATION AND CLOSEOUT DOCUMENTATION

SECTION M-101

PART 1 DESCRIPTION

1.01 GENERAL

- A. The work must consist of preparatory work and operations necessary for permits, the movement of personnel, equipment, supplies, and incidentals to the Project site; for the establishment of offices, buildings, and other facilities necessary for work on the Project; for any and all required utilities, including coordination with ComEd and provisions for ComEd secondary service to Contractor Staging/Trailer Area; and for all other administrative work or operations which must be performed, or costs incurred when beginning work on the Project. This work also consists of demobilization of equipment, trailers, supplies, clean up, and close-out of the project.
- B. The Contractor must submit all documents as described in Part Two, General Conditions of the Specifications prior to the first request for partial payment for Mobilization:
 - 1. Construction Operations Plan Part 2, Article IV.D.1
 - 2. Sustainability Requirements: Part 2, Article IV.D.2
Contractor/Subcontractor
Equipment Verification Report;
Local/Regional Materials Estimate;
Recycled Content Estimate;
Sustainable Temporary Construction
Materials Pre-Construction
Estimate; Construction Waste
Management Plan and C&D
Recycling Worksheet
 - 3. Anticipated Workforce Projection Part 2, Article IV.D.3
Form
 - 4. Procedures, Methods, Structures Part 2, Article IV.D.4
and Equipment
 - 5. Subcontractor Agreements Part 2, Article V.C.1
 - 6. Source of Materials Part 2, Article VI.E.2.a

- | | |
|--|---------------------------------------|
| 7. Key Personnel | Part 2, Article VII.B.1 |
| 8. Baseline Schedule | Part 2, Articles VIII.E.2.b and E.4.a |
| 9. Shop Drawings, Product Data and Samples, "Index and Schedule" | Part 2, Article XI.B.4 |

1.02 CLOSEOUT DOCUMENTATION INCLUDES

- A. The Work must consist of preparing and obtaining approval of the closeout documentation per Part 2, Article IX.G. Contractor must submit all documents as described in Part Two, General Conditions of the Specifications and receive acceptance from the Commissioner prior to the request for payment for Closeout Documentation and includes the items below:
 - 1. All permits – Part 2, Article III.E
 - 2. Final Punch List Completed – Part 2, Article VIII.D
 - 3. Record Shop Drawings – Part 2, Article XII.C
 - 4. As-Built Contract Drawings – Part 2, Article XII.A
 - 5. O&M Manuals – Part 2, Article XII.B
 - 6. Contract Warranty – Part 2, Article VI.F.1
 - 7. Manufacturers' Warranty – Part 2, Article VI.F.2
 - 8. Contractor Demobilization Completed – Part 2, Article IX.G.3.a
 - 9. Final Waivers – Part 2, Article IX,G.2.d
 - 10. Final Sworn Statement and Affidavit – Part 2, Article IX.G.2.b

PART 2 PRODUCTS – Not Applicable

PART 3 EXECUTION – Not Applicable

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Measurement will be made for Mobilization as a lump sum.

- B. No separate measurement will be made for coordination with ComEd and establishing ComEd secondary service to the Contractor Staging/Trailer Areas.
- C. Measurement will be made for closeout documentation for a lump sum amount of \$500,000.

PART 5 BASIS OF PAYMENT

5.01 MOBILIZATION

- A. The Contractor is to include a cost for this item not to exceed six percent (6.0%) of the total Contract bid amount.
- B. Partial payment of the lump sum for Mobilization will be made in accordance with the following schedule:
 - 1. The Contractor may draw 75% of the pay item as part of the first request for partial payment.
 - 2. When 10% or more of the original Contract amount is earned, an additional 15% of the pay item will be paid.
 - 3. When 90% or more of the revised Contract amount is earned, the remaining balance of the pay item will be paid.
- C. Nothing herein must be construed to limit or preclude partial payments for other items as provided for by the Contract.
- D. Payment will be made under the item Mobilization (Total Price for Mobilization Must Not Exceed 6% of the Total Base Bid), per lump sum.

5.02 CLOSEOUT DOCUMENTATION

- A. Payment will be made under the item Closeout Documentation per lump sum for \$500,000 after all documentation has been accepted by the Commissioner.

END OF SECTION M-101

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AIRPORT SAFETY AND SECURITY

SECTION M-103

PART 1 DESCRIPTION

1.01 GENERAL

- A. The work for this project will occur within, adjacent to, or in the vicinity of the Aircraft Operations Area (AOA) and is subject to the operational safety and security requirements of the City of Chicago Department of Aviation (CDA), O'Hare Modernization Program (OMP) and the FAA. The Contractor must comply with any additional requirements as may be deemed necessary by the aforementioned organizations at no cost to the Owner.
- B. During the performance of Airport Safety and Security work the Contractor must adhere to the applicable provisions set forth in Part Two General Conditions, Article XIV – Safety and Environment and Article XV – Airport Security and Operations, Airport Safety and Security, Code of Federal Regulation (14 CFR) Part 139 and Part 77, O'Hare International Airport Certification Manual (ACM) all applicable FAA Advisory Circulars, the FAA's determination on the preliminary 7460-1 submitted for the project, the Construction Safety and Phasing Plan (CSPP) and as described herein.
- C. Contractor must carry out his operations in a manner that must minimize interference with air traffic, and must cooperate with the FAA, the Commissioner, the Airlines, and other Contractors working in the area. The Contractor must designate a full-time safety representative for the Project in accordance with Paragraph XIV. B of Part 2 - General Conditions. All work must be completed in accordance with the City of Chicago Department of Aviation's Airport Construction Safety Manual, the Construction Safety and Phasing Plans, 14 CFR Part 139, 14 CFR Part 77, all applicable FAA Advisory Circulars (AC's), specifically FAA AC 150/5370-2 Latest Edition, Operational Safety on Airports During Construction, the O'Hare International Airport Certification Manual, and the Contract Documents.
- D. All personnel that will be badged and allowed to perform work or duties within the AOA must complete the mandatory "303 Training" every year. Refer to the *CDA/OMP Standard Notes on General Requirements* for the requirements and details of the "303 Training".
- E. Refer to the *CDA/OMP Standard Notes on General Requirements* for requirements and details on Traffic Control, Safety Requirement, and

ID Badging Process; Staging and Storage Areas; and 14CFR Part 139 Requirements.

- F. All vehicles and vehicle operations must comply with the Chicago Airport System, O'Hare and Midway International Airports, Ground Motor Vehicle Operation Regulation Manual, latest edition.
 - 1. All vehicles must be equipped with flashing yellow lights and must have their headlights and flashing yellow lights turned on at all times while on the airfield or Aircraft Operations Area (AOA).
- G. The Contractor must supply, place, maintain, move and store the items listed herein, as appropriate, to facilitate construction and protect aircraft traffic. An adequate extra supply of these items must be available on site at all times.

PART 2 EQUIPMENT AND MATERIALS

2.01 WARNING LIGHTS

- A. Warning lights must be flashing red lights meeting the requirements of the latest edition of the "Manual on Uniform Traffic Control Devices" for Type A and Type B flashers.

2.02 WARNING MARKERS

- A. Warning markers must be the type and size detailed on the Plans. Markers must be equipped with a red warning light per Paragraph 2.01A.

2.03 BARRICADES

- A. All efforts are to be made to utilize O'Hare specific "A" frame barricades as detailed in the CDA/OMP Standards. However, if they are not available in emergency situations, IDOT Type II barricades may be used. Barricades must be Class A barricades, as detailed on the Plans. The stabilization tube must consist of alternating orange and white fluorescent stripes and must be filled with sand to prevent damage or dislodging resulting from jet blast. Each barricade must be equipped with a red light as detailed on the Plans. An adequate supply of such barricades must be kept on the Project site. The barricades must be placed in locations as directed by the Commissioner.

- B. Low slung barricades and/or low mass low profile lighted barricades shall be as detailed on the Plans.

2.04 TEMPORARY SAFETY AREA FENCE

- A. All AOA, runway safety areas (RSA) and taxiway object free areas (TOFA), TSA, ROFA, TOFA, and NAVAID critical areas affected by construction work must be designated and marked with a clearly visible fence. The fence must be made of wood posts or stakes and a durable orange fabric stapled to the posts.
- B. Wood supports must meet the following requirements:
 - 1. Posts/stakes must be kiln dried oak or hickory.
 - 2. Posts/stakes must be peeled, sound, straight-grained, and free from decay, cracks, and splits.
 - 3. Posts/stakes must be 48 inches long and have a cross section of 2 inches by 2 inches. Any safety fence used within a ROFA or TOFA cannot be higher than 18 inches. Safety fence to delineate the outer limits of OFAs can be 36 inches in height.
 - 4. Outer bark must be completely removed from all posts/stakes including depressions.
 - 5. Support and bracing of wood posts/stakes, where needed must be of the same material and quality as the wood supports
- C. Fabric must be sized appropriately, i.e. 12 inches wide (for the 18-inch high fence) or 30 inches wide (for the 36-inch high fence) and orange in color. Fabric must be woven polyester, polypropylene, stabilized nylon, polyethylene, or polyvinylidene chloride and meet the following requirements:
 - 1. Minimum grab tensile strength in the machine direction per ASTM D4632 = 120 lb (550 N)
 - 2. Minimum grab tensile strength in the cross machine direction per ASTM D4632 = 100 lb (450 N)
 - 3. Minimum ultraviolet stability, percent of strength retained after 500 hours exposure per ASTM D4355 = 70%
- D. Fabric must be stapled to the wood supports using No. 9 galvanized steel wire staples that are at least 1 inch long but no longer than 1-1/2 inches. Staples must be 3/4 inch wide.

- E. The Contractor shall furnish, install, maintain, and remove upon project completion.
- F. Safety fence used to delineate runway or taxiway critical areas must maintain a 6-inch gap between the grass line and the bottom of the fabric to allow for efficient maintenance of vegetation cutting.

2.05 TEMPORARY UNDERGROUND UTILITY MARKING

- A. Prior to start of earthwork, all underground utilities (including but not limited to FAA ducts and cables, electrical and ComEd ductbanks and cables, telephone and communication lines, gas mains, watermains and sewer pipes, fuel lines, etc.) on the work area must be delineated with 2 inch diameter and 5 feet minimum length Schedule 40 PVC pipe posts with APWA colored labels identifying the specific utility type or as directed by the Commissioner. Refer to OMP Detail Nos. 1-10/B1 and 1-10/B2.
- B. Install the temporary underground utility marking in accordance with Paragraph 3.20.

PART 3 EXECUTION

3.01 CONTROL REQUIREMENTS

- A. The Contractor will be held responsible for controlling his employees and his Subcontractors and their employees, with regard to traffic movement.
- B. The Contractor must rebuild, repair, restore, and make good at his own expense all injuries or damages to any portion of the work occasioned by his use of these facilities before completion and acceptance of the work.
- C. The Contractor must submit to the Commissioner in writing a detailed construction operation plan as outlined in Paragraph IV. D of Part II, General Conditions. The plan must include, but not be limited to, construction sequencing of earthwork, paving, drainage, airfield lighting, signing and electrical systems, equipment haul roads, light plants and maintenance of airfield electrical and NAVAID power and control circuits. The plan must also include a breakdown of the work in each construction phase, as described in the Construction Phasing Plans. At least 14 calendar days before commencing work in each phase, an updated plan must be submitted for approval. No work within the construction phase may commence until the phase work plan is approved.
- D. The Contractor must submit to the Commissioner in writing an Airport Traffic Management Plan, as outlined in Paragraph IV. D of Part II,

General Conditions. The plan must address the control of construction equipment and vehicular movements for each construction phase.

- E. The Contractor must provide a responsible Traffic Manager whose duty will be to direct all traffic on or near active runways, taxiways, haul roads, and highways. Paved surfaces must be kept clear at all times and specifically must be kept free from all debris which might damage aircraft.
- F. The Contractor must prepare a security badge control plan for review by the Commissioner. The plan must be submitted prior to or at the Pre-Construction Meeting. No work may commence until this plan is approved. The plan must be prepared on the Contractor's company letterhead and signed by the company representative who is authorized to sign the badge applications. The plan must describe, in detail, the Contractor's and/or Subcontractor's plan to control badges.
- G. The Contractor must submit to the Commissioner in writing a detailed safety plan that outlines the procedures and methods intended to be used to maintain the safety of the airfield, the traveling public and the Contractor's employees. The plan must be broken down by each construction phase and must be submitted at least 14 days prior to beginning construction. No work may commence until the Contractor's safety plan is approved in writing and can be immediately implemented. The plan should address the following items, as applicable:
 - 1. Scope of work to be performed, including proposed duration of work.
 - 2. Procedures and methods of protecting and maintaining all runway and taxiway lighting fixtures and conditions of all pavement marking.
 - 3. Procedures for protecting all operational runway and taxiway areas as shown on the Construction Phasing Plans. This includes limitations on equipment height and stockpiled materials.
 - 4. Areas and operations affected by the construction activity, including possible safety problems.
 - 5. NAVAIDs that could be affected, especially critical area boundaries, and temporary marking of underground FAA utilities.

6. Methods of separating vehicle and pedestrian construction traffic from the Airport movement areas. This may include barricades, barriers, or fencing off construction areas to keep equipment operators in restricted areas in which they are authorized to operate. Fencing, or some other form of restrictive barrier, is an operational necessity in some cases.
7. Procedures and equipment, such as barricades (identify type), to delineate closed construction areas from the Airport operational areas, as necessary.
8. Limitations on construction.
9. Required compliance of Contractors or personnel with all Airport safety and security measures.
10. Location of stockpiled construction materials, construction site parking, and access and haul roads.
11. Radio communications.
12. Vehicle information.
13. Trenches and excavations and cover requirements.
14. Procedures for notifying ARFF personnel if water lines or fire hydrants must be deactivated or if emergency access routes must be rerouted or blocked.
15. Emergency notification procedures for medical and police response.
16. Use of temporary visual aids.
17. Wildlife management.
18. Foreign object debris (FOD) control provisions.
19. Hazardous materials (HAZMAT) management.
20. Notice to Airmen (NOTAM) issuance.
21. Inspection requirements.
22. Procedures for locating and protecting existing underground utilities, cables, wires, pipelines and other underground facilities in excavation areas.

23. Procedures for contacting responsible representatives / points of contact for all involved parties. This should include off-duty contact information so an immediate response may be coordinated to correct any construction-related activity that could adversely affect the operational safety of the Airport. Particular care should be taken to ensure that appropriate Airways Facilities personnel are identified in the event that an unanticipated utility outage or cable cut occurs that impacts FAA NAVAIDs.
 24. Vehicle operator training.
 25. Penalty provisions for noncompliance with Airport rules and regulations and the safety plan (e.g., if a vehicle is involved in a surface incident).
 26. Any special conditions that affect the operation of the Airport and will require a portion of the safety plan to be activated (e.g., low-visibility operations, snow removal).
- H. The Contractor must provide a responsible full time safety representative whose duty it is to monitor Contractor activities for compliance with all federal, state and local laws. This person must be on-site at all times when any construction activity or setup is taking place.
- I. Under the requirements of Advisory Circular 150-5370-2 Latest Edition, a Construction Safety Phasing Plan (CSPP) has been developed for this Project and submitted to the FAA and CDA for review and approval.

It is the responsibility of the Contractor to carefully review the FAA's Preliminary 7460-1 determination, the CSPP and submit a Safety Plan Compliance Document (SPCD) to the Commissioner for review and approval. The SPCD must be submitted and approved prior to any construction activities associated with the project beginning on the AOA.

The Contractor shall identify any deviations, revisions or modifications to the CSPP. Any changes must clearly identify the following:

- I. The reason why the deviation, revision or modification is required.
- II. Provide detailed and sufficient narrative and/or graphical descriptions of the proposed changes so a complete review of the proposal can be made.

III. Detail interaction between new or revised construction activities and aircraft/airport operations.

IV. Monetary values are not to be included in the description of proposed changes.

Any construction details that may not have been addressed at the time of the submission of the CSPP must be addressed in the SPCD. The SPCD does not restate or propose differences to provisions already stated in the CSPP. If there are no deviations, revisions or modifications to be made to the CSPP, the Contractor must clearly state: "No deviations, revisions or modifications to the CSPP are proposed".

Pursuant to AC 150-5370-2F section 104.c.1:

"Submit a Safety Plan Compliance Document (SPCD) to the airport operator describing how it will comply with the requirements of the CSPP and supplying any details that could not be determined before contract award. The SPCD must include a certification statement by the contractor that indicates it understands the operational safety requirements of the CSPP and it asserts it will not deviate from the approved CSPP and SPCD unless written approval is granted by the airport operator. Any construction practice proposed by the contractor that does not conform to the CSPP and SPCD may impact the airport's operational safety and will require a revision to the CSPP and SPCD and re-coordination with the airport operator and the FAA in advance".

Pursuant to AC 150-5370-2F section 204.b:

"The Safety Plan Compliance Document (SPCD) should include a general statement by the construction contractor that he/she has read and will abide by the CSPP. In addition, the SPCD must include all supplemental information that was not included in the CSPP prior to the contract award. The contractor statement should include the name of the contractor, the title of the project CSPP, the approval date of the CSPP, and a reference to any supplemental information (that is, "I, Name of Contractor, have read the Title of Project CSPP, approved on Date, and will abide by it as written and with the following additions as noted.") The supplemental information in the SPCD should be written to match the format of the CSPP indicating each subject by corresponding CSPP subject number and the title. If no supplemental information is necessary for any specific subject, the statement, "No supplemental information", should be written after the corresponding subject title. The SPCD should not duplicate information in the CSPP."

The SPCD must also identify the contractor's on-site employee(s) who

will be responsible for compliance with the CSPP and SPCD during all construction activities. At least one employee must be on-site whenever construction activities are occurring.

3.02 VEHICLE AND PEDESTRIAN CONTROL

- A. Vehicle and access routes for Airport construction will be controlled as necessary to prevent inadvertent or unauthorized entry of persons, vehicles or animals onto the Air Operations Area (AOA). No vehicle will enter the AOA except at predetermined locations. The amount of construction traffic will require the Contractor to use security guards at access gates and flagpersons to control traffic crossing active taxiways. Two (2) bonded security guards are required at each access location when the Contractor works airside. Crossing of runways is to be avoided if at all possible. Any runway crossings that may be necessary must be approved by the Commissioner. Any vehicle crossing a runway must receive clearance through the CDA from the ATCT specifically Ground Control on their frequency. The Contractor is not to contact the ATCT directly. Contractor personnel who operate vehicles in the AOA must comply with the Airport operator's rules and regulations for vehicle marking, lighting, and operation as described in Article XV – Airport Security and Operations of Part 2 – General Conditions. Failure to comply may result in fines.

3.03 CONTROL AND WARNING DEVICES

- A. The Contractor must furnish and maintain warning markers as detailed on the Plans at the locations designated by the Commissioner. The Contractor must maintain warning markers and red warning flags around all equipment, stockpiles, or other areas as directed by the Commissioner.
- B. The Contractor must provide the phone numbers of three (3) of its personnel, including the Project superintendent, who may be contacted in an emergency. Personnel must be on call 24 hours per day for maintaining warning markers. The Contractor will employ watchmen to maintain and service all traffic control equipment.

3.04 VEHICLE MARKING AND IDENTIFICATION

- A. Large construction vehicles used on a job site located in the AOA must display in full view above the vehicle a 3' x 3' or larger, orange and white checkerboard flag, each checkerboard color being 1-foot square. Construction vehicles include but are not limited to: bull dozers, earth moving vehicles, paving machines, excavating machines, grinders, backhoes, lifting cranes, etc. Any construction vehicle operating in

the AOA must be equipped with a flashing amber (yellow) dome-type light, mounted on top of the vehicle and of such intensity to conform to local codes for maintenance and emergency vehicles. All vehicles operating within the airfield boundary must be identified with a sign on each side of the vehicle bearing the Contractor's name.

- B. All other vehicles that do not fall into the category in 3.04.A, must be equipped with a rotating or flashing yellow light (strobe, LED, or incandescent) mounted on the top of the vehicle and the light must be visible and in operation anytime the vehicle is on the AOA.
- C. Vehicles making only occasional visits to the job site are exempt from the identification requirements contained above provided that a properly identified vehicle escorts them into, through, and out of the AOA. These and other vehicles needing intermittent identification may be marked with tape or with magnetically attached markers that are commercially available.

3.05 VEHICLE TRAFFIC AND OPERATIONS

- A. When any vehicle other than those approved for use in the AOA is required to travel to or from the work area or over any portion of the work area, it must be escorted by a vehicle properly identified to operate in the area and be provided with a flag on a staff attached to the vehicle. All construction vehicles/equipment must have automatic signaling devices to sound an alarm when moving in reverse. All equipment must be operated within the approved speed limit(s).

3.06 VEHICLE PARKING

- A. All vehicles must be parked and serviced in the designated staging and employee parking areas. The Contractor is responsible for transporting his/her employees from these areas to the jobsite.

3.07 RADIO COMMUNICATIONS

- A. The control of vehicular activity on the AOA is of the highest importance and requires coordination with the Airport users and the Air Traffic Control Tower (ATCT). The Contractor will have no direct contact with ATCT Ground Control. All communications with ATCT will be coordinated through CDA personnel. However, the Contractor must properly train his/her personnel, particularly flagpersons, on the proper procedures for monitoring radio frequencies.
- B. All vehicles and/or construction equipment operating inside the active AOA, but outside of the designated haul roads, must be escorted by

CDA personnel, who will maintain radio contact with the ATCT. Crossing an active runway will not be permitted. Vehicular traffic crossing an active taxiway will be controlled by the CDA via two-way radio with the ATCT and through the use of a CDA escort or a flagperson. Active runways and taxiways are those pavements being used for the operation of aircraft. The clearance will be through the CDA escort and confirmed by the driver's personal observation that no aircraft is approaching his/her position. Aircraft always have the right-of-way and construction equipment must always yield to aircraft.

- C. The Contractor must have a flagperson stationed on each side of an active taxiway crossing to monitor aircraft movement and to direct construction traffic. The flagperson must be equipped with handheld signs or flags to assist in the direction of construction traffic. The flagperson must also be equipped with lighted wands and light plants on each side of the taxiway during nighttime construction. In addition, one vacuum sweeper must be dedicated to and stationed full time at each active taxiway crossing to maintain the surface of the taxiway free from construction traffic debris. Mud and other material tracked onto taxiway surfaces must be removed by hand if necessary to achieve its complete removal. The Contractor must arrange a physical inspection of the completed work area with CDA for inspections prior to opening for aircraft use any runway, taxiway, ramp area or Airport roadway that has been closed for work, or that has been used for a crossing point or haul route by the Contractor.
- D. All flaggers are required to complete the O'Hare Flagger Certified Training Program. Flag persons will not be permitted to operate on the airfield in that capacity until all training requirements are met.

3.08 AIRPORT SECURITY REQUIREMENTS

- A. The Airport is operated in strict compliance with Federal Aviation Regulation (FAR) Part 107, 49 CFR Parts 1520 (Protection of Sensitive Security Information), 1540 (Civil Aviation Security), and 1542 (Airport Security), which prohibits unauthorized persons or vehicles in the AOA. Equipment and personnel will be restricted to the work area defined on the Plans. Any violations by Contractor's personnel will subject the Contractor to penalties imposed by the FAA and the CDA Airport Security Office.
- B. Airport restricted areas are fenced and must remain fenced at all times. Any required temporary security fences and/or gates will be constructed by the Contractor. The gates will remain closed and locked, or if it is being continuously used for ingress and egress, a gate operator will be provided at the Contractor's expense. The

Contractor must furnish the gate operator with a roster of personnel and ensure that each individual has adequate identification. Interlocking locks supplied by the Contractor will not be allowed.

- C. Gate guards, as required by Part Two of the Contract documents, provided by the Contractor will be provided direct and/or indirect methods of communications to contact the CDA. Direct access is defined as a guard having immediate access to a telephone. Indirect access is defined as the guard having a radio that communicates with an individual who has direct access. Gate guards are to be instructed on rules of performance relative to AOA Security. Entrance to the airfield is subject to strict security regulations. All personnel entering the airfield must obtain and display security identification badges and all vehicles must have and display special permits which are available through the CDA Security Badge Office. All vehicles are subject to inspection upon entering the AOA. All vehicles may be searched each time prior to entering or exiting the security checkpoint and may be subject to random searches while operating in the AOA.
- D. All vehicle deliveries must be coordinated in advance. The persons escorting the delivery will coordinate with the Commissioner. The vehicle license plate and expected delivery time must be provided. The Contractor may compile the expected daily delivery schedule on one (1) sheet for submission to the Commissioner. The vehicle operator must have in his or her possession a commercial manifest, which identifies the contents of the vehicle and/or trailer. An escort from the company for whom the shipment is intended must respond to the vehicle access gate and remain with the vehicle until the vehicle exits the secured area. Once the vehicle search is completed, vehicles will be permitted escorted access to their delivery point. Priority consideration may be offered to concrete trucks, with resulting delays estimated to be 20 minutes. To receive priority consideration, concrete deliveries must be scheduled with Airport security at the time of batching. These requirements may severely reduce throughput of vehicles entering the AOA at these check points, thereby potentially affecting the execution time of some construction activities. The Contractor must account for the possible loss of time associated with these vehicle searches in his/her bid. No additional time or compensation will be permitted for actions resulting from these vehicle searches.
- E. The Contractor must maintain the security integrity between the public and the AOA. All barrier designs and their phasing must be submitted to and approved by the Commissioner, in writing, prior to erection.

- F. All construction personnel assigned to the Project, except for escorted in-transit material suppliers, must make application for and wear security badges. The prime Contractor and the Subcontractor can make application for these items by contacting the City of Chicago CDA at (773) 894-3828 (Badging Office) to make arrangements. The Contractor must comply with all provisions of the latest version of the Chicago Airport System Security Credentials Manual Policy and Procedures Handbook. The Contractor will be responsible for assuring that all employees have background checks performed in accordance with CDA security badging procedures. Photo identification badges will be made for each employee. Replacement cost for lost badges is \$50.00. Badges must be surrendered upon termination of the employee or Contract.
- G. Company official/officials listed on the company application for AOA access must sign each individual employee badge application form and state why the individual badge is required.
- H. The Contractor must maintain an up-to-date record of all badge holders showing name, address, sex, height, weight, eye color and badge number. The Contractor will be required to furnish this information to the Airport upon request.
- I. The Contractor must restrict passage into the secured area to badged persons, vehicles and equipment displaying company identification or that of the Airport. Should the Contractor wish to allow visitors, vendors or delivery vehicles through access points, the following items must be provided:
 - 1. A method, acceptable to the CDA, of temporarily placing company identification on each person or vehicle. (An acceptable alternate will be to provide an escort for each person or vehicle).
 - 2. Each person or vehicle entering the secured area displaying the Contractor's identification or under escort will carry the full coverage of his liability and property damage.
- J. The Contractor will be responsible to provide at his own cost an escort service for all vehicles that do not operate on a daily basis within the AOA. Escorted vehicles must not be left unattended. Any escorted vehicle allowed on the AOA by the Contractor must be escorted back and forth to the point of entry.

- K. The Contractor is required to submit a plan on how he/she will safely operate within the AOA. This plan must be submitted and approved by the Commissioner before the commencement of any construction.
- L. The Contractor will contact the Security Manager, telephone (773) 894-3828 ten (10) days prior to start of construction to submit the necessary Airport security information for all vehicles and personnel required inside the restricted area during construction.

3.09 VIOLATION OF RESPONSIBILITIES

- A. Any violation of Paragraphs 3.01 through 3.08 must be considered a violation of the Contract itself and will be sufficient cause for halting the work without extending the time limit of the Contract.

3.10 COORDINATION OF CONSTRUCTION ACTIVITIES

- A. The Contractor must contact the Commissioner each day before work begins to coordinate the status and nature of work to be done that day. The Contractor must also report to the Commissioner at the end of each day to schedule the work planned for the following day.
- B. Violations of any coordination requirements will be considered a violation of the Contract itself and will be sufficient cause for halting the work without extending the time limit of the Contract.

3.11 SAFETY REQUIREMENTS

- A. Before entering upon or crossing any runway or taxiway, the Contractor will obtain permission from the Commissioner, who will request the proper clearance through the CDA escort from the ATCT. Emergencies and operating conditions may necessitate sudden changes, both in Airport operations and in the operations of the Contractor. Aircraft operations must always have priority over any and all of the Contractor's operations. Should runways or taxiways be required for the use of aircraft and should Airport operations, the ATCT, or the Commissioner deem the Contractor to be too close to active runways or taxiways the Contractor must suspend operations, remove personnel, plant, equipment, and materials to a safe distance and stand by until the runways and taxiways are no longer required for use by aircraft. There will be no compensation for delays or inefficiencies due to these changes.
- B. Throughout the duration of the job, any practice or situations that the Commissioner determines to be unsafe or a hindrance to regular Airport operations will be immediately rectified.

- C. Any violation of these safety requirements will be considered a violation of the Contract itself and will be sufficient cause for halting the work without extending the time limit of the Contract.
- D. The Contractor must acquaint supervisors and employees with the operations that are inherent to Chicago O'Hare International Airport and must conduct construction activities to conform to all routine and emergency air traffic requirements and guidelines for safety specified herein. The Contractor will be responsible for providing all safety devices as required for the protection of personnel.
- E. Protection of all persons must be provided throughout the progress of the work. The work must proceed in such a manner as to provide safe conditions for all workers and personnel. The sequence of operations must be such that maximum protection is afforded to ensure that personnel and workers in the work area are not subject to any dangerous conditions. The Contractor must provide safety measures to guard against injury.
- F. During the performance of this Contract, the Airport facility must remain in use to the maximum extent possible. Use of areas near the Contractor's work will be controlled to minimize disturbance to the Airport's operation. The Contractor must not allow employees, Subcontractors, suppliers, or any other unauthorized person to enter or remain in any Airport area which would be hazardous to persons.
- G. All work to be performed which is too close to an active runway, taxiway or apron under operational conditions must be performed when the runway, taxiway or apron is not in use. Such work must not be accomplished without prior permission from the Commissioner. Requested closings must be directed to the Commissioner in writing at least 72 hours in advance. The Commissioner will then notify the CDA of the upcoming closure.
- H. The Contractor must be aware of the following types of safety problems and/or hazards. These problems or hazards will not be permitted. Should any of these problems or hazards arise during construction, the Contractor must immediately rectify/correct the problem or hazard to the satisfaction of the Commissioner and CDA Personnel:
 - 1. Trenches, holes, or excavations on, adjacent to, or within 250 feet of the centerline of any active runway.

2. Unmarked/unlighted holes or excavation in any apron, active taxiway, or within 124/137 feet of the centerline of any active Aircraft Design Group (ADG) V/VI taxiway, respectively.
3. Mounds or piles of earth, construction materials, temporary structures, or other objects within 400 feet of the centerline of any active runway unless indicated in the approved CSPP, or within 160/193 feet of any active ADG V/VI taxiway, respectively, or in a related safety, approach, or departure area.
4. Vehicles or equipment (whether operating or idle) on any active runway, taxiway, taxilane, or in any related safety, approach, or departure area, ROFA and TOFA.
5. Vehicles, equipment, excavations, stockpiles, or other materials which could degrade or otherwise interfere with electronic signals from radios or electronic navigational aids (NAVAIDS).
6. Runway paving projects resulting in excessive lips greater than 1 inch between abutting pavement edges and exceeding 3 inches for edges between the edge of pavements and new surfaces at runway edges and ends.
7. Unmarked utility, NAVAID, weather service, runway lighting, or other power or signal cables that could be damaged during construction.
8. Objects (whether or not marked or flagged) or activities anywhere on or in the vicinity of the Airport which could be distracting, confusing, or alarming to pilots during aircraft operations.
9. Unflagged/unlighted low visibility items (such as tall cranes, drills, and the like) anywhere within the limits defined in Item 3, or in any approach or departure area.
10. Misleading or malfunctioning obstruction lights or unlighted/unmarked obstructions in an approach to any open runway.
11. Inadequate approach/departure surfaces needed to assure adequate landing/takeoff clearance over obstructions or work or storage areas.

12. Inadequate, confusing or misleading (to user pilots) marking/lighting of runways, taxiways, or taxilanes, including displaced or relocated thresholds.
 13. Water, dirt, debris, or other transient accumulation which temporarily obscures pavement marking, pavement edges, or derogates visibility of runway/taxiway marking or lighting.
 14. Inadequate or improper methods of marking, barricading, and lighting of temporarily closed portions of the AOA.
 15. Trash or other materials with foreign object debris (FOD) damage (FOD) potential, within the limits defined in Item 3.
 16. Inadequate barricading or other marking which is placed to separate construction or maintenance areas from active aircraft operating areas.
 17. Failure to control vehicle and human access to active aircraft operating areas.
 18. Failure to maintain radio communication between construction/maintenance vehicles and the ATCT, as coordinated with Chicago Department of Aviation Operations personnel.
 19. Construction/maintenance activities or materials which could hamper the response of Aircraft Rescue and Firefighting (ARFF) equipment from reaching all aircraft or any part of the runway/taxiway system, runway approach and departure areas, and aircraft parking locations.
 20. Bird attractants on Airport, such as edibles (food scraps, etc.), miscellaneous trash, or ponded water.
 21. Parking or staging of material or equipment on closed pavements. However, in the event of larger pieces of construction equipment that cannot be readily moved, these may be permitted to be parked on closed pavements provided prior approval is received from CDA Operations and the equipment are properly barricaded and lighted.
- I. The Contractor must conduct activities so as not to violate any safety standards contained herein. The Contractor must inspect all construction and storage areas as often as necessary and promptly

take all steps needed to prevent/remedy any unsafe or potentially unsafe conditions/activities discovered.

- J. Before actual commencement of construction activity, the Contractor must notify in writing, at least seven (7) days in advance, the CDA and the Commissioner of his intentions to begin construction, stating the proposed time, date, and area in which commencement is to occur in order for the appropriate NOTAM to be issued.
- K. Upon completion of work and return of all related areas to standard conditions, the Contractor must again notify the CDA and the Commissioner in writing, and describe the area that is complete and available for normal Airport operations.
- L. Debris, waste and loose material or any other FOD (including dust and dirt) capable of causing damage to aircraft landing gear, propellers or being ingested in jet engines must not be allowed on active aircraft movement areas or adjacent infield areas. Materials observed to be within these areas must be removed immediately and/or continuously by the Contractor. The Contractor must be required to have an adequate number of sweeping machines and operators on site, ready at all times during construction activity. Where travel on or across runways, ramp areas, taxiways or aircraft aprons is required, the Contractor must provide adequate personnel and equipment to keep such surfaces clear of debris at the discretion of the Commissioner. Closed pavements must be swept clean prior to reopening to aircraft traffic. Exposed earth in excavation areas within 75 feet of the centerline immediately adjacent to active taxiways must be covered to prevent dust from jet blast. Cover material must be weighted to prevent movement from jet blast.
- M. Flagpersons. In accordance with the Specifications, the Contractor must furnish, at his or her own expense, flag persons as necessary at each taxiway crossing location at all times to control traffic unless otherwise directed by the Commissioner as indicated in the Contract documents. Flaggers are required to complete the O'Hare Flagger Certified Training Program. Flagpersons will not be permitted to operate on the airfield in that capacity until all training requirements are met.
- N. Trenches, Excavations and Stockpiled Material. Open trenches or excavations exceeding 3 inches in depth and 3 inches in width will not be permitted within the limits defined in Paragraphs 3.11.H.1 and 3.11.H.2. Stockpiled material will not be permitted within the limits defined in Paragraph 3.11.H.3. Covering for open trenches or

excavations must be of sufficient strength to support the weight of the heaviest aircraft operating on the runway or taxiway.

- O. Construction in Proximity to Active Runways and Taxiways must be in accordance with FAA AC 150/5370-2F, Operational Safety on Airports During Construction, the construction phasing plans and the approved Construction Safety and Phasing Plan (CSPP):
 - 1. Runway Sides. If appropriate construction/maintenance NOTAM has been issued, construction is permissible as close as 250 feet from the centerline of the active runway and 124/137 feet from the centerline of the active ADG V/VI taxiway, respectively, provided that all CDA and FAA criteria are met including FAA approval of the Construction Safety and Phasing Plan. The 250 feet must be clearly marked in the infield areas with orange fabric fence as described in Paragraph 2.05 of this specification. No work will be permitted and no equipment or materials may be stored within 1,000 feet of the end of the active runway.
 - 2. Taxiway Sides. If appropriate construction/maintenance NOTAM has been issued, construction is permissible as close as the dimensions shown on the Construction Phasing Plans, provided that all CDA and FAA criteria are met including FAA approval of the Construction Safety and Phasing Plan. This dimension(s) must be clearly marked in the infield areas with orange fabric safety fence as described in Paragraph 2.05. Safety fence to identify the TSA cannot exceed 18 inches in height.
- P. Equipment Height Restrictions
 - 1. Maximum equipment height requirements are shown on the Construction Safety and Phasing Plans and must not be exceeded unless prior approval is obtained from the Commissioner. Atop all equipment booms must be mounted the white and orange checkered flag described in Paragraph 3.04. The top ten feet (10') of these booms must be painted fluorescent orange and they must be equipped with a red obstruction light. Any crane erections must be coordinated with CDA Operations and the Commissioner during every shift.
 - 2. The Contractor is advised that FAA 7460 permit applications have been submitted for all anticipated crane usage and permanent object construction within the Project limits. The Contractor must adhere to all requirements outlined in the FAA

7460 Permits. This may include additional coordination and other requirements as outlined in the FAA 7460 permits. At the time of bidding, the FAA final determinations have not been completed. When the FAA issues final determinations for all permits, the documents will be made available to the Contractor.

Q. Miscellaneous

1. Open flame, welding or torch cutting operations are prohibited unless adequate fire and safety precautions have been taken and the procedure has been approved by the Commissioner. Under no circumstances will flare pots be used.
2. All materials and equipment when not in use must be placed in approved areas where they will not constitute a hazard to aircraft operations and not penetrate clearance height restrictions as shown on the Construction Phasing Plan(s). All equipment must be parked in the appropriate area(s) when not in use. Parked equipment and/or stockpiles will not be allowed inside the ROFA or TOFA, unless indicated in the approved CSPP.
3. The Contractor must provide the Commissioner with a current list of all employees working on the Airport. The list must be maintained current by the Contractor and Subcontractors.
4. Except for emergencies, all contact with Airport personnel must be made through the Commissioner. For emergencies involving safety (injuries, fires, security breaches, etc.), the Contractor will make direct contact with the CDA followed by notification to the Commissioner as soon as possible.

3.12 HAZARD MARKINGS

- A. Hazard-marking barricades, traffic cones, red flashers, etc. should be used to identify and define the limits of construction making them visible to aircraft, personnel, or vehicles; to identify hazards such as open manholes, small areas under repair, stockpiled material, waste areas, etc.; to prevent aircraft from taxiing onto a closed runway for takeoff; and to identify FAA, Airport, and National Weather Service facilities, cables, power lines, instrument landing system (ILS) critical areas, and other sensitive areas to prevent damage, interference, and facility shutdown. The Contractor must have a designated person on call 24 hours a day for emergency maintenance of Airport hazard lighting and barricades.

3.13 CONSTRUCTION AREA MARKING AND LIGHTING

- A. All construction areas should be clearly and visibly separated from active air operation areas (AOA). Low profile lights, retroreflective taxiway edge markers, low level barriers, snow fence, jersey barrier, warning flags and profile low mass barricades must be provided and erected by the Contractor as shown on the Plans or as directed by the Commissioner. All construction areas should be clearly and visibly separated from active air operation areas.(flags are not to be installed on barricades). Hazard areas, facilities, cables, and power lines should also be clearly identified by the Contractor. The Contractor is responsible for maintaining the condition and visibility of all markers identifying above-mentioned areas and that marking and lighting aids remain in place. Alternating orange and white flaglines, traffic cones, approved barricades, omnidirectional red flashers, and/or signs should be used as necessary to clearly separate all construction/maintenance areas from other parts of the AOA. All barricades, temporary markers, flaglines supports, and other objects placed and left on or in the vicinity of any open runway, taxiway, or taxilane cannot exceed 18 inches in height and must be: as low as possible to the ground; of low mass; easily collapsible upon contact with an aircraft or any of its components; weighted down or sturdily attached to the surface to prevent displacement from propwash, jet blast, wing vortex, or other surface wind currents; and if affixed to the surface, frangible at ground level. Barricades, temporary markers, and other objects are not permitted to remain within the safety area of an open runway or taxiway.
- B. The Contractor will be required to furnish, install and remove all Low Mass Low Profile barricades required for the protection of work areas adjacent to active airfield pavement that is open to aircraft where there is a drop off of three inches or greater within the limits of the safety area.

3.14 CONSTRUCTION NEAR NAVIGATIONAL AIDS

- A. Construction materials and equipment must not be placed or parked where they may interfere with the line-of-sight of the ATCT and navigational aids in operation. The Commissioner will determine if any materials or equipment will cause any type of interference.

3.15 CONSTRUCTION SITE ACCESS AND HAUL ROADS

- A. The Contractor will not be permitted to use any access or haul roads other than those designated on the Contractor's approved construction phasing plan. The Contractor will submit specific proposed ingress

and egress routes associated with specific construction activities to the Commissioner for evaluation and approval prior to commencing construction activities. Aircraft Rescue and Firefighting (ARFF) right-of-way on access roads, haul roads, taxiways, and runways will not be impeded at any time.

3.16 CONSTRUCTION MATERIALS STOCKPILING AND EQUIPMENT STORAGE

- A. Stockpiling of construction materials and equipment storage is not permitted within 400 feet of the active runway centerline and 160/193 feet of the ADG V/VI active taxiway centerline, respectively unless indicated in the approved CSPP.
- B. Stockpiled materials and equipment should be prominently marked with red flags, safety fence and lighted red obstruction lights during hours of restricted visibility or darkness if in the air operations area. Stockpiled material or equipment should not be stored near aircraft turning areas or operational movement areas, aprons, or excavations and trenches. Stockpiled materials must not be stored near NAVAIDs, visual or approach aids, nor will they obstruct the ATCT's line of sight to any runway or taxiway. The Contractor must ensure that stockpiled construction materials and equipment do not cause degraded or hazardous conditions to Airport safety. This includes determining and verifying that stockpiled materials and equipment are stored or parked at an approved location, that they are properly stowed to prevent foreign object debris (FOD), attraction by wildlife, or obstruction of air operations either by their proximity to NAVAIDs or to aircraft movement areas.

3.17 FOREIGN OBJECT DEBRIS (FOD) MANAGEMENT

- A. Waste and loose materials capable of causing damage to aircraft landing gears or propellers, or capable of being ingested in jet engines must not be left or placed on or near active aircraft movement areas. Materials tracked onto these areas must be continuously removed during the construction Project. Waste or loose materials which would attract wildlife must be carefully controlled and removed on a continuous basis.

3.18 RUNWAYS AND TAXIWAYS

- A. Nothing must be placed upon runways, taxiways, taxilanes, or aprons pavements without written authorization from the Commissioner.

3.19 INSTALLATION OF TEMPORARY SAFETY AREA MARKING FENCE

- A. Installation of the AOA and safety area fence must conform to the following:
1. The fence must be placed 1 foot outside the safety or critical area being delineated.
 2. The fence must be installed on the existing grade along the edge the AOA, RSA, TSA, ROFA, TOFA, and NAVAIDS critical areas and runway safety area (RSA) and taxiway object free area (TOFA) as determined by field survey, as shown on the plans or as directed by the Commissioner.
 3. Posts/stakes must be set plumb, and in good line on the side on which the fabric is to be fastened. Posts/stakes must be set full depth and must not be cut off to eliminate rock or other excavation. Where rock is encountered, it must be removed. The posts/stakes adjacent to ends, corners, or anchors must be braced. Posts/stakes should be driven 18 inches into the ground and be spaced at 4 feet center-to-center maximum.
 4. The top edge of the fabric must be affixed to within 1 inch of the top of each post/stake leaving a nominal 6 inch clearance between the ground surface and the bottom edge of the fabric.
 5. A minimum of four evenly spaced staples per post must be used to affix the fabric. Where joints are necessary, each end of the fabric must be securely fastened to a post and those posts be placed adjacent to each other or wrapped around each other similar to a silt fence.
 6. Safety fence must be maintained in good condition at all times, and inspected weekly at a minimum. The fence must be replaced immediately if torn, dislodged, or otherwise damaged to prevent it from becoming FOD, or as directed by the Commissioner.
 7. Safety fence must be installed within 30 days of Notice to Proceed and prior to beginning work in any phase. Fence must be removed at the completion of work in a phase as directed by the Commissioner. Multiple installations of fence may be required due to phasing of the project, the Contractor must install, remove, or relocate fence as necessary so active safety and critical areas are delineated at all times.

8. In the event active safety or critical areas lie on pavement, temporary Low Mass Low Profile barricades must be used to delineate safety areas as directed by the Commissioner. Construction Low Mass Low Profile barricades must not be placed within active Runway or Taxiway Safety Areas, and must be removed prior to reopening runways or taxiways, as directed by the Commissioner.

3.20 INSTALLATION OF TEMPORARY UNDERGROUND UTILITY MARKING

- A. For FAA underground utilities including ducts, cables, and structures, the Contractor must provide, install, and maintain 2" PVC posts with light blue colored labels identifying FAA along the center and over the utility, at 25 foot intervals for the entire work zone except inside the 250' Runway Safety Area (RSA) or 160' (ADG V)/193' (ADG VI) Taxiway Object Free Area (TOFA), where marking paint on the ground only must be used to mark utilities. In areas where the FAA utility will be exposed, the Contractor must provide, install, and maintain two lines of similarly marked 2" PVC posts at 5 foot offsets on each side of the FAA utility centerline at 25 foot intervals. Post markers must also be installed at all points where the FAA line changes direction.
- B. For all other underground utilities (electrical and ComEd ductbanks and cables, telephone and communication lines, gas mains, water mains, sewer pipes, fuel lines, etc.), the Contractor must provide, install and maintain 2" PVC posts with APWA colored labels identifying the specific utility type along the center and over the utility, at 25 -foot intervals for the entire work zone except inside the 250' RSA or 160' (ADG V)/193' (ADG VI) TOFA, where marking paint on the ground only must be used to mark utilities.
- C. Labels for 2" PVC pipe must be self-adhesive vinyl labels, with high visibility APWA color coded per the detail provided by the Commissioner, a minimum 12 inches long by 7.5 to 7.75 inches wide, with 1.75 inches lettering with the words "GAS, POWER, FAA, PHONE, WATER, CED, FIBER, OR STORM/SAN" as required.
- D. Provide labels from one of the following manufacturers (or equal):
 1. Mainstreet Lettering – 5659 Box Elder Road, Marshall, WI 53559, 608-655-4757.
 2. Uline – Custom Dept. 2105 South Lakeside Drive, Waukegan, IL 60085, 800-295-5510 Ext. 5099.

- E. The PVC posts must be a minimum of 5 feet in overall length. The exposed post height must be at least 4 feet and embedment to a depth necessary to keep the post vertical and stable. Maintenance of posts and/or replacement of any damaged posts will be at the Contractor's cost.

3.21 PROTECTION AND SUPPORTS FOR UNDERGROUND UTILITIES

- A. The Contractor must provide adequate provisions to protect all underground utilities and structures exposed during the proposed work or being crossed by access roads, new sewer lines, new electrical ducts, new drainage lines and haul roads.
- B. The Contractor will be responsible for notifying the Utility Owner at the Project pre-construction meeting should utility relocation become necessary (for FAA cable relocation, notify the FAA Technical Operations).
- C. All excavating within 5 feet on either side of existing underground utilities and infrastructures is to be performed by hand. The Contractor will be responsible for locating and hand digging to locate the utility lines and structures.

3.22 TEMPORARY SUPPORT OF UNDERGROUND UTILITIES

- A. The Contractor must submit a plan and design indicating the size, type and configuration of the materials to be used in supporting the underground utilities and structures that will be exposed. Drawings showing how the utility lines/structures will be protected must be provided in advance by the Contractor for approval by the Utility Owner before installation. The Contractor must provide the identity of the registered Professional Engineer approving the design prior to the work. At least one copy of the stamped/approved design must be maintained at the jobsite while the support is being constructed. The Contractor is responsible for all associated costs to acquire approved design, materials and the construction of the utility supports.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. With the exception of the Allowances for Security Staffing, Maintenance and Infrastructures, Supplemental Safety Measures, and Road Maintenance as described in this Section, all flaggers, sweeping, barricades, fence, jersey barriers, construction of haul routes, maintenance of haul routes, and all Airport safety and security as described herein will not be measured separately for separate payment. The cost of meeting these requirements of this Specification

will be included in the Contract as a whole and no additional compensation will be allowed.

- B. All flaggers, sweeping, barricades, fence, jersey barriers, signage, construction of haul routes, and maintenance of haul routes as outlined in the contract documents must be considered incidental to the Contract. Recognizing that this Contract will be constructed on an operating airfield, there could be changes to the anticipated configuration of the aforementioned which may deviate from what is represented in the Contract Drawings.
- C. Allowance for Security Staffing, Maintenance and Infrastructure will cover costs of providing qualified security guards / manpower, prefabricated guard booths, portable toilets, and lighting and heating for these infrastructures only. Expenses from the Allowance will be subject to prior review and approval by the Commissioner only, and will be measured for payment as described in Article X, "Changes in Work", of the Part 2 General Conditions document
- D. No separate measurement will be made for Temporary Safety Area Fence procurement, installation, maintenance, relocation and removing the fence.
- E. Allowance for Supplemental Safety Measures shall compensate the Contractor for changes made to plans, as described in paragraph 4.01B, as outside of what was originally outlined in the Contract Drawings. This allowance establishes a mechanism to compensate the Contractor for all labor, equipment and material as may be required to procure, place, remove, and /or modify the airfield construction safety plan as it relates to barricades, haul route signage, haul route construction, haul route maintenance, road maintenance, sweepers, flaggers as deemed necessary to make traffic flow and protect aircraft. This allowance will also include providing flag personnel in addition to the flaggers, as specified herein, required in the approved contractor's safety plan within the AOA, and additional signage requested by the Commissioner. Expenses from the allowance will be subject to prior review and approval by the Commissioner. Unused portions of this allowance will not be paid to the Contractor, but will be returned to the City in the form of an appropriate credit.
- F. Allowance for Utility / Drainage Conflicts shall compensate the Contractor for the costs associated with performing work, as directed by the Commissioner and not otherwise shown, related to existing utility or drainage modifications either as required by utility service company or mitigation of unforeseen conflicts or impacts. Work may include, but is not limited to, providing utility access, resolution of utility

or drainage conflicts, drainage or grading modifications, subsurface investigation, existing ductbank proofing, test pits, and facility utility costs beyond substantial completion.

- G. Allowance for Safety and Security Coordination will cover costs to reimburse CDA Security for furnishing materials and connecting the security cameras at Guard Post 2. Contractor will coordinate with CDA security to arrange for the camera installation and connection once the camera infrastructure has been built and cable pulled by the Contractor. Expenses from the Allowance will be subject to prior review and approval by the Commissioner.
- H. Low Mass Low Profile Barricades and Type A Barricades: Furnishing, installing, maintaining and removing Low Mass Low profile Barricades and Type A barricades will not be measured separately for payment.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. With the exception of expenses from the Allowances for Security Staffing, Maintenance and Infrastructure; Supplemental Safety Measures; Utility and Drainage Conflicts; and CDA/FAA Coordination, specific items listed herein, Airport safety and security will not be paid for separately, but will be considered included in all other items of Work included in these Specifications. Airport safety and security will include furnishing all materials and equipment, including but not limited to flag persons, guards assigned outside the AOA, escort vehicles and operators, sweepers, jersey barriers, construction and maintenance of haul routes, warning markers, safety area markings, underground utility markings, protection and supports for underground utilities, medium and low level barriers, other traffic control devices and necessary equipment, and other materials and equipment listed herein, and the maintenance thereof and all other labor, materials, equipment, tools, and all work necessary to accomplish this item. No additional payment will be made for these items.
- B. Item M-103-01 Allowance for Security Staffing, Maintenance and Infrastructure: Payment for the required work will cover costs for providing qualified security guards / manpower, prefabricated guard posts, portable toilets, lighting, HVAC, and temporary utilities for these infrastructures, and will be based from measured for payment as shown in General Conditions, Article X, Changes in Work, 3. Time and Materials proposals from Basis. Any remaining balance from the Allowance will be retained by the city.

- C. Item M-103-02 -- Allowance for Supplemental Safety Measures: The Contractor must receive written notice from the Commissioner and Chief Procurement Officer to proceed with the work. The work will be paid for as shown in Article X, "Changes in the Work," of the Part 2, General Conditions. Any remaining balance from the Allowance will be retained by the city.
- D. Item M-103-03 Allowance for Utility and Drainage Conflicts: The Contractor must receive written notice from the Commissioner and Chief Procurement Officer to proceed with the work. The work will be paid for as shown in Article X, "Changes in the Work," of the Part 2, General Conditions. Any remaining balance from the Allowance will be retained by the city.
- E. Item M-103-04 Allowance for CDA/FAA Coordination: The Contractor shall be compensated from this allowance for the cost associated with performing work related to CDA/FAA modifications, maintenance, cleaning and coordination. The allowance has been established for change work as deemed necessary by the Commissioner. Work may include, but is not limited to, work associated with CDA/FAA facility modifications and change requests, work inside or outside the project limits required for the commissioning of the facility, Airfield Lighting Systems modifications and supplemental work, systems coordination and GFE coordination. Any remaining balance from the Allowance will be retained by the City.
- F. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
M-103-01	ALLOWANCE FOR SECURITY STAFFING, MAINTENANCE AND INFRASTRUCTURES	AL
M-103-02	ALLOWANCE FOR SUPPLEMENTAL SAFETY MEASURES	AL
M-103-03	ALLOWANCE FOR UTILITY AND DRAINAGE CONFLICTS	AL
M-103-04	ALLOWANCE FOR CDA/FAA COORDINATION	AL

END OF ITEM M-103

NIGHT CONSTRUCTION

SECTION N-100

PART 1 DESCRIPTION

1.01 GENERAL

- A. This Section will cover all airfield construction work normally scheduled as Night Time Work that requires turn over of the work site to Airport Operations during the day. All work must be completed by 6:00 AM and the work area turned over for the morning runway, taxiway, or AOA reopening. Delay in turn over will be subject to penalty as specified in the Contract documents.

1.02 ADVANCE NOTICE

- A. The Contractor is required to give a minimum of 48 hours advance notice to Airport Operations prior to performing any night work. Under no circumstance will any work be performed at night without written approval by the Commissioner and/or the Airport Operations Manager.

1.03 STANDBY EQUIPMENT

- A. The Contractor will be required to provide standby equipment at the construction site for all work included in the specifications and Plans. The standby equipment must be provided for all types of equipment to be used in the required construction operations. Operators will not be required for the standby equipment. The standby equipment must not be used except in the case of emergencies or regular equipment breakdown. The standby equipment must be listed in the daily equipment as usually required by the Contract specifications. When standby equipment is required to be used, the Contractor will be required to promptly repair or replace the broken equipment before being allowed to begin the next scheduled work shift. No Contract time extension will be granted due to the broken equipment being repaired or replaced nor will the Contractor be entitled to any compensation for the suspension of work.

- B. The standby equipment will be required in the following:

<u>Regular Equipment Used</u>	<u>Standby Equipment Required</u>
1 - 6 units	1 unit
7 or more units	2 units

- C. In all cases the Contractor will be required to park standby equipment readily available to the construction area in the event of breakdown of

the regular equipment. Suitable equipment will be provided for the rapid movement of the asphalt spreaders and other equipment units and in no event will crawl-type equipment be allowed to traverse grassed areas.

1.04 OBSTRUCTION LIGHTING

- A. At the beginning of each night's work and after having received instructions to proceed with the work from the Commissioner, the Contractor must place illuminated barricades to block off any connecting taxiways if required.
- B. At the end of each night's work all illuminated barricades must be removed from the runway and stored in the Contractor's work area outside the approach zone of the runway.
- C. Contractor must install the illuminated barricades and temporary lights in accordance with the locations and details must be as shown on the Plans or as directed by the Commissioner.
- D. The Contractor must replace batteries in the lighting units when the brilliancy of the lamps becomes inadequate as determined by the Commissioner. If any light fails or the barricade is damaged, displaced, or not in an upright position, from any cause, the Contractor must restore the barricade to its original acceptable condition.

1.05 CONSTRUCTION LIGHTING

- A. The Contractor is required to install, maintain, and relocate temporary lights to illuminate each work area during the hours of darkness when overlay operations are in progress.
- B. The lighting equipment must be trailer-mounted units, each with 4-1,000 watt metal halide or high pressure sodium lights on a winch-lift telescopic mast. The Contractor will provide sufficient units to have the capacity of producing an average maintained illumination level of 5 horizontal foot candles throughout the working area. The Contractor is required to submit isolux curves or charts showing the pattern of lights. Levels should be calculated and measured in accordance with the standards of Illumination Engineering Society (IES) current practice. In addition, quality control personnel will be required to verify and document nightly compliance with this requirement.
- C. In addition, all excavating machinery, backhoes, paving machines, rollers, distributors, trucks, and other equipment (except haul trucks)

must be equipped with sufficient illumination to safely complete the work.

- D. Location of lights may need to be changed as directed by the Commissioner to correct problems to the Control Tower caused by the lights.
- E. Minimum illumination level must be 5 horizontal foot candles and should be maintained in the following areas:
 - 1. An area 25' wide and 12' long immediately behind the asphalt spreader during the operation of the machine.
 - 2. An area 12' wide by 30' long immediately in front and back of all rolling equipment during the operation of the equipment.
 - 3. An area 12' wide by 12' long at any point where an area is being tack-coated prior to placement of the hot mix asphalt.
 - 4. All concrete paving operations and electrical installation work areas.
 - 5. Minimum 5 foot horizontal candles should be maintained in an area 25 feet wide and 30 feet long in front and behind the concrete paver or finishing equipment.
- F. Contractor will be allowed access to work areas each night subject to the operational requirements of the Airport as determined by the Commissioner. It is the intent that the Contractor will be allowed access to work areas by 10:30 p.m. each working night. If permission for such access is delayed due to such operational requirements of the Airport as determined by the Commissioner, the Contractor will be allowed compensation for labor, time, and equipment costs for delay in starting work in excess of one hour past the nominal time for starting night time work. This claim will be in accordance with the General Conditions. Any such claim for delay will not exceed amounts for labor and equipment costs in excess of 4 hours per working night.

1.06 LIMITS OF OVERLAY/SCARILAY OPERATIONS

- A. The Contractor must be required to overlay the full depth of the pavement for a minimum of 500 lineal feet for the full width of runway or taxiway per night on average. If the Contractor Plans to pave more than 500 feet per night, he must guarantee the Commissioner that he will be able to complete the desired length of full width paving prior, including cool down time, to the scheduled morning runway reopening. Bituminous tack coat must be applied immediately prior to the night's paving operations. The tack coat must be applied only to the length of pavement to be overlaid each night.

- B. For scarilay work with no change in final grade, the Contractor will be required to scarify and pave (scarilay) a single lift for a minimum of 2,000 lineal feet for a minimum of 25 foot width per night on average. If the Contractor Plans to scarilay more than 2,000 feet per night, he must guarantee the Commissioner that he will be able to complete the desired length of paving prior, including cool down time, to the scheduled morning runway reopening.

1.07 GRADE CONTROL

- A. Transition joints and grades must be installed as detailed on the Contract Drawings.
- B. Final grades and elevations must conform to the requirements of the Plans and specifications. Automatic grade control devices must be used on the paving and milling machines to insure accuracy of grades and elevations. Any pavement that does not meet specified tolerance must be corrected at the Contractor expense.

1.08 OTHER BITUMINOUS CONCRETE REQUIREMENTS

- A. All other requirements for bituminous concrete as stated in Section P-401 Plant Mix Bituminous Pavements (Superpave™) and/or P-405 Bituminous Concrete Pavements of these specifications must apply, respectively.

1.09 ASPHALT AND CONCRETE PLANTS

- A. Asphalt Plants must be as specified in Section P-401 Plant Mix Bituminous Pavements (Superpave™) and/or P-405 Bituminous Concrete Pavements as applicable. The Contractor must maintain a standby asphalt plant to be used in case of breakdown of the main asphalt plant.
- B. Concrete Plants must be as specified in Section P-501 Portland Cement Concrete (PCC) Pavement. The Contractor must maintain a standby concrete batch plant to be used in case of breakdown of the main concrete plant.

PART 2 PRODUCTS – Not Applicable

PART 3 EXECUTION – Not Applicable

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Night construction procedures as described herein will not be measured for separate payment. The costs of meeting the requirements of this specification will be included in the Contract price as a whole, and no additional compensation will be allowed.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Night construction will be considered included in the overall Contract price. No additional payment will be made for this item.

END OF SECTION N-100

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PAVEMENT REMOVAL

SECTION P-150

PART 1 DESCRIPTION

1.01 GENERAL

- A. This work will include removal of existing bituminous concrete access roads shown on the Plans to be removed within the Project limits. Limits of pavement removal must be as shown on the Plans. The Contractor must note the variable depths of the existing bituminous pavements. The work under this Section is subject to the requirements of the Contract Documents.
- B. The work under this Section is related to Airside pavements subject to vehicle use as directed by the Commissioner.
- C. The Contractor shall provide connection between limits of removal on these items to existing underdrain and electrical items that are to remain in service. Disruption of service shall be minimal and coordinated with the Commissioner.

1.02 RELATED WORK

Section P-152 – Excavation and Embankment

PART 2 MATERIALS – Not Applicable

PART 3 CONSTRUCTION METHODS

3.01 PAVEMENT REMOVAL

- A. Method of Removal – Equipment and methods used for removing pavement or shoulders will be such as to prevent cracking, shattering, or spalling of the adjacent pavement remaining in place. All bituminous pavement removal, including the pavement from bituminous composite pavement, must be removed by milling operation. Breaking pavement by means of a ball breaker or a gravity drop hammer will not be permitted. Double Saw cutting of pavement full depth is required prior to removal where shown on the plans or directed by the Commissioner.
- B. Recycling - The Contractor must submit a sieve analysis per ASTM C 136 for every 2500 tons of aggregate produced, or a minimum of one test every two weeks, whichever is more frequent to show that the

product meets gradation of **CA-6 for Recycled Asphalt Pavement (RAP)**; conforming to Article 1004 of the Illinois Department of Transportation, Standard Specifications for Road and Bridge Construction (S.S.R.B.C.), latest edition.

- C. Disposal – Surplus materials and broken pavement conforming to the Recycling gradation specified herein will be disposed of as directed by the Commissioner on-site, within Airport limits, as specified in Specification Section 01524 Construction Waste Management.
- D. Comply with all applicable City, State and Federal governmental regulations regarding crushing operations. This includes but is not limited to: Illinois Environmental Protection Agency (IEPA) Joint Construction and Lifetime Operating Permit for Portable Emissions Unit; City of Chicago Department of Environment (DOE) Construction Site Reprocessing Authorization Application Requirements (Crushing Authorization) and Installation Permit Application for Processing Equipment or Area (Crushing Equipment Installation Permit).

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Bituminous concrete pavement removal will be measured in place at the top surface of pavement and the area computed in square yards. Additional measurements and compensation will not be allowed for pavements that are thicker than shown on the plans. No distinction shall be made between bituminous shoulder pavement or bituminous roadway pavement, regardless of the thicknesses shown in the plans. Saw cutting limits of pavement removal of all pavements will be incidental to this item. The removal of subgrade material and the base granular materials under the pavement to be removed will be measured and paid for as Unclassified Excavation described in Section P-152 Excavation and Embankment.
- B. For locations of pavement removal required for utility installation, the maximum pavement removal for payment shall be the maximum trench width plus 2 feet.
- C. If additional pavement is removed due to negligence on the part of the Contractor, the additional quantity of pavement removal and replacement will not be measured for payment.
- D. Bituminous surface removal will be measured for payment according

to Article 440.07 of the Illinois Department of Transportation Standard Specifications.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment will be made at the Contract unit price per Square Yard for Pavement Removal – Bituminous (Full Depth) which will be payment in full for all labor, materials, equipment, saw cutting, milling and all work necessary to remove the entire pavement, recycle and/or dispose of offsite in accordance with this Specification.
- B. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
P-150-01	PAVEMENT REMOVAL - BITUMINOUS CONCRETE FULL DEPTH	SY
P-150-02	PAVEMENT REMOVAL - BITUMINOUS ACCESS ROAD FULL DEPTH	SY
P-150-03	PAVEMENT REMOVAL - BITUMINOUS CONCRETE VARIABLE DEPTH	SY
P-150-04	PAVEMENT REMOVAL – PORTLAND CEMENT CONCRETE VARIABLE DEPTH	SY

END OF SECTION P-150

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CLEARING AND GRUBBING

SECTION P-151

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item will consist of clearing and grubbing, including the disposal of materials off the Airport all areas within the limits designated on the Plans or as required by the Commissioner.
- B. Clearing will consist of the cutting and removal of all trees, stumps brush, logs, hedges, the removal of fences and other loose or projecting material from the designated areas. The grubbing of stumps and roots will not be required.
- C. Clearing, when so designated, will consist of the cutting and removal of isolated single trees or isolated groups of trees. The cutting of all the trees of this classification must be in accordance with the requirements for the particular area being cleared, or as shown on the Plans, or as directed by the Commissioner. The trees will be considered isolated when they are 40 feet or more apart, with the exception of a small clump of approximately five trees or less.
- D. Clearing and grubbing will consist of clearing the surface of the ground of the designated areas of all trees, stumps, roots, down timber, logs snags, brush, undergrowth, hedges, heavy growth of grass or weeds, fences, structures, debris, and rubbish, of any nature, natural obstructions or such material which in the opinion of the Commissioner is unsuitable for the foundation of strips, pavements, or other required structures, including the grubbing of stumps, roots, matted roots, foundations, and the disposal off the Airport of all spoil materials resulting from clearing and grubbing.

PART 2 CONSTRUCTION METHODS

2.01 GENERAL

- A. The areas denoted on the Plans to be cleared or cleared and grubbed must be staked on the ground by the Contractor after verification by the Commissioner. The clearing and grubbing must be done a satisfactory distance in advance of the grading operations.

- B. All spoil materials removed by clearing or by clearing and grubbing must be disposed off the Airport to approved disposal areas. Disposal by burning will not be allowed.
- C. As far as practicable, waste concrete and masonry must be transported to the Recyclable Material stockpile in accordance with Sections 02245 Recycled Crushed Concrete and Asphalt and P-154 Frost Protection Course, or must be placed on slopes of embankments or channels as directed by the Commissioner. When embankments are constructed of such material, this material must be placed in accordance with requirements for formation of embankments.
- D. Any broken concrete, asphalt pavement or masonry which does not meet the definition of Recyclable Material in Sections 02245 Recycled Crushed Concrete and Asphalt and P-154 Frost Protection Course or cannot be used in construction as directed by the Commissioner, and all other materials not considered suitable for use elsewhere, must be disposed of by the Contractor.
- E. In no case will any discarded materials be left in windrows or piles adjacent to or within the Airport limits. The manner and location of disposal of materials will be subject to the approval of the Commissioner and must not create an unsightly or objectionable view. When the Contractor is required to locate a disposal area outside the Airport property limits at his/her own expense, he must obtain and file with the Commissioner permission in writing from the property owner for the use of private property for this purpose. Blasting will not be allowed.
- F. The removal of existing structure and utilities required to permit orderly progress of work will be accomplished by local agencies, unless otherwise shown on the Plans. Whenever a telephone or telegraph pole, pipeline, conduit, sewer, roadway or other utility is encountered and must be removed or relocated, the Contractor must advise the Commissioner who will notify the proper local authority or owner and attempt to secure prompt action.

2.02 CLEARING

- A. The Contractor must clear the staked or indicated area of all objectionable materials. Trees unavoidably falling outside the specified limits must be cut up, removed, and disposed of in a satisfactory manner. In order to minimize damage to trees that are to be left standing, trees must be felled toward the center of area being cleared. The Contractor must preserve and protect from injury all trees not to be removed. The trees, stumps, and brush must be cut to

a height of not more than 12 inches above ground. The grubbing of stumps and roots will not be required.

- B. When isolated trees are designated for clearing, the trees will be classed in accordance with the butt diameter size as measured at a point 18 inches above the ground level or at a designated height specified in the proposal.
- C. Fences must be removed and disposed of when directed by the Commissioner. Fence wire must be neatly rolled and the wire and posts stored on the Airport if they are to be used again, or stored at a designated location if the fence is to remain the property of a local owner or a civic authority.

2.03 CLEARING AND GRUBBING

- A. In areas designated to be cleared and grubbed, all stumps, roots, buried logs, brush, grass, and other unsatisfactory materials must be removed, except where embankments exceeding 3-1/2 feet in depth are to be made outside of paved areas. In cases where such depth of embankments is to be made, all unsatisfactory materials must be removed, but sound trees, stumps, and brush can be cut off within 6 inches above the ground and allowed to remain. Tap roots and other projections over 1-1/2 inches in diameter must be grubbed out to a depth of at least 18 inches below the finished subgrade or slope elevation.
- B. Any building and miscellaneous structures that are shown on the Plans to be removed must be demolished or removed, and all materials therefore must be disposed off the Airport. The remaining or existing foundations, wells, cesspools, and all like structures must be destroyed by breaking out or breaking down the materials of which the foundations, wells, cesspools, etc., are built to a depth at least 2 feet below the existing surrounding ground. Any broken concrete, blocks, or other objectionable material which cannot be used in backfill must be removed and disposed offsite. The holes or openings must be backfilled with acceptable material and properly compacted.
- C. All holes remaining after the grubbing operation in embankment areas must have the sides broken down to flatten out the slopes, and must be filled with acceptable material, moistened and properly compacted in layers to the density required in Section P-152 Excavation and Embankment. The same construction procedure must be applied to all holes remaining after grubbing in excavation areas where the depth of holes exceeds the depth of the proposed excavation.

PART 3 METHOD OF MEASUREMENT

3.01 MEASUREMENT

- A. The quantities of clearing and grubbing as shown by the limits on the Plans or as ordered by the Engineer will be the number of acres, or fractions thereof, of land specifically cleared or cleared and grubbed.

PART 4 BASIS OF PAYMENT

4.01 PAYMENT

- A. Payment will be made at the Contract unit price per acre for clearing and grubbing. The price will be full compensation for furnishing all materials and for all labor, equipment, tools, and all work necessary to complete the item.
- B. Payment will be made under the following item:

ITEM NO.	DESCRIPTION	UOM
P-151-01	CLEARING AND GRUBBING	ACRE

END OF SECTION P-151

EXCAVATION AND EMBANKMENT

SECTION P-152

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item covers excavation, sorting, screening, stockpiling, borrow, disposal, placement, backfilling and compaction of materials within the limits of the work required to construct the safety areas, runways, taxiways, aprons, pavements, and intermediate as well as other civil work areas in accordance with these Specifications and in conformity to the dimensions and typical sections shown on the Drawings or as directed by the Commissioner.
- B. This item also includes the excavation and removal of aggregate roadways.
- C. This item does not include excavation for underground conduit, drainage, utilities, structures, or pavement removal.
- D. This item does not include items regarding demolition and associated excavation as specified in Section X-100, Site Demolition.
- E. The work under this section is subject to the requirements of the Contract Documents.
- F. This item includes the handling of excess spoils from other operations.

1.02 RELATED DOCUMENTS

- A. Related Specification Sections include the following:
 - 1. Section 01111 Air Quality-Equipment Emissions
 - 2. Section 01502 Traffic Control
 - 3. Section 02710 Dust Control
 - 4. Section M-103 Airport Safety and Security
 - 5. Section P-150 Pavement Removal
 - 6. Section P-151 Clearing and Grubbing
 - 7. Section P-154 Frost Protection Course
 - 8. Section P-156 Temporary Air and Water Pollution, Soil Erosion, and Sediment Control
 - 9. Section P-158 Lime Stabilized Frost Protection Course
 - 10. Section Q-100 Quality Control Program
 - 11. Section T-905 Topsoiling
 - 12. Section X-100 Site Demolition

1.03 CLASSIFICATION – EXCAVATION AND EMBANKMENT

A. All excavated material will be classified as defined below:

1. Unclassified Excavation: Unclassified excavation will consist of the excavation, placement, and/or disposal of all material, regardless of its nature, including stripping of topsoil, which is not otherwise classified and paid for under other items. Unclassified Excavation includes the following:
 - a. Required Excavation: Excavation will consist of the excavation within the project limits required to achieve the grading depicted on the Drawings or as directed by the Commissioner.
 - b. Borrow Excavation: Borrow Excavation will consist of excavation of approved material required for the construction of embankment or for other portions of the work in excess of the quantity of usable material available from required excavations. Borrow material will be obtained from areas as shown on the Drawings or as directed by the Commissioner. Borrow Excavation shall be used when necessary and with prior approval from the Commissioner. All excavated materials generated from onsite cut and or spoils from other excavations shall be exhausted and incorporated back into the project prior to borrow materials being utilized. The Contractor will not be allowed to stockpile on-site cut and/or excavation spoils and then expect to be paid for Borrow Excavation.
 - c. Topsoil Stripping: Topsoil Stripping will consist of the stripping of topsoil material. Topsoil which cannot be placed in its final location will be stockpiled or disposed of as instructed by the Commissioner. Stockpiles will be at the locations and to the heights and slopes approved by the Commissioner. Section P-156 Temporary Air and Water Pollution, Soil Erosion, and Sediment Control requirements will apply to all stockpiles and all stockpiles will be included in this Work.
 - d. Excavation and Sorting of Recyclable Material: This refers to the excavation of any recyclable material such as large chunks of Portland cement concrete, large chunks of bituminous concrete, brick, metallic debris, or materials otherwise considered unsuitable for embankment construction with a maximum dimension exceeding two feet in any direction. These items must be delivered to the Recyclable Material stockpile area on the

Airport as instructed by the Commissioner, within five miles of the site for materials to be stockpiled or for recycling or disposal by others. Wood must be chipped and disposed of offsite.

- e. Unsuitable Material is any material containing vegetable or organic matter, such as muck, peat, organic silt, topsoil, or sod and will be considered unsuitable for use in embankment construction. Such material, when approved by the Commissioner as capable of supporting vegetation, may be used on embankment slopes.
- f. Refuse material is any material containing trash, bagged refuse, demolition debris, and any material that is by general definition, garbage. Such material must be sorted from other classifications and transported off site to an approved sanitary landfill.

2. Unclassified Excavation – Contaminated Material: Unclassified Excavation – Contaminated Material will consist of the excavations, on-site handling and placement, on-site disposal of non-hazardous contaminated materials; and the excavation, handling, and offsite disposal of hazardous waste and Non Aqueous Phase Liquids (NAPL). This also includes removal and disposal of underground storage tanks (UST), drums, and other containers with either regulated substances or contaminated materials inside. Disposal must conform to Article XIV, Part 2, General Conditions, of the Contract Documents:

- a. Contaminated Material is any material which contains a regulated substance. A regulated substance is a hazardous substance, special waste, (non-hazardous substance), or petroleum or any fraction thereof, as those terms are defined in the Illinois Compiled Statutes. Environmental studies must be performed on any contaminated material to determine how the material should be classified.
- b. State and local permitting requirements must be complied with prior to disturbing underground storage tanks (UST). These requirements include, but are not limited to, applying for and obtaining regulatory permits, environmental sampling protocols, and site visits by the regulatory agencies to approve the removal of the tank.
- c. Based on the results of the environmental studies, the soils will be classified as non-hazardous contaminated material, hazardous contaminated material, or NAPL. If

the environmental studies of the work area have identified areas of contaminated soil, non-hazardous contaminated material, such material maybe stockpiled on the Airport property as directed by the Commissioner. If directed by the Commissioner the Contractor will dispose of the hazardous waste or NAPL offsite. Hazardous contaminated material, NAPL, or UST, drums, and other containers with such materials inside, must be disposed of off Airport property, as directed by the Commissioner. The Contractor must document proper disposal at a facility licensed to accept these soils at a licensed facility.

- B. All excavated material will be further classified for placement in embankments or stockpiles, or otherwise disposed of as defined below:
 - 1. Suitable Material: To be considered suitable for construction of subgrade and embankment areas for safety areas, runways, taxiways, aprons, pavements, building foundations, or service roadways, the material must meet the conditions described below:
 - a. Suitable material is unclassified excavation. Suitable Fill refers to non-contaminated material that is non-organic, non-decayable, and non-rubble material having, and has a maximum dry density of not less than 98 pounds per cubic foot. The material must be approved by the Commissioner and must be easily compactable to the required density. Suitable Fill must be used in subgrade and embankment areas for taxiways, aprons, runways, safety areas or service roadways. Any rock, stones, or broken concrete greater than four (4) inches in the largest dimension in the top twelve (12) inches of the proposed subgrade; no greater than nine (9) inches in the largest dimension within one (1) foot to four (4) feet below the finished subgrade; and no greater than twenty (20) inches in the largest dimension below four (4) feet of the finished subgrade. The material must be easily compactable to the required density and approved by the Commissioner. Compaction requirements for suitable material are provided in Table 1. Suitable material must be placed in the embankment in accordance with the size limitations described in Paragraph 3.05.D.

In addition, the top 1.5 feet minimum of embankments under all pavement areas must be an impervious

cohesive soil, uncontaminated by deicing salts, chemical waste, sewage, or disposal wastes of any kind, with the following properties:

- (1) The material will not possess an organic content greater than five (5) percent when tested in accordance with AASHTO T-194.
 - (2) The material will have a maximum dry density of not less than 98 pounds per cubic foot.
 - (3) The material must have:
 - 40% or more passing No. 200 sieve.
 - A plasticity index between 12% and 25%.
 - A liquid limit between 25% and 50%.
2. **Restricted Material:** Material with deviations from the above requirements for suitable material is restricted to use for construction of embankments in areas outside of the runway or taxiway safety areas, apron pavements, service roadways, or building footprints if acceptable to the Commissioner. The Commissioner will be the sole judge of the suitability of all materials whether taken from required excavations, on-site stockpiles, or off-site borrow sources. Compaction requirements for restricted material are provided in Table 1.
3. **Unsuitable Material:**
- a. Unsuitable Material is any material containing vegetable or organic matter, such as muck, peat, organic silt, or sod and will be considered restricted for use in embankment construction. Such material must be disposed of as directed by the Commissioner. When approved by the Commissioner as suitable to support vegetation, such material may be used as dressing on embankment slopes.
 - b. Material as defined in Section 1.03.A.1.e is not suitable for embankment construction.
 - c. Asphalt grindings must not be used in embankments.
4. **Recyclable Material:**
- a. Recyclable Material refers to any large chunks of Portland cement concrete or bituminous concrete with a maximum dimension exceeding 20 inches in any direction.

- b. Masonry, brick, metallic debris, or other such materials unacceptable for use in embankment construction may be considered Recyclable Material, if directed by the Commissioner.
 - c. These items must be delivered to the Recyclable Material Stockpile area on Airport property, as stipulated in Section 1.03.A.1.d or as directed by the Commissioner. The Contractor must recycle or otherwise dispose of these items on Airport property as directed by the Commissioner. If directed by the Commissioner, the Contractor will dispose of the material off Airport property. Alternatively, the Commissioner may direct that the disposal be performed by others.
 - d. This work will be included in the Contract unit price for the pay item "Unclassified Excavation".
- C. Pavement Removal: The Contractor must refer to Section P-150, Pavement Removal. Pavement removal will be paid for separately under P-150.

1.04 SUBMITTALS

- A. Work Plan – The Contractor must submit a work plan to the Commissioner for approval prior to beginning the excavation and embankment work. The Work Plan must include:
 - 1. Excavation of materials and direct placement excavation. Sequence and schedule of excavation and placement operations, in compliance with the Contract requirements, including the following:
 - a. Excavation of materials and direct placement in embankment;
 - b. Excavation of materials, stockpiling in temporary stockpile areas and final placement in embankment; and
 - c. Excavation and placement of excess materials in the stockpile areas as directed by the Commissioner.
 - 2. The Plan must provide Provisions for multiple work areas within the Project area for performing Work such that there will always be work areas available if certain areas are shut down or are unavailable to the Contractor for any reason.
 - a. Procedure and schedule for seeding mulching, and erosion control in accordance with the Erosion Control Plan.

- b. List of equipment to be used for excavation, hauling, compaction, disking and testing.
- c. Sequence of excavation and placement and schedule in compliance with Contract requirements.
- d. Quality Control testing plan and independent testing laboratory experience for performing quality control testing as established in the requirements of Section Q-100, Quality Control Program, of these Specifications.
- e. Procedures for constructing, maintaining and removing haul roads, including signage as required in Section 01502, Traffic Control.

PART 2 PRODUCTS – Not Applicable

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

- A. The Contractor must inform and satisfy himself as to the character, quantity and distribution of all material to be excavated. The Commissioner will make the final determination of classification of all excavated material as Restricted Fill, Suitable Fill, Unsuitable Fill, Topsoil, or Unsuitable Material. No payment will be made for any excavated material which is used for purposes other than those designated. Before beginning excavation, grading and embankment operations in any area, the area must be completely cleared and grubbed and stripped of topsoil. Erosion control measures and materials must be installed prior to land disturbing activities in accordance with the Contractor's approved Erosion Control Plan as accepted by the Commissioner and in accordance with Section P-156 Temporary Air and Water Pollution, Soil Erosion, and Sediment Control. The Contractor must be responsible for the sorting and segregation of Suitable, Restricted, Unsuitable, Recyclable, Topsoil, and Unsuitable materials, whether during excavation, placement, or stockpiling operations. Stockpiles will be placed at the locations and to the heights and slopes approved by the Commissioner. Section P-156 Temporary Air and Water Pollution, Soil Erosion, and Sediment Control requirements must apply to all stockpiles placed.
- B. The Contractor is advised that it must classify and sort all materials encountered according to the requirements of Paragraph 1.03. Attention is called to the Drawings, soil borings, geotechnical report, and other applicable Contract Documents. The Contractor may need to modify its earthwork operations and methods in order to sort, embank, and stockpile materials accordingly. In addition to the

requirements of Section Q-100 Quality Control Program, the Contractor must employ a full time licensed professional engineer, specializing in geotechnical engineering and acceptable to the Commissioner, who must be on site at all times during earth moving operations.

- C. The suitability of material to be placed in embankments must be acceptable to the Commissioner. All Unsuitable Material must be disposed of at the Contractor's expense in waste areas on the Airport property as designated on the Drawings or as directed by the Commissioner or as designated on the Drawings. All non-hazardous and contaminated material must be disposed of at the Contractor's expense in waste areas on Airport property as designated on the Drawings or as directed by the Commissioner. All hazardous contaminated material and NAPL must be disposed of in a licensed disposal site in accordance with Article XIV of Part 2 of the General Conditions. All waste areas on the Airport, if so designated, property will be graded to allow positive drainage of the area and of adjacent areas. The surface elevation of waste areas will not extend above the surface elevation of adjacent usable areas of the Airport, unless specified on the Drawings or approved by the Commissioner.
- D. Recycled Material. Any broken concrete, asphalt pavements or masonry greater than twenty (20) inches in any direction which cannot be used in construction and all other materials not considered suitable for use elsewhere, must be disposed of in designated waste areas for recycling and disposal by others as directed by the Commissioner. In no case will any discarded materials be left in windrows or piles adjacent to or within the Airport limits. The manner and location of disposal of materials will be subject to the acceptance of the Commissioner and must not create an unsightly or objectionable view. When the Contractor is required to locate a disposal area outside the Airport property limits at its own expense, the Contractor must obtain and file with the Commissioner, permission in writing from the property owner for the use of private property for this purpose.
- E. Blasting will not be allowed.
- F. If it is necessary to interrupt existing surface drainage, sewers or under-drainage, conduits, utilities, or similar underground structures, the Contractor will be responsible for and must take all necessary precautions to preserve them or provide temporary services. When such facilities are encountered, the Contractor must notify the Commissioner, who will arrange for their removal if necessary. The Contractor must, at its own expense, satisfactorily repair or pay the cost of all damage to such facilities or structures which may result from any of the Contractor's operations during the period of the Contract.

- G. When the Contractor's excavating operations encounter artifacts of historical or archaeological significance, the operations must be temporarily discontinued. At the direction of the Commissioner, the Contractor must excavate the site in such a manner as to preserve the artifacts encountered and allow for their removal. Such excavation will be paid for as extra work.
- H. Those areas outside of the pavement areas in which the top layer of soil material has become compacted, by hauling or other activities of the Contractor must be scarified and disked to a depth of 4 inches, in order to loosen and pulverize the soil.
- I. The excavation must be carried out to the required lines and grades shown on the Drawings unless the Commissioner authorizes over-excavation to remove unsuitable materials or for any other reason. Should the Contractor, through negligence or other fault of its own, excavate beyond the designated lines, it must replace the excavation with approved materials, in an acceptable manner and condition, at its own expense.
- J. The Contractor must repair eroded areas and take all measures to prevent continued erosion immediately and/or as indicated by the Commissioner. No separate payment will be made for this Work.
- K. The Contractor must sort, separate, and remove all logs and other wood material encountered in excavated material with a maximum dimension exceeding 2 feet in any direction. The Contractor must chip this wood material and dispose of offsite. No separate payment will be made for sorting, separating, chipping, or disposal of the wood material.
- L. The borrow material placed must meet the requirements Section P-152 Part 3 Construction Methods.

3.02 EXCAVATION

- A. No excavation will be started until the work has been staked out and cross sectioned by the Contractor and the Commissioner has received, reviewed, and concurred with the elevations and measurements of the ground surface. All Suitable Material must be used in the formation of embankment, subgrade, or for other purposes shown on the Drawings. Excess Unsuitable Material will be disposed of as directed by the Commissioner. All Unsuitable Material must be disposed of as shown on the Drawings or as directed by the Commissioner.
- B. When the Contractor encounters an area of suspected contaminated material, any container with suspect contents inside, and/or underground storage tank (UST), the Commissioner must be notified immediately prior to any further work in the general vicinity. The area

must be marked and delineated with safety fencing to alert personnel of a potential hazard in the area. The Commissioner will perform tests as necessary to determine the degree of contamination and the limits of material to be removed and disposed of as Unclassified Excavation-Contaminated Material. At the direction of the Commissioner, the Contractor, at no expense to the City, must redirect its labor and equipment to other work areas until the City's environmental consultant can evaluate the types and levels of contamination. Test results will be furnished to the Contractor for his use in securing the necessary permits and licenses for disposal if necessary. The Contractor must be responsible for any additional testing required in obtaining permits for hauling and disposal of the Contaminated Material.

Based on the results from the Commissioner's environmental consultant's assessment, the Commissioner will direct the Contractor as follows:

1. Non-hazardous Contaminated Material Can Remain on Site:
The City will issue the Contractor a Field Order to proceed with the excavation and placement or disposal of the material. Such material may be stockpiled on Airport property as directed by the Commissioner. If directed by the Commissioner, the Contractor will dispose of the material off Airport property. Should the Commissioner's direction require the Contractor to perform work beyond the effort necessary to comply with Contract requirements, the City will compensate the Contractor for eligible costs in accordance with Article X.C.3 of Part 2 – General Conditions using the allowance included in Pay Item P-152-03 "Allowance for Contaminated or Hazardous Material Remediation or Hard to Handle Material." Where applicable, the Commissioner will subtract the volume of the contaminated material removed from the appropriate P-152 Pay Item to avoid double payment for the same quantity of material.
2. Hazardous Contaminated Material and NAPL must be transported by the Contractor to a Licensed Disposal Facility: If the Contractor has the resources to properly manage this material, the City may issue the Contractor a Field Order to handle and transport the material to a licensed disposal facility. The Contractor must be responsible for any additional testing required in obtaining permits for hauling and disposal. Compensation for this Work will be in accordance with Article X.C.3 of Part 2 – General Conditions using the allowance included in Pay Item P-152-03 "Allowance for Contaminated or Hazardous Material Remediation or Hard to Handle Material." For any soil handled by the Contractor in this manner, the Commissioner will subtract this volume of contaminated material

from the appropriate P-152 Pay Item to avoid double payment for the same quantity of soil.

3. Hazardous Contaminated Material and NAPL must be transported by a Third Party Contractor to a Licensed Disposal Facility: The City reserves the right to use a Third Party Contractor for managing this type of material. If the City selects this option, the Contractor will not be eligible for any additional compensation as a result of the Third Party Contractor's work. For any soil removed by a Third Party Contractor, the Commissioner will deduct the volume of this contaminated material from the Contractor's appropriate P-152 Pay Item to avoid double payment for the same quantity of material.
 4. If the Contractor's additional compensation for Items 1 and 2 above exceeds the allowance amount in Pay Item P-152-03 "Allowance for Contaminated or Hazardous Material Remediation or Hard to Handle Material" a Contract Modification will be required in accordance with Article X.D of Part 2 – General Conditions. Any additional compensation resulting from the Contractor's handling and management of contaminated soil is subject to the Commissioner's approval.
- C. When the volume of the required excavation exceeds that required to construct the embankments to the grades indicated, the excess will be used to grade the areas of ultimate development or disposed of as directed by the Commissioner. The Contractor must plan to use all excavation and excavated spoils from utility structures and ductbank installations prior to using borrow materials.
- D. When the volume of excavation is not sufficient for that required to construct the embankments to the grades indicated, the deficiency will be obtained from borrow areas. Borrow must be obtained from sources as shown on the Drawings or as directed by the Commissioner. The Contractor must notify the Commissioner at least 15 days prior to beginning the excavation, so necessary measurements and tests can be made. All borrow pits must be opened up to expose the vertical face of various strata of suitable material to enable obtaining a uniform product. Borrow pits must be excavated to regular lines to permit accurate measurements, and they must be drained and left in a neat, presentable condition with all slopes dressed uniformly.
- E. The grade must be maintained so that the surface is well drained at all times. When necessary, temporary drains and drainage ditches must be installed to intercept or divert surface water which may affect the work.

- F. After surface stripping in areas of proposed embankment, and in cut areas, the cut grade or subgrade must be inspected by proof-rolling in embankment areas, after surface stripping, and in cut areas, after excavating to the required subgrade level. The cut grade or subgrade must be proof-rolled with a 25 ton (or heavier) pneumatic tired roller making at least 8 passes over the entire area in alternate (perpendicular) directions or a fully loaded semi-truck loaded to the legal limit at the Commissioner's discretion. Any continuously yielding or unstable area, as determined by the Commissioner, must be undercut and backfilled in accordance with the undercutting requirements below, or disked, dried, and compacted to the requirements of Table 1, as directed by the Commissioner. The final lift of embankment must be proof rolled under pavement areas and where directed by the Commissioner.
- G. Selective Grading: When selective grading is indicated on the Drawings or Specifications, the more suitable material as designated by the Commissioner must be used in constructing the embankment or in capping the pavement subgrade. If, at the time of excavation, it is not possible to place this material in its final location, it must be stockpiled in approved areas for later use.
- H. The Contractor is advised that it must classify and sort all materials encountered according to the requirements of Section P-152 Excavation and Embankment. Attention is called to the Drawings, soil borings, Geotechnical Report, and other Contract Documents. The Contractor may need to modify its excavation methods and operations in order to sort, embank, and stockpile materials accordingly. The Contractor must adhere to the requirements of Section Q-100 Quality Control Program and employ qualified Quality Control technicians on a full-time basis to accomplish this task. The Commissioner will make the final determination of classification of excavated material. The suitability of material to be placed in embankments or stockpiles must be acceptable to the Commissioner.
- I. Undercutting: Rock, shale, hardpan, loose rock, boulders, or other material unsatisfactory for runway safety areas, subgrades, roads, shoulders, or any areas intended for turbing must be excavated to a minimum depth of 12 inches, or to the depth directed by the Commissioner, below the subgrade or designated grade. Muck, peat, matted roots, or other yielding material, unsatisfactory for subgrade foundation as determined by the Commissioner, must be removed to the depth specified by the Commissioner and any undercut area as described above must be backfilled with either Suitable Material or with Stabilization Stone CA-1, as directed by the Commissioner, in accordance with Section P-152 Excavation and Embankment and/or the requirements for undercut and backfill of Section P-154 Frost

Protection Course. Any failures of the proof rolling operation on the final lift of embankment placed by the Contractor under pavement areas must be undercut or corrected by the Contractor to the satisfaction of the Commissioner at no cost to the Commissioner. Unsuitable materials must be disposed of as shown on the Drawings or as directed by the Commissioner.

- J. Overbreak: Overbreak, including slides, is that portion of any material displaced or loosened beyond the finished work as shown on the plan or authorized by the Commissioner. The Commissioner must determine if the displacement of such material was unavoidable and the Commissioner's decision must be final. All overbreak must be graded or removed by the Contractor and disposed of as directed; however, payment will not be made for the removal and disposal of overbreak. Unavoidable overbreak as determined by the Commissioner will be classified and paid for as "Unclassified Excavation".

3.03 EMBANKMENT

- A. Compaction Requirements: Refer to Table 1 for subgrade compaction requirements in Sections under proposed pavements and Sections outside pavement areas. The material to be compacted must be within +/- 2 percent of optimum moisture content before rolling to obtain the prescribed compaction.
1. The Commissioner will make the determination as to cohesive and non-cohesive soil in regards to selecting the proper type of equipment required to compact the material.
 2. When the level of compaction of in-situ soils reaches the specified level of compaction, no further removal, manipulation and recompaction is necessary.
 3. Further removal, manipulation and recompaction necessary to obtain the required field density will not be paid separately, but considered included in the Unclassified Excavation.
 4. The in-place field density will be determined in accordance with ASTM D 1556, ASTM D 2167 or ASTM D 6938. Stones or rock fragments larger than 4 inches in their greatest dimension will not be permitted in the top 12 inches of the subgrade. The finished grading operations, conforming to the typical cross section, must be completed and maintained at least 1,000 feet ahead of the paving operations or as directed by the Commissioner.
 5. In cuts, all loose or protruding rocks on the back slopes must be barred loose or otherwise removed to line of finished grade of

slope. All cut-and-fill slopes must be uniformly dressed to the slope, cross section, and alignment shown on the Drawings or as directed by the Commissioner.

TABLE 1
Soil Compaction Requirements
Percent of Maximum Density as Determined by ASTM D-1557

	Beneath Rigid Pavement ¹		Beneath Flexible Pavement ²		Outside Pavement Area	
	Cohesive Soils	Noncohesive Soils ³	Cohesive Soils	Noncohesive Soils ³	Cohesive Soils	Noncohesive Soils
Cut sections (compaction of subgrade)	<ul style="list-style-type: none"> Top 6 inches of subgrade - 95% 	<ul style="list-style-type: none"> Top 6 inches of subgrade - 100% Next 18 inches - 95% 	<ul style="list-style-type: none"> Top 9 inches of subgrade - 95% 9 to 18 inches below top of subgrade - 90% 18 to 27 inches below top of subgrade - 85% 27 to 36 inches below top of subgrade - 80% 	<ul style="list-style-type: none"> Top 23 inches of subgrade - 100% 23 to 41 inches below top of subgrade - 95% 41 to 59 inches below top of subgrade - 90% 59 to 76 inches below top of subgrade - 85% 		
Fill sections (including existing subgrade if fill thickness is less than 36 inches for cohesive soils and 76 inches for noncohesive soils)	<ul style="list-style-type: none"> Entire fill section - 90% Top 6 inches of existing soil - 90% 	<ul style="list-style-type: none"> Top 6 inches of fill - 100% Remaining depth of fill - 95% Top 6 inches of existing soil - 90% 	<ul style="list-style-type: none"> Top 9 inches of fill - 95% 9 to 18 inches below top of fill - 90% 18 to 27 inches below top of fill - 85% 27 to 36 inches depth and below - 80% (including top 6 inches of existing soil if fill thickness is greater than 36 inches) 	<ul style="list-style-type: none"> Top 23 inches of fill - 100% 23 to 41 inches below top of fill - 95% 41 to 59 inches below top of fill - 90% 59 to 76 inches below top of fill - 85% 76 inch depth and below - 80% (including top 6 inches of existing soil if fill thickness is greater than 76 inches) 	<ul style="list-style-type: none"> Entire fill section - 90% 	Entire fill section - 95%

¹Rigid pavements consist of Portland Cement Concrete placed upon a granular or treated subbase course over compacted subgrade. Rigid pavements may have bituminous overlays.

²Flexible pavements consist of a bituminous wearing surface placed on a base course and possibly a subbase over a compacted subgrade. The base course may consist of bituminous base, crushed aggregate base or cement treated base course.

³For those soils having a plasticity index (P.I.) of greater than or equal to 4 or less than 6 and other borderline soils, the Commissioner will determine the soil classification for the purpose of determining soil compaction requirements and compaction equipment (see 2.08.A). The Commissioner will determine the type of compaction equipment under 2.08.A. Non-cohesive soils for purposes of determining compaction are those soils having a plasticity index (P.I.) of less than 6.0.

3.04 PREPARATION OF EMBANKMENT AREA

- A. Where an embankment is to be constructed, all topsoil, sod and vegetable matter must be removed from the surface upon which the embankment is to be placed, and the cleared surface must be completely broken up by plowing or scarifying to a minimum depth of 6 inches. This area must then be compacted as required by this Specification.
- B. Where embankments are to be placed on natural slopes steeper than 3 to 1 (H:V), or against cut slopes, horizontal benches 2 to 3 feet wide must be cut into the slope or constructed as directed by the Commissioner.
- C. No direct payment will be made for the preparation work performed under this Section. No separate payment will be made for benching. This work will be considered a necessary part of the embankment and will be included in the Contract unit price for Unclassified Excavation.

3.05 FORMATION OF EMBANKMENTS

- A. Embankments will be formed in successive horizontal layers of not more than 8 inches in loose depth for the full width of the cross section, unless otherwise directed by the Commissioner.
- B. The grading operations must be conducted, and the various soil strata must be placed, to produce a soil structure as shown on the typical cross section or as directed. Materials such as topsoil, brush, hedge, roots, stumps, grass and other organic matter will not be incorporated or buried in the embankment. All materials used in the formation of embankments must be Suitable Fill Material, Restricted Fill Material, or Unsuitable Fill Material, as indicated on the Drawings.
- C. Operations on earthwork must be suspended at any time when satisfactory results cannot be obtained because of rain, freezing, or other unsatisfactory conditions of the field. The Contractor must drag, blade, or slope the embankment to provide proper surface drainage if operations are suspended.
- D. Subgrade materials will contain no rock, stones, or broken concrete greater than four (4) inches in the largest dimension in the top twelve (12) inches of the proposed subgrade; no greater than nine (9) inches in the largest dimension between one (1) foot and four (4) feet below finished subgrade; and no greater than twenty (20) inches in the largest dimension at depths greater than four (4) feet below the finished subgrade.
- E. The material in the layers must be within +/- 2 percent of optimum moisture content as determined by ASTM D 1557 before rolling to

obtain the prescribed compaction. In order to achieve uniform moisture content throughout the layer, wetting or drying of the material and manipulation must be required when necessary. Should the material be too wet to permit proper compaction or rolling, all Work on all of the affected portions of the embankment must be delayed until the material has dried to the required moisture content. The material may be disked to a depth of 8 inches to facilitate drying and then be recompacted to the requirements listed in Table 1. Sprinkling of water on dry material to obtain the proper moisture content must be done with approved equipment that will sufficiently distribute the water. Sufficient equipment to furnish the required water must be available at all times. Samples of all embankment materials for testing, both before and after placement and compaction, will be taken for each 250 cubic yards or in a 100 ft. x 100 ft. grid of material placed per layer, or as required by the Commissioner. Based on these tests, the Contractor must make the necessary corrections and adjustments in methods, materials or moisture content in order to achieve the correct embankment density. The Contractor must at a minimum perform one modified proctor ASTM D1557 for each 5,000 CY of material placed or when materials change substantially as determined by the Commissioner.

- F. Wet soils are defined as those soils whose moisture content, when placed in an embankment, exceeds the optimum moisture content necessary for compaction in accordance with this Specification. Embankment layers that are determined to be wet as a result of the moisture content of the in-situ excavation will be subject to the requirements below. No separate payment will be made for drying by any means of embankment layers that become wet as the result of the Contractor's failure to properly control surface drainage during construction. If wet soils are encountered during embankment construction or subgrade preparation, the Contractor, at a minimum, must take the following steps in an effort to obtain the moisture content needed to achieve the specified level of compaction:
1. If the moisture is within 4% of the optimum moisture content for the soil, the Contractor must air dry the uncompacted layer. The Contractor must disc, till or use whatever means appropriate to process the full depth of the uncompacted layer each day for three (3) consecutive good drying days. The Contractor must periodically check the moisture content during processing. As soon as acceptable moisture contents are achieved, the Contractor must acceptably complete the compaction of that layer.
 2. If, in the opinion of the Commissioner, the specified level of compaction or moisture content cannot be obtained after air

drying or the in situ moisture level at the time of excavation is excessive, Lime Modification may be performed in accordance with Section P-159, Lime Modified Soils when authorized by the Commissioner in writing. The quantity of lime approved for modification of the soil layer will be determined by the moisture content of that soil layer and by the type of the soil in the layer. Lime modified soil layers will be accepted based on the compaction and testing requirements of this Specification. The Commissioner has the sole discretion in the use of lime for the purpose of modifying soils in order to achieve the specified level of compaction.

- G. Compacting operations for Suitable Fill and Restricted Fill Material must be continued until the embankment is compacted to the requirements listed in Table 1. Compacting operations for Unsuitable Fill Material must be continued until the embankment is compacted to not less than 85 percent of maximum dry density, as determined by ASTM D1557.
- H. On all areas outside of the pavement area, no compaction will be required on the top 4 inches.
- I. The in-place field density must be determined in accordance with ASTM D 1556, ASTM D 2167 or ASTM D 2922.
- J. Compaction areas must be kept separate, and no layer will be covered by another until the proper density is obtained.
- K. During construction of the embankment, the Contractor must route his/her equipment at all times, both when loaded and when empty, over the layers as they are placed and must distribute the travel evenly over the entire width of the embankment. The equipment must be operated in such a manner that hardpan, cemented gravel, clay, or other chunky soil material must be broken up into small particles and become incorporated with the other material in the layer.
- L. In the construction of embankments, layer placement must begin in the deepest portion of the fill; as placement progresses, layers must be constructed approximately parallel to the finished pavement grade line.
 - 1. In embankments greater than 10 feet, sands, silts, silty sands and sandy silts shall be placed in the lower portion of the embankment as directed by the Commissioner. Sands, silts, silty sands, and sandy silts must not be placed in the top 5 feet of embankment.
- M. The final lift of embankment must be proof rolled under pavement areas, and where directed by the Commissioner, as defined in Paragraph 3.02.F Any failures of the proof rolling operation on the final

lift of embankment under pavement areas will be undercut or corrected by the Contractor to the satisfaction of the Commissioner at no cost to the Commissioner

1. Sands, silts, silty sands and sandy silts should not be placed in the top 5 feet of embankment.
- N. When rock and other embankment material are excavated at approximately the same time, the rock must be incorporated into the outer portion of the embankment and the other material must be incorporated under the future paved areas. Stones or fragmentary rock larger than 4 inches in their greatest dimensions will not be allowed in the top 12 inches of the subgrade. Rockfill must be brought up in layers as specified or as directed and every effort must be exerted to fill the voids with the finer material forming a dense, compact mass. Rock or boulders must not be disposed of outside the excavation or embankment areas, except at places and in the manner designated by the Commissioner.
- O. When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in layers of the prescribed thickness without crushing, pulverizing or further breaking down the pieces, such material may be placed in the embankment, as directed by the Commissioner, in layers not exceeding 2 feet- 0 inches in thickness. Each layer must be leveled and smoothed with suitable leveling equipment and by distribution of spalls and finer fragments of rock. These type lifts must not be constructed above an elevation 4 feet below the finished subgrade. Density requirements will not apply to portions of embankments constructed of materials which cannot be tested in accordance with specified methods.
- P. Frozen materials must not be placed in the embankment nor will embankment be placed upon frozen material.
- Q. There will be no separate measurement for payment for compacted embankment, and all costs of placing in layers, compacting, disking, watering, mixing, sloping, and other necessary operations for construction of embankments will be included in the Contract price for Unclassified Excavation.
- R. No additional payment will be considered for material excavated, stockpiled and rehandled. The work required to rehandle stockpiled Suitable Fill, Unsuitable Fill, or Restricted Fill material will be considered included in the Contract unit price for Unclassified Excavation.
- S. Any subgrade or embankment in paving areas constructed in the previous year must be recompacted to the requirements of Table 1 for the top 8 inches and re-approved by the Commissioner before paving

or additional embankment construction. This requirement will consist of disking, recompact and proof-rolling the embankment surface in accordance with these Specifications. No additional payment will be made for this Work.

3.06 FINISHING AND PROTECTION OF SUBGRADE

- A. After the subgrade has been substantially completed, the full width must be conditioned by removing any soft or other unstable material which will not compact properly. The resulting areas and all other low areas, holes or depressions must be brought to grade with suitable or restricted material, as directed by the Commissioner. Scarifying, blading, rolling, and other methods must be performed to provide a thoroughly compacted subgrade shaped to the lines and grades shown on the Drawings.
- B. Grading of the subgrade must be performed so that it will drain readily. The Contractor must limit hauling over the finished subgrade to that which is essential for construction purposes.
- C. All ruts or rough places that develop in a completed subgrade must be smoothed and recompact.
- D. No subbase or other paving course will be placed on the subgrade until the subgrade has been accepted by the Commissioner. Any damage to the accepted subgrade due to the Contractor must be repaired to the satisfaction of the Commissioner by the Contractor at the Contractor's expense.

3.07 HAUL

- A. All hauling will be considered a necessary part of the work. Its cost must be considered by the Contractor and included in the Contract unit price for the pay of items of work involved. No payment will be made separately or directly for hauling on any part of the work.

3.08 EQUIPMENT

- A. The Contractor may use any type of earth moving, compaction and watering equipment it may desire or has at its disposal, provided that the equipment is in satisfactory condition and is of sufficient capacity to perform the Work as specified. The only requirements specified are that tamping rollers (generally referred to as Sheepfoot Rollers) will be considered the proper type of equipment for compaction of cohesive soils and vibratory/mechanical tamping equipment will be applicable for compacting granular soils. Subgrade rollers can be used to smooth minor surface deviations in both types of subgrade/embankment, but in no case will a steel wheel or vibratory roller be used to compact cohesive embankment. In all cases, the

adequacy of the equipment will be determined by the Commissioner. Failure to obtain the specified results or failure to meet the schedule planned by the Contractor and acceptable to the Commissioner, due to inadequate equipment will not be cause for delay or additional payment. The Contractor must furnish, operate, and maintain such equipment as is necessary to control density, section and smoothness of grade.

- B. The requirements of Section 01111, Air Quality-Equipment Emissions apply to this Specification Section.

3.09 TOLERANCES

- A. In those areas upon which a subbase or base course is to be placed, the top of the subgrade must be of such smoothness that, when tested with a 16-foot straightedge applied parallel and at right angles to the centerline, it must not show any deviation in excess of ½-inch, or must not be more than 0.05-foot from true grade as established by grade hubs or pins. Any deviation in excess of these amounts must be corrected by loosening, adding, or removing materials; reshaping; and recompacting by sprinkling and rolling.
- B. On safety areas, intermediate and other designated areas, the surface must be of such smoothness that it will not vary more than 0.10 foot from the design grade as established by grade hubs. Any deviation in excess of this amount must be corrected by loosening, adding or removing materials, and reshaping.

3.10 TOPSOIL

- A. When topsoil is specified or required as shown on the Drawings or under Item T-905, it must be salvaged from stripping or other grading operations. The topsoil must meet the requirements of Section T-905 Topsoiling. If, at the time of excavation or stripping, the topsoil cannot be placed in its proper and final section of finished construction, the material must be stockpiled at approved locations. Stockpiles must not be placed within 50 feet of pavement or areas and must not be placed on areas which subsequently will require any excavation or embankment.
- B. Upon completion of grading operations, stockpiled topsoil must be handled and placed as directed, or as required in Section T-905 Topsoiling. No stockpiles will be allowed to remain within the project limits at the end of the Project. If excess topsoil remains at the end of the Project, it must be stockpiled at a location as directed by the Commissioner.
- C. No separate payment will be made for topsoil stripping and stockpiling as such under Section P-152 Excavation and Embankment. The

quantity removed and placed directly or stockpiles is included the Contract unit price for the Pay Item "Unclassified Excavation".

3.11 BACKFILLING OF REMOVAL ITEMS

- A. Any items removed as part of site demolition that lie in the proposed pavement or shoulder areas must be backfilled to grade with FA-6 or CA-6 and mechanically compacted with vibratory equipment in accordance with Section X-100 Site Demolition as directed by the Commissioner.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. The quantity of Unclassified Excavation and any required Borrow Excavation to be paid for will be the number of cubic yards measured in its original position after pavement removal and vegetation clearing and grubbing has been completed.
- B. The quantity of Unclassified Excavation – Undercut and Backfill with stabilization stone to be paid for will be the number of cubic yards measured in its final position, compacted volume. Specification Section P-152 Excavation and Embankment covers undercut and Section P-154 Frost Protection Course covers backfill requirements.
- C. Measurement will not include the quantity of materials excavated without authorization beyond normal slope lines, and dimensions shown on the Drawings, or the quantity of material used for purposes other than those directed.
- D. No measurement or payment will be made for stockpiled or rehandled material that is used for embankment.
- E. The topsoil quantity removed and either placed directly or stockpiled will be paid as Unclassified Excavation.
- F. Allowance for contaminated or hazardous material remediation or hard to handle material: An allowance is established for approved excavation and on site placement of non-hazardous contaminated materials and excavation and disposal offsite of hazardous waste and NAPL contaminated soils. The allowance is to be used exclusively to pay for the additional/extra work if required to remove and dispose of the contaminated material above and beyond the conditions shown on the Drawings. Work under this allowance will be subject to prior approval by the Commissioner.
- G. For payment specified by the cubic yard, measurement for all excavation will be computed by the average end area method. The end area is that bound by the original ground line (after clearing and

grubbing) established by field cross sections and the final theoretical pay line established by excavation cross sections shown on the Drawings, subject to verification by the Commissioner. After completion of all excavation operations and directed, including undercutting; and prior to placing of embankment, suitable fill, restricted fill, unsuitable fill, base or subbase material, the final excavation will be verified by the Commissioner by means of field cross sections taken randomly at intervals not exceeding 50 linear feet. The volume quantity for payment of Unclassified Excavation will be subject to the applicable deductions in accordance with Paragraph 3.02.B.

- H. Final field cross sections will be employed if the following changes have been made: Plan width of embankments or excavations are changed by more than plus or minus 1.0 foot; or Plan elevations of embankments or excavations are changed by more than plus or minus 0.5 foot.
- I. Clearing and Grubbing will not be measured separately and will be considered incidental to Section P-152 Excavation and Embankment as discussed under Section P-151 Clearing and Grubbing.
- J. Pavement Removal will be measured and paid for separately under Section P-150 Pavement Removal.
- K. Cost of excavation for erosion control devices/measures will not be measured separately and will be considered included in the erosion control P-156 Temporary Air and Water Pollution, Soil Erosion, and Sediment Control Pay Items.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. For "Unclassified Excavation" payment will be made at the Contract unit price per cubic yard. This price will be full compensation for excavation of material from its original place and placement in its final location or embankment as specified, directed by the Commissioner, or shown on the Drawings including single or multiple handling. This price will include furnishing all materials, surveying, labor, equipment, tools, hauling, and all work necessary to complete the item, including topsoil stripping and placement, undercutting, borrow material excavation, sorting, stockpiling, sawcutting, disposal, interim stockpiling and re-handling, as required by this Specification or shown on the Drawings. This price will also include segregating the recyclable materials and other debris, stockpiling such materials at the designated area shown on the Drawings, and disposing of unsuitable materials as shown on the Drawings or as directed by the

Commissioner. Wood must be segregated, chipped and disposed of off Airport property, as directed by the Commissioner.

- B. For "Excavation from Stockpile to Embankment" payment will be made at the Contract unit price per cubic yard. This price will be full compensation for excavation of material from its original place and placement in its final location or embankment as specified, directed by the Commissioner, or shown on the Drawings including single or multiple handling. This price will include furnishing all materials, surveying, labor, equipment, tools, hauling, and all work necessary to complete the item, including topsoil stripping and placement, undercutting, borrow material excavation, sorting, stockpiling, sawcutting, disposal, interim stockpiling and re-handling, as required by this Specification or shown on the Drawings. This price will also include segregating any recyclable materials and other debris, stockpiling such materials at the designated area shown on the Drawings, and disposing of unsuitable materials as shown on the Drawings or as directed by the Commissioner. Wood must be segregated, chipped and disposed of off Airport property, as directed by the Commissioner.
- C. For "Allowance for Contaminated or Hazardous Material Remediation or Hard to Handle Material" payment will be made for excavation, onsite placement or offsite disposal of contaminated material and includes approved additional special handling and procedures required during excavation, obtaining waste stream authorization, surveying, loading into hauling trucks, transporting and disposing of the materials at an approved disposal facility. This allowance is only for any effort that is clearly above and beyond the effort required for Unclassified Excavation. Any work under this allowance must receive written notice from the Commissioner to proceed with the work. The work will be paid for as shown in General Conditions, Article X, Changes in Work, 3. Time and Materials Basis. Unused portions of this allowance will not be paid to the Contractor, but will be returned to the City in the form of an appropriate credit.
- D. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
P-152-01	UNCLASSIFIED EXCAVATION	CY
P-152-02	EXCAVATION FROM STOCKPILE TO EMBANKMENT	CY

ITEM NO.	DESCRIPTION	UOM
P-152-03	ALLOWANCE FOR CONTAMINATED OR HAZARDOUS MATERIAL REMEDIATION OR HARD TO HANDLE MATERIAL	AL

END OF SECTION P-152

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FROST PROTECTION COURSE

SECTION P-154

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item consists of a subbase course, hereinafter referred to as the frost protection course, composed of granular materials constructed on a prepared subgrade or other underlying course or stabilization course in accordance with these Specifications, and in conformity with the dimensions and typical cross section shown on the Drawings, or as directed by the Commissioner. The work under this Section is subject to the requirements of the Contract Documents.

1.02 RELATED WORK

- A. As specified in the following Sections:
 - 1. Section 02245 Recycled Crushed Concrete and Asphalt
 - 2. Section P-152 Excavation and Embankment
 - 3. Section P-156 Temporary Air and Water Pollution, Soil Erosion, and Sediment Control
 - 4. Section P-629 Geotextile Fabric

PART 2 MATERIALS

2.01 GENERAL

- A. The frost protection material must consist of crushed stone or crushed recycled concrete having a gradation of CA-1, CA-5, CA-6, Recycled Concrete Base (RCB) or as specified on the Drawings, conforming to the requirements of the Illinois Department of Transportation, Standard Specifications for Road and Bridge Construction (S.S.R.B.C.), latest edition. The material must be Class D quality or better. The portion of the frost protection material passing a No. 40 sieve must have a plasticity index of not more than 4 when tested in accordance with ASTM D 4318.
- B. The materials to be used for Stabilization Stone must consist of crushed stone or crushed recycled concrete having a gradation of CA-1, capped with CA-6 as directed by the Commissioner, quality Class D or better, conforming to the requirements of Article 1004.01 of the S.S.R.B.C.

- C. Where crushed recycled concrete (CA-1, CA-5, CA-6, and RCB) are used for frost protection course, stabilization stone, they must be produced on site by the Contractor by crushing Portland cement concrete. They must be crushed from clean rubble obtained from pavement removal or foundations from O'Hare Airport projects. Refer to relevant provisions of Section 02245 Recycled Crushed Concrete and Asphalt.
- D. Material to be used for the geotextile fabric must be nonwoven and meet the requirements of Section P-629 Geotextile Fabric.
- E. Recycled Concrete Base (RCB) used as frost protection subbase under runway, taxiway and taxilane shoulders must meet the following gradation:

Sieve Size	Percent Passing
4"	100
3"	60 - 100
¾"	30 - 70
½"	20 - 60
#4	35 maximum percent passing
#40	20 maximum percent passing
#200	0 - 5.0

- 1. The RCB will be subject to acceptance testing procedures by the Commissioner/Construction Manager (CM). Crushing operation at the jobsite will be subject to monitoring by the Commissioner to ensure that the material is clean and meets the requirements. Uniformity in production of clean recycled concrete and uniformity of placement in the field free of segregation are required. Precautions shall be taken to avoid segregation of material in the stockpile or during placement. RCB must be free of reinforcing bars, PVC pipes, RAP, metals, geotextile fabric, and other objectionable materials.
- F. For the material to be used for the geotextile fabric, see Section P-629 Geotextile Fabric.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

- A. The frost protection course must be placed where designated on the Drawings or as directed by the Commissioner. The material must be shaped and thoroughly compacted within the tolerances specified.
- B. Stabilization stone must only be placed in areas of severely adverse subgrade conditions and as directed by the Commissioner.
- C. Granular subbases which, due to grain sizes or shapes, are not sufficiently stable to support without movement the construction equipment, must be mechanically stabilized to the depth necessary to provide such stability as directed by the Commissioner. The mechanical stabilization must principally include the addition of a fine-grained medium to bind the particles of the subbase material sufficiently to furnish a bearing strength, so that the course will not deform under the traffic of the construction equipment. The addition of the binding medium to the subbase material must not increase the soil constants of that material above the limits specified.
- D. The frost protection course, and stabilization stone must be placed in accordance with the requirements of Section 311 of the S.S.R.B.C. for Type B except as modified herein.

3.02 OPERATION IN PITS

- A. All work involved in clearing and stripping pits and handling unsuitable material encountered must be performed by the Contractor at his/her expense. The frost protection course, and stabilization stone material must be obtained from pits or sources that have been accepted by the Commissioner. The material in the pits must be excavated and handled in such a manner that a uniform and satisfactory product can be secured.

3.03 PREPARING UNDERLYING COURSE

- A. Before any frost protection, or stabilization stone material is placed, the underlying course must be prepared and conditioned as specified. The course must be checked and accepted by the Commissioner before placing and spreading operations are started. The subgrade must be compacted in accordance with the requirements of Section P-152 Excavation and Embankment. Immediately before placement of the frost protection course, the subgrade must be proof-rolled with a 25 ton or heavier pneumatic tired roller making at least 8 passes over the entire area in alternate (perpendicular) directions or a fully loaded semi-truck loaded to the legal limit at the Commissioner's discretion.

- B. Grade control between the edges of the pavement must be by means of grade stakes, steel pins, or forms placed in lanes parallel to the centerline of the pavement and at intervals which will permit string lines or check boards to be placed between the stakes, pins, or forms.
- C. In areas where the Commissioner directs the Contractor to over-excavate below subgrade level and backfill the over-excavation with stabilization stone, the stabilization stone must be placed on a layer of non-woven geotextile filter fabric per Section P-629 Geotextile Fabric, leveled and compacted to make the subgrade firm and stable. Areas of undercut of 6 inches or less must be stabilized with CA-6, crushed stone or crushed recycled concrete; areas of undercut greater than 6 inches must be stabilized with crushed stone or crushed recycled concrete, CA-1 capped to subgrade level with 4 inches of CA-6. All undercut and backfill work to be directed as authorized by the Commissioner.
- D. To protect the subgrade and to ensure proper drainage, the spreading of the frost protection course must begin along the centerline of the pavement on a crowned section or on the high side of pavements with a one-way slope.

3.04 MATERIALS ACCEPTANCE IN EXISTING CONDITION

- A. When the entire frost protection course, or stabilization stone material is secured in a uniform and satisfactory condition and contains approximately the required moisture, such approved material may be moved directly to the spreading equipment for placing. The material may be obtained from gravel pits, stockpiles, or may be produced from a crushing and screening plant with the proper blending. The materials from these sources must meet the requirements for gradation, quality, and consistency. It is the intent of this section of the Specifications to secure materials that will not require further mixing. The moisture content of the material must be approximately that required to obtain maximum density. Any minor deficiency or excess of moisture may be corrected by surface sprinkling or by aeration. In such instances, some mixing or manipulation may be required, immediately preceding the rolling, to obtain the required moisture content. The final operation must be bladed or dragged, if necessary, to obtain a smooth uniform surface true to line and grade.

3.05 PLANT MIXING

- A. When materials from several sources are to be blended and mixed, the material must be processed in a central or travel mixing plant. The material must be thoroughly mixed with the required amount of water.

After the mixing is complete, the material must be transported to and spread on the underlying course without undue loss of the moisture content.

3.06 GENERAL METHODS FOR PLACING

- A. The frost protection course must be constructed in layers. Any layer must be not more than 6 inches thickness for CA-6; nor more than 12 inches for CA-5, CA-1, or RCB. The material, as spread, must be of uniform gradation with no pockets of fine or coarse materials. The frost protection course, unless otherwise permitted by the Commissioner, must not be spread more than 2,000 square yards in advance of the rolling. Any necessary sprinkling must be kept within this limit. No material will be placed in snow or on a soft, muddy, or frozen course.
- B. All stockpiles created per Section 02245 Recycled Crushed Concrete and Asphalt, and placed as Paving – Frost Protection Course for shoulders, apron, and roadway pavements shall be depleted prior to hauling Paving – Frost Protection Course, CA-5 or CA-6 on-site. Any excess from Section 02245 Recycled Crushed Concrete and Asphalt, may be used in lieu of or in combination of Paving – Frost Protection CA-6 as aggregate material for the proposed service road. Placement of all 02245 Recycled Crushed Concrete and Asphalt, RCB, shall be approved and directed by the Commissioner.
- C. When more than one layer is required, the construction procedure described herein must apply similarly to each layer.
- D. During the placing and spreading, sufficient caution must be exercised to prevent the incorporation of subgrade, shoulder, or foreign material in the frost protection course mixture.
- E. Where geotextile fabric is required to be placed under the frost protection course, it must be placed over the subgrade in accordance with the manufacturer's recommendations and Section P-629 Geotextile Fabric. The fabric must be non-woven. In areas of undercut and backfill, the fabric must be placed over the backfill at the top of subgrade level. The frost protection course material must be back-dumped on the fabric in a sequence of operations beginning at the outer edges of the area with subsequent placement toward the middle. Dumping of the material directly on the fabric will only be permitted to establish an initial working platform. No vehicles or construction equipment will be allowed on the fabric prior to the placement of the frost protection course. Fabric which is damaged during installation or subsequent placement of frost protection course must be repaired or

replaced by the Contractor at his own expense to the satisfaction of the Commissioner.

3.07 FINISHING AND COMPACTING

- A. After spreading or mixing, the material must be thoroughly compacted by rolling and sprinkling, when necessary. Sufficient rollers must be furnished to adequately handle the rate of placing and spreading of the frost protection course.
- B. The field density of the compacted material under aircraft pavements must be at least 100 percent of the maximum density of laboratory specimens prepared from samples of the subbase material delivered to the jobsite for CA-5 or CA-6 material. The laboratory specimens must be compacted and tested in accordance with ASTM D 1557. The in-place field density shall be determined using a nuclear gage in accordance with ASTM D6938.
- C. The course must not be rolled when the underlying course is soft or yielding or when the rolling causes undulation in the subbase. When the rolling develops irregularities to the CA-5 or CA-6 that exceed 1/2-inch when tested with a 16-foot straightedge, the irregular surface must be loosened and then refilled with the same kind of material as that used in constructing the course and again rolled as required above. Irregularities in the CA05 or CA-6 or RCB placement must not exceed ½ inch and must be checked by means of surveying.
- D. The field density of the compacted RCB material for runway, taxiway and taxilane shoulders, FAA access roads, haul roads and service roads must be at least 95% of the maximum density of laboratory specimens when compacted and tested in accordance with ASTM D1557. The in-place field density shall be determined using a nuclear gage in accordance with ASTM D6938.
- E. CA-1, CA-5 and CA-6 must be compacted to consolidation in a manner approved by and to the satisfaction of the Commissioner. They must be rolled to consolidate and lock the aggregates into stable layers.
- F. Verification of consolidation and interlocking of the RCB will be performed via a rolling pattern procedure. The rolling pattern will be developed by recording the number of passes of a vibratory roller needed to ensure proper consolidation and interlocking of the RCB material using survey elevation data. The RCB will be installed in twelve (12) inch lifts and rolled an acceptable number of times until survey data shows that the consolidation of the material is negligible

and acceptable to the Commissioner. The specified number of passes, determined by the rolling pattern, will be the required amount of passes used for the RCB material and that particular vibratory roller for the project. If the Contractor wishes to change vibratory rollers during the project, then a new rolling pattern must be developed. The Contractor must verify the rolling pattern once per week or every time a new piece of equipment is used. The rolling pattern development must be performed in the presence of and to the satisfaction of the Commissioner. The Contractor will perform a rolling pattern verification whenever the Commissioner deems it is needed to properly control the process or the Commissioner deems the process out of control.

- G. Along places inaccessible to rollers, the subbase material must be tamped thoroughly with mechanical or hand tampers.
- H. Sprinkling during rolling, if necessary, must be in the amount and by equipment acceptable to the Commissioner. Water must not be added in such a manner or quantity that free water will reach the underlying layer and cause it to become soft.

3.08 ACCEPTANCE SAMPLING AND TESTING

- A. CA-1, CA-5, CA-6 and RCB shall be accepted for gradation and density or consolidation as specified herein. Sampling locations shall be determined on a random basis in accordance with statistical procedures contained in ASTM D3665. Sampling of aggregates shall be in accordance with ASTM D75.
- B. One gradation test per ASTM C136 must be run per 5000 tons per each aggregate type delivered or a minimum of one test per week, whichever is more frequent, or when materials substantially change as determined by the Commissioner. The aggregate type will be accepted for gradation when it falls within the limits and tolerances specified for CA-1, CA-6 and RCB. If the proper gradation is not attained, the gradation test must be repeated. A material that does not pass the gradation after retest shall be rejected and replaced by the Contractor at the Contractor's expense.
- C. For CA-5 and CA-6, each lift must be tested for density; a minimum of one test must be taken for each 250 cubic yards of material placed per layer, or as directed by the Commissioner. The material will be accepted for density when the field density is at least the specified percent of the maximum density of the laboratory specimen prepared from samples delivered to the job site. If the specified density is not attained, the material shall be reworked and additional random density tests made. This procedure shall be followed until the specified

density is reached.

- D. Consolidation of the RCB will be accepted if the proper rolling pattern had been utilized during the installation of the material, all aggregate interlock is complete and the consolidation effort has been checked. The consolidation effort will be checked via the survey data per P-154.3.07F every 400 LF/lift installed.

3.09 SURFACE TEST

- A. After the course is completely compacted, the surface must be tested for smoothness and accuracy of grade and crown; any portion found to lack the required smoothness or to fail in accuracy of grade or crown must be scarified, reshaped, recompact, and otherwise manipulated as the Commissioner may direct until the required smoothness and accuracy are obtained. The finished surface must not be above the theoretical vertical grade and may not vary more than 1/2-inch when tested with a 16 foot straightedge applied parallel with, and at right angles to the centerline. Surface testing may be made by means of survey and/or templates.

3.10 THICKNESS

- A. The thickness of the completed subbase course must be determined by depth tests, survey, or cores conducted by the Contractor taken at intervals so each test must represent no more than 500 square yards. When the deficiency in thickness is more than 1/2 inch, the Contractor must correct such areas by scarifying, adding satisfactory mixture, rolling, sprinkling, reshaping, and finishing in accordance with these Specifications. The Contractor must replace at his/her expense the frost protection material where borings are taken for test purposes.

3.11 PROTECTION

- A. Work on frost protection course must not be conducted during freezing temperatures or when the subgrade is wet. When the subbase material contains frozen material or when the underlying course is frozen, the construction must be stopped.

3.12 MAINTENANCE

- A. Following the final shaping of the material, the subbase must be maintained throughout its entire length by the use of standard motor graders and rollers until, in the judgment of the Commissioner the frost protection course meets all requirements and is acceptable for the construction of the next course. The Contractor is totally responsible for the preparation, maintenance and protection of the frost protection

course and no additional compensation will be considered for any reworking of the material for any reason.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. The yardage of frost protection course to be paid for will be the number of square yards of frost protection material of a nominal thickness or the number of cubic yards of frost protection course material of a variable thickness based on average cross sectional area per drawing dimensions multiplied by the length placed, compacted and accepted in the completed course. The quantity of frost protection and granular subbase course material will be measured in final position based on surface area, or by means of average end areas computed from depth dimensions in the Drawings. Frost protection and granular subbase materials will not be included in any other excavation quantities.
- B. The yardage of undercut and backfill with stabilization stone to be paid for will be the number of cubic yards of undercut material removed, measured in place. This quantity will govern regardless of the volume of stone or recycled concrete required for backfill. This item will be used for areas at which the Commissioner makes a field decision to undercut below subgrade and backfill with stone.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment will be made at the Contract unit price per square yard or per cubic yard for frost protection course. This price will be full compensation for furnishing all materials including geotextile fabric; for all preparation, hauling, placing and compacting of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.
- B. Payment will be made at the Contract unit price per cubic yard for undercut and backfill with stabilization stone. This price will be full compensation for furnishing all materials including geotextile fabric; for all excavation, removal and disposal of off the Airport, preparation, hauling, placing and compacting of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item. Payment will not be made for materials placed outside the theoretical grade line beyond the limits defined on the typical sections.

C. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
P-154-01	EXCAVATING – UNDERCUT AND BACKFILL WITH STABILIZED STONE, CRUSHED STONE	CY
P-154-02	EXCAVATING – UNDERCUT AND BACKFILL WITH STABILIZED STONE, CRUSHED RECYCLED CONCRETE	CY
P-154-03	PAVING - 6" - FROST PROTECTION COURSE, CA-6 CRUSHED RECYCLED CONCRETE (INCLUDES GEOTEXTILE FABRIC PER P-629)	SY
P-154-04	PAVING - 12" - FROST PROTECTION COURSE, CA-6 (INCLUDES GEOTEXTILE FABRIC PER P-629)	SY
P-154-05	PAVING - 18" - FROST PROTECTION COURSE, CA-6 (INCLUDES GEOTEXTILE FABRIC PER P-629)	SY
P-154-06	PAVING – VARIABLE DEPTH FROST PROTECTION COURSE, CA-5 (INCLUDES GEOTEXTILE FABRIC PER P-629)	CY

END OF SECTION P-154

**TEMPORARY AIR AND WATER POLLUTION, SOIL EROSION,
AND SEDIMENT CONTROL**
SECTION P-156

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item consists of temporary control measures as shown on the Plans or as ordered by the Commissioner during the life of a Contract to control water pollution, soil erosion, and sediment control through the use of aggregate berms, earth berms, temporary ditches, ditch and watercourse checks, sediment traps, sediment logs, erosion control blankets, stone, temporary seeding, inlet and pipe protection, stabilized construction entrances/exits, bioinfiltration basins, and other erosion control devices or methods.
- B. This special provision will be used in conjunction with the plan documents and the Storm Water Pollution Prevention Plan (SWPPP).
- C. The Contractor must control soil erosion in accordance with the provisions of NPDES permit ILR10 issued by the Illinois Environmental Protection Agency (IEPA) for stormwater discharges associated with construction site activities.
- D. The Contractor must meet the Specifications of the Illinois Urban Manual (latest edition, published by IEPA and Illinois Natural Resources Conservation Service), as modified in the Contract Drawings and Specifications.
- E. The Contractor must coordinate temporary erosion control measures with the permanent erosion control measures to the extent practical to assure economical, effective, and continuous erosion control throughout the construction period.
- F. Temporary erosion control is not limited to areas within the construction limits; construction operations at sites such as borrow pits, equipment and material storage sites, waste areas, temporary stock piles, temporary plant sites, and others are also subject to erosion control requirements.
- G. The best way to prevent sediment from entering storm sewer systems and waterways is to stabilize the disturbed areas of a site as quickly as possible, preventing erosion and stopping sediment transport at its source.
- H. Prior to commencing land disturbing activities other than those indicated on the Plans (including but not limited to additional phases of the development and off-site borrow, waste, asphalt and/or concrete

batch plant areas) a supplemental erosion and sediment control plan must be submitted to the Commissioner for review and approval by North Cook County Soil and Water Conservation District (NCCSWCD) or Kane Dupage Soil and Water Conservation District (KDSWCD).

- I. Erosion control and storm water pollution prevention measures not shown on the plans shall be installed as directed by the Commissioner during the project. Pay Items and Quantities have been estimated for bidding purposes only.

1.02 REFERENCES

- A. Illinois Department of Transportation - Standard Specifications for Road and Bridge Construction, latest edition (SSRBC).
- B. Illinois Urban Manual: A Technical Manual for Urban Ecosystem Protection and Enhancement, latest edition. United States Department of Agriculture, Natural Resources Conservation Service, Champaign, Illinois, latest edition.
- C. Soil Erosion and Sediment Control Plan for the O'Hare Modernization Program.

1.03 DEFINITIONS

- A. Channels: All ditches and watercourses will be considered "channels."

1.04 SUBMITTALS

- A. Contractor to submit Product Data – catalogs, brochures, and performance and test data to support conformance with the Specifications for the materials to include but not limited to:
 1. Temporary Seed – Signed statement by Vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing, within 6 months of delivery. Statement must include: name and address of laboratory, date of test, lot numbers for each kind of seed, results of the tests as to seed name, percentages of purity, and of germination, and in case of mixture, the proportion of each kind of seed.
 2. Mulch
 3. Erosion Control Blanket
 4. Fertilizer
 5. Silt Fence and Stakes
 6. Sediment Log and Stakes
 7. Sediment Containment Filter Bag
 8. Inlet Protection

9. Polymer (Powder form)
10. Polymer (Floc Log form)
11. Geotextile Fabric
12. Jute Netting
13. Temporary Stream Crossing – Aggregates, pipe, and installation drawing
14. Concrete Washout Facility – 30 mil polyethylene liner
15. Aggregates – Gradation test for each size of aggregate by a certified testing laboratory.

PART 2 MATERIALS

2.01 SEEDING, TEMPORARY

A. Temporary Protection by Vegetation

1. Seed:
 - a. For disturbed areas that will not be in the active work area between 14 days and 365 days, seed must be applied at the following rates:
 - 1) Seed with 90 lbs. per acre of cereal rye and 25 lbs. per acre of perennial ryegrass, or
 - 2) Seed with 90 lbs. per acre of spring oats and 25 lbs. per acre of perennial ryegrass.

Mixture	Temporary Grass Seed Mixture	Lbs/acre (pure live seed)
1	Cereal rye	90
	Perennial ryegrass	25
2	Spring Oats	90
	Perennial ryegrass	25

B. Hydroseeding

1. Fertilizer, seed, and mulch shall be applied using an acceptable hydroseeding distribution method approved by the Commissioner.
2. Mulch shall be applied at a rate of 25-40 pounds per 1000 square feet.
3. Hydroseeding equipment shall include a pump rated and operated at no less than 100 gallons per minute and no less than 100 psi pressure. The tank shall have a mechanical

agitator powerful enough to keep the seed and fertilizer in a uniform suspension in the water.

2.02 MULCH

- A. Mulches must not consist of hay, straw, bark, or woodchips. Mulch may be hydromulch, polymer, or other suitable material approved by the Commissioner that is reasonably clean and free of noxious weeds and deleterious materials.
- B. Materials for High Performance Mulch must be per manufacturer's specification, and as approved by the Commissioner. Acceptable products for high performance mulch include the following:
 - 1. Hydra CX2 Extreme Slope Matrix.
 - 2. Profile Erosion Control Systems Flexterra FGM
 - 3. North American Green Geoskin XT;

2.03 EROSION CONTROL BLANKET

- A. Acceptable manufacturers include North American Green, Enviroscope ECM, Ltd., and U.S. Construction Fabrics LLC.
- B. The Erosion Control Blanket must meet requirements of the Manufacturer's Specification and recommendations.
- C. Erosion Control Blanket shall consist of a machine produced mat of straw fiber and shall be furnished in rolls and meet the following minimum requirements:
 - 1. Weight - 0.5 lbs. per sq. yd., + or - 10%.
 - 2. Material - 100 percent weed free straw.
 - 3. The straw blanket shall be bound to the netting with a biodegradable thread sewn on 1 ½" centers.
 - 4. The top and bottom of each blanket may be covered with a 5/8 by 5/8 of an inch opening size biodegradable or non-biodegradable netting.
- D. All disturbed areas must be stabilized with Erosion Control Blanket as shown on the Drawings and as required below:
 - 1. Slopes of 4 to 1 or less must be stabilized at a minimum with a single net erosion control blanket that meets a maximum shear stress of 0.5 lbs/ft² and a minimum tensile strength of 5 lbs/ft.
 - 2. Slopes greater than 4 to 1 and all channels, swales, conveyances, flow lines, etc., must be stabilized at a minimum with a double net erosion control blanket that meets a maximum

shear stress of 1.5 lbs/ft² and a minimum tensile strength of 50 lbs/ft.

- E. "U" shaped staples must consist of 0.12 inch diameter (No. 11 wire gage) or greater, with a minimum leg length of 6 inches and a minimum width of 1 inch and must be used to anchor the Erosion Control Blanket. In sandy soils, the minimum leg length of the staples must be 9 inches. Push pins or circle top pins are acceptable and must meet the material specifications stated above.
- F. All materials shall be new and unused.

2.04 FERTILIZER

- A. Fertilizer must meet the Specifications of Section T-901 Seeding. Fertilizer must be a standard commercial grade and must conform to all federal and state regulations and to the standards of the Association of Official Agricultural Chemists.

2.05 SILT FENCE

- A. Materials for silt fence must be in accordance with the detail Drawings (must meet requirements of applicable Sections of the latest edition of IDOT SSRBC Articles 280 and 1080.02). Filter fabric for the silt fence must meet the Illinois Urban Manual material Specification 592 or as indicated on the Drawings.

2.06 COARSE AGGREGATE AND RIPRAP

- A. Coarse Aggregate and Riprap material (for Rock Check Dam, Aggregate Berm, Riprap, Inlet and Pipe Protection, Construction Entrances, or other erosion control functions) used for erosion control must meet the requirements of IDOT SSRBC. Coarse Aggregate and Riprap for erosion control must be crushed/broken recycled concrete or crushed stone. Coarse Aggregate must consist of CA-1, CA-2, CA-3 or CA-4 as indicated on the Drawings. Riprap must consist of Gradation No. RR3 or RR 4; and geotextile fabric must meet the requirements of the Illinois Urban Manual material Specification 592, unless otherwise directed by the Commissioner.

2.07 SEDIMENT LOG AND GEOSYNTHETIC CHECK STRUCTURE

- A. Material for Sediment Logs must be either American Excelsior Company standard 12-inch diameter Curlex Sediment Log, North American Green Straw Waffle, Sediment Stop, Western Excelsior Excel Aspen Excelsior Logs or similar 12-inch diameter (minimum) and as approved by the Commissioner.
- B. Material for Geosynthetic check structure must be rigid or foam pad wrapped with geosynthetic fabric material meeting the requirements of

the Illinois Urban Manual material Specification 592. Fabric material must be stapled in a 3 to 6 inch trench on the upstream end and securely stapled to the ground on both sides of the check structure.

2.08 SEDIMENT CONTAINMENT FILTER BAG

- A. Sediment Control Filter Bags must be ACF Environmental ERO-TEX dewatering filter bag, US Fabrics filter bag, or JMD Enviro-Protection filter bag as approved by the Commissioner, of the size required to adequately filter pumped water per the manufacturers' specifications.
- B. Filter bags shall not be placed on a relatively flat level surface, preferably on a porous surface free of sharp objects that could puncture the bag (such as haybales or aggregate), and checked daily when in use to ensure they are functioning properly. Flow from the bag shall be directed to a suitable receiving body as approved by the Commissioner. Sediment bags shall be replaced once the bag is sufficiently full that it can no longer contain sediment material adequately, or when flow rate is reduced significantly. Bags shall be disposed of appropriately when full or clogged and shall not be reused.

2.09 INLET PROTECTION AND PIPE (CULVERT) PROTECTION

- A. Material for Pipe Culvert Protection must be Coarse Aggregate (must meet the standards defined above for Coarse Aggregate and Riprap).
- B. Materials for Above Ground Inlet protection must be per the manufacturer's specification, and as approved by the Commissioner. Acceptable products for above ground inlet protection include the following:
 - 1. Dandy Bag, Curb Bag, and Dandy Pop by Dandy Products
 - 2. Sediguard Inlet Protection Device by Earth Support Systems
 - 3. Storm Drain Inlet Frame and Filter Assembly by Silt Saver Sediment Control Products
- C. Materials for Below Ground Inlet protection must be per manufacturer's specification, and as approved by the Commissioner. Acceptable products for below ground inlet protection include the following:
 - 1. Catch-All Inlet Protector by Mar-Mac Manufacturing Co., Inc.
 - 2. Dandy Sack and Dandy Curb Sack by Dandy Product
 - 3. SedCatch Sediment Basket by SedCatch Environmental Products.
- D. Inlet protection is only to be used as a filter for sheet flow or in conjunction with a sediment containment filter bag. Inlet protection is not to be used as a filter for dewatering directly to the structure.

2.10 SUMP PIT

- A. Materials for Sump Pit must be 2 inch Coarse Aggregate and a filter fabric with a ¼ to ½ inch hardware cloth wire placed around the standpipe prior to attaching the filter fabric as shown and described in the OMP Detail No. 7-03-02E.

2.11 POLYMER

- A. The polymer must be a water-soluble anionic polyacrylamide (PAM) used to minimize soil erosion, bind soil particles, remove suspended particles, and act as a construction aide. All site-specific soils must be tested by a Certified Professional in Erosion and Sediment Control (CPESC) each time a PAM is used. The polymer must be used in accordance with manufacturer's guidelines and as approved by the Commissioner.
- B. Anionic PAM mixture must have $\leq 0.05\%$ free acrylamide monomer by weight as established by the Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA).
- C. The PAM mixture must be accompanied by manufacturers written instructions to ensure proper (1) Product and Site Preparation, (2) Application, (3) Maintenance/Re-application, (4) Storage, and (5) Safety, in accordance with Occupational Safety and Health Administration (OSHA) material safety data sheet (MSDS) requirements and other applicable guidelines including manufacturer's recommendations for specified use.
- D. Anionic PAM application must comply with all federal, state, and local laws, rules or regulations governing anionic PAM. The Contractor will be responsible for securing required permits.
- E. In addition to soil testing, a CPESC must design the installation plan for the polymers based on contact, mix time, settling time, and point of entry.
- F. The materials used must be harmless to plant and aquatic life.
- G. Different types of polymers may be required for each soil type or combination of soils. The manufacturer or supplier will provide general written application methods, based on site conditions, such as slope and soil type.

2.12 GEOTEXTILE FABRIC

- A. Geotextile fabric material must meet the requirements of the Illinois Urban Manual material Specification 592 – Geotextile as indicated on the detail Drawings.

2.13 JUTE NETTING

- A. Jute netting must be of a uniform, open, plain weave, undyed and unbleached single jut yarn. The yarn must be of loosely twisted construction and must not vary in thickness by more than one-half its normal diameter.
- B. Minimum width must be 48 inches, + or – 1 inch from manufacturer's rated width.
- C. Seventy-eight warp ends per 4 feet of width.
- D. Forty one weft ends per yard.
- E. Weight must average 1.22 lbs per linear yard with a tolerance of + or – 5%.
- F. The opening size for the weave must not be larger than $\frac{5}{8}$ " by $\frac{5}{8}$ ".
- G. Jute netting must be used in conjunction with polymer (PAM) as per CPESC and Commissioner.

2.14 TEMPORARY CONCRETE WASHOUT FACILITY

- A. Install a device to control concrete wastes to prevent both on-site and off-site pollution. The device must be installed on any construction site where concrete is used.
- B. Temporary concrete washout facility must be in accordance with OMP Standard Detail No. 7-03-02II Barrier Type or 7-03-02JJ Earthen Type or 7-03-02KK Straw Bale Type.
- C. Temporary concrete washout facilities must be supplied in sufficient quantity and size to manage all liquid and solid wastes generated by washout operations.
- D. The walls of above grade facilities may be constructed of straw bales, barrier walls, or earthen berms. Straw bales and barrier walls must be butted tightly end-to-end. All types of concrete washout facilities must be lined with a 30-mil polyethylene liner free of holes and tears and must be secured using sandbags, 6" wire staples, or other anchors, as approved by the Commissioner.

2.15 OTHER

- A. All other materials must meet commercial grade standards and must be approved by the Commissioner before being incorporated into the Project.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

- A. In the event of conflict between these requirements and pollution control laws, rules, or regulations of other federal, state, or local agencies, the more restrictive laws, rules, or regulations must apply.

3.02 SCHEDULE

- A. Prior to the start of construction, the Contractor must submit schedules (timing for erosion control work to be performed relative to other construction items) for accomplishment of temporary and permanent erosion control work. The Contractor must also submit a proposed method of erosion and dust control on haul roads and borrow pits and a plan for disposal of waste materials. Work must not be started until the erosion control schedules and methods of operation for the applicable construction have been accepted by the Commissioner and initial erosion control items have been properly installed.

3.03 AUTHORITY OF COMMISSIONER

- A. The Commissioner has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, to limit the surface area of erodible earth material exposed by excavation, borrow and fill operations, and to direct the Contractor to provide immediate permanent or temporary pollution control measures to minimize contamination of adjacent streams or other watercourses, lakes, ponds, or other areas of water impoundment.

3.04 TEMPORARY RE-ROUTING OF CHANNELS

- A. Re-Routing Channels. All channels must continue to provide existing flow capacities until new stormwater conveyance and storage structures are constructed and fully operational. For construction practices that reduce channel capacity for longer than the working hours of one work day, the Contractor must re-route the channel, and allow at least the original flow capacity and in the case of regulated streams, according to the IDNR permit requirements. The channel must be replaced to original contours after construction, unless otherwise shown on the Plans or directed by the Commissioner.
- B. Re-routed Channel Protection. Re-routed channels must be protected from erosion and sediment using Erosion Control Blanket (single or double net), Turf Reinforcement Mat (TRM), Geofabric, Temporary Seeding, Riprap, Sediment Log, Geosynthetic Check Structure, Aggregate Ditch Check, and as directed by the Commissioner.

3.05 CHANNEL CHECKS

- A. All channels must be protected from erosion from surrounding construction zones. Channel checks must consist of Rock Check Dams, Aggregate Berms, Sediment Logs and others. Channel checks must be installed prior to disturbing land within their drainage areas; must be installed during the lowest reasonable flow conditions; and must be installed in a manner to minimize disturbance. The purpose of this practice is to reduce flow velocity and to pond water, thereby reducing active channel erosion and promoting settling of suspended solids.
- B. Sediment accumulated upstream of channel checks (including Rock Check Dams, Aggregate Berms, Sediment Logs, and others) must be removed when it reaches $\frac{1}{2}$ the height of the check spillway invert. Removed sediment must be deposited in an area previously approved by the Commissioner. Sediment must not be placed in areas that contribute to sediment off-site or are not permanently stabilized.
- C. Remove and replace stone for Rock Check Dams and Aggregate Berms when the structures become plugged, silt laden, or as required by the Commissioner.
- D. Rock Check Dams and Aggregate Berms. Rock Check Dams and Aggregate Berms in channels must be constructed from stone (coarse aggregate and riprap) as shown on the Drawings. Stone for Rock Check Dams and Aggregate Berms must be placed on the surfaces and to the depths specified. Stone must be placed in one operation and in such a manner to avoid serious displacement of the underlying materials. Stone must be delivered and placed in a manner to ensure that the stone is reasonably homogeneous with the larger stones evenly distributed and firmly in contact with one another with smaller stones filling the voids between the larger stones.
 - 1. Height. Rock Check Dams and Aggregate Berms must have a minimum height of 12 inches and a maximum height of 36 inches.
 - 2. Spillway. Rock Check Dams and Aggregate Berms must be installed with sides 6 inches to 12 inches higher than the central spillway, forming a weir.
 - 3. Dimensions. Rock Check Dams and Aggregate Berms must have a minimum top width of 2-feet measured in the direction of flow with maximum side slopes of 2:1 (h:v).
 - 4. Location. Rock Check Dams and Aggregate Berms must be placed and sized such that resultant ponding must not cause inconvenience or damage to adjacent areas, such as roads.

- 5. Stability. For additional stability in higher flow channels, Rock Check Dams and Aggregate Berms should be keyed into the soil to a depth of 6-inches.
- 6. Filter fabric: Filter fabric used in Rock Check Dams must be in accordance with the Illinois Urban Manual material Specification 592 Geotextile, as shown on the Drawings, and included in the pay item Rock Check Dam. No additional payment will be made for filter fabric.
- E. Sediment Logs. Sediment logs must be installed according to the manufacturer's instructions, except as modified in the Contract Drawings and Specifications. Sediment logs must be staked and keyed into the soil to a depth of two inches, unless otherwise directed by the Commissioner.
- F. Geosynthetic Check Structure: Fabric material that covers rigid foam pad must be stapled in a 3 to 6 inch trench on the upstream end and securely stapled to the ground on both sides of the check structure. The center of the geosynthetic check structure must be 6 inches lower than the sides and secured (barrier and fabric) in the ground staples.

3.06 TEMPORARY STREAM CROSSING

- A. Whenever construction equipment must cross streams at frequent intervals, temporary stream crossing must be provided.
- B. As a minimum, structure must be designed to pass 2-year, 24-hour storm without overtopping and no erosion will result from the 10 year peak storm. In case of regulated streams, the Commissioner will facilitate the permit application process through the IDNR-OWR. Temporary stream crossing must be designed and installed according to the IDNR permit requirements.
- C. Outlet of the crossing structure must be stabilized if the flow velocity can cause erosion for the receiving stream channel.
- D. The aggregate for the roadway must be a minimum of 6 inches thick, stone meeting requirements of IDOT S.S.R.B.C.

3.07 STABILIZED CONSTRUCTION ENTRANCE / EXIT / ROAD

- A. Construction entrance / exit must be used at all points of construction ingress and egress to the public road.
- B. The aggregate for the construction entrance / exit must meet the requirements of IDOT SSRBC and Geotextile Fabric must meet the requirements of the Illinois Urban Manual material Specification 592.
- C. Each construction entrance / exit must meet the following minimum dimensions: thickness of 6 inches, width of 14 feet; but not less than full width of ingress or egress point, and length of 70 feet. Filter fabric

must be installed under aggregate to minimize the migration of the stone into the underlying soil.

- D. See plan for dimension and placement of stabilized construction entrance/exit/road.

3.08 DEWATERING

- A. Sump Pit. Pumping water from open trenches or other areas must be performed in a manner to minimize the turbidity of the pumped water in accordance with OMP Detail No. 7-03-02E (Illinois Urban Manual IL-650). The pumping operation must start with the installation of the intake hose into the Sump Pit and then discharge directly into a sediment trap, stabilized ditch, temporary stabilized ditch that leads to a sediment trap, designed treatment channel, sediment containment filter bag, or another Best Management Practice (BMP) that is approved by the Commissioner.
- B. Sediment Containment Filter Bag. When water cannot be pumped directly to a sediment trap, or site conditions call for use of an additional layer of erosion control, water must be pumped directly into a Sediment Containment Filter Bag. Sediment Containment Filter Bags must be used according to the manufacturer's instructions, as modified by the Contract Drawings and Specifications. Sediment Containment Filter Bag must be placed flat on a stabilized surface as shown in the Drawings.
- C. Temporary dewatering channels and sediment traps. Pumped water from junction chambers, junction manholes, and open cut sewer construction trenches shall be discharged into temporary dewatering channels or sediment traps at locations as shown on the drawings. The dewatering operation including furnishing, installing, operating, monitoring, and maintaining dewatering system shall be as described in Section 02241 Control of Water of the Specifications. Work under this section will be on a lump sum basis. Erosion control measures necessary for control of sediments will be paid for in accordance with Section 4.01 measurement of this Specification. Quantities shown for floc logs and sediment logs shown on the Design Estimate Tabulations are minimum requirement and shall be paid for in accordance with the corresponding pay item unit price. Additional quantities of floc logs and sediment logs including the provision of jute netting and PAM polymer required to provide additional treatment necessary due to heavy sediment and / or cold temperature conditions shall be included in the lump sum cost for control of water as described in Section 02241 Control of Water of the Specifications.

3.09 TEMPORARY STOCKPILES

- A. Stockpile Sediment and Erosion Control. If a stockpile is to remain in place more than 3 days, perimeter barrier must be installed and "tracking" with machinery (tracking up and down the slope parallel to the direction of the slope, such that the track cleat marks are perpendicular to the direction of the slope in order to prevent the development of erosion rills/gullies) must be provided. If the construction activity temporarily or permanently ceases, and construction activity will not occur for a period of 14 days, temporary stabilization must be provided for each stockpile within 1 working day after activity has ceased. If the stockpile is to remain inactive for more than 365 days, the stockpile must be permanently seeded per Contract Specifications. Stockpile sediment and erosion control can include Temporary Seeding, Permanent Seeding, Polymer, Silt Fence, Erosion Control Blanket, or other methods approved by the Commissioner. Contractor must maintain the installed sediment and erosion control measures for the duration of the Project or until the Contractor's responsibilities for maintenance cease as determined by the Commissioner.

3.10 SEDIMENT TRAPS AND TEMPORARY DITCHES

- A. Sediment Trap: Sediment Traps are relatively effective at trapping medium to coarse-grained particles, and must meet the following Specifications:
1. Depth. Sediment trap must be a minimum of 2 feet measured from the sediment trap bottom to the invert of the stone outlet to provide sediment and detention storage.
 2. Shape: Sediment trap must have a length-width ratio of at least 2:1. Side slopes must be no steeper than 2:1 (h:v) and must be stabilized.
 3. The surface of the trap must be stabilized with Geotextile Fabric which meets the Illinois Urban Manual material Specification 592. The trap must be maintained and regularly cleaned of sediments to maintain its holding capacity. Any damaged fabric must be replaced or repaired.
 4. Outlet: The position of the outlet must be as such to minimize short-circuiting of the water flow path. The crest of the spillway must be at least 1 foot below the top of the embankment. The width of the rock check dam outlet must span the width of the outlet channel. The top of the rock check dam outlet must be constructed so that the center is approximately 6 inches lower than the outer edges. Discharge from the outlet must be to a stabilized area.

- B. Stone Outlet Structure for Sediment Trap
 - 1. Riprap (RR-4) for Stone Outlet Structure must meet the requirements of the IDOT Standard Specifications for Road and Bridge Construction (SSRBC).
 - 2. Geotextile Fabric must meet the requirements of the Illinois Urban Manual material Specification 592.
 - 3. Cost of Geotextile Fabric is included in the pay item of stone outlet structure for sediment trap and no additional payment will be made.
- C. Temporary Ditch. Temporary Ditches must be constructed as shown on the Drawings or as directed by the Commissioner to provide drainage paths to sediment traps. These ditches must have side slopes no steeper than 2:1 (h:v). The slopes of the temporary ditch must be stabilized with Temporary Seeding, Erosion Control Blanket, (single, double net or TRM), Geofabric, and/or Riprap as directed by the Commissioner, before ditches convey flow.

3.11 INLET AND PIPE (CULVERT) PROTECTION

- A. All inlets to storm sewers that will potentially be affected by the Contractor's construction activities must be protected with Inlet and Pipe Protection barriers. Coarse Aggregate for culvert protection, above ground and below ground inlet protection meeting manufacturer's specification and as approved by the Commissioner must be installed at the direction of the Commissioner.
- B. Inlet protection must be constructed before upslope land disturbance begins and before the storm drain becomes operational.
- C. The inlet protection barriers must allow for overflow from a severe storm event.

3.12 SILT FENCE

- A. Silt Fence must be installed in accordance with the Illinois Urban Manual where erosion would occur in the form of sheet flow and there is no concentration of water flowing to the barrier. Silt Fence must be placed as close to the contour as possible with the ends extending upslope. The area below the fence if possible, must be undisturbed or stabilized. Fence posts must be a minimum of 48 inches long and with a minimum cross sectional area of 3.0 square inches. The maximum spacing between posts must be 5 feet and driven a minimum of 18 inches into the ground. The silt fence must be entrenched to a minimum depth of 6 inches with an additional 6 inches extending along the bottom of the trench in the upslope direction.

3.13 RIPRAP AND COARSE AGGREGATE

- A. Riprap and Coarse Aggregate are specified for use in several erosion control items as shown on the detail Drawings.
- B. Where filter fabric is required on the Drawings, the fabric must conform to the Illinois Urban Manual material Specification 592 Geotextile.
- C. Coarse aggregate and riprap or rock/reclaimed concrete for Culvert Inlet Stone Protection, Rock Check Dams, Temporary Sediment Trap, and Stabilized Construction Entrance, Construction Road Stabilization and Temporary Stream Crossing must be placed in accordance with the IL Urban Manual construction Specification 25 Rockfill, using Method 1 and Class III compaction.
 - 1. Foundations for rockfill must be stripped to remove vegetation and other unsuitable materials. Earth foundation surfaces must be graded to remove surface irregularities and cavities filled with compacted earthfill of approximately the same kind and density as the adjacent foundation material. Rockfill and/or bedding must not be placed until the foundation preparation is completed and the foundation or excavations have been inspected and approved by the Commissioner.
 - 2. When a bedding layer beneath rockfill is specified, the bedding material must be spread uniformly on the prepared subgrade surfaces to the depth indicated.
 - 3. Reclaimed concrete materials must be free from reinforcing bars.
 - 4. For Method 1 placement, the rock must be dumped and spread into position in approximately horizontal layers not to exceed 3 feet in thickness. It must be placed in a manner to produce a reasonably homogeneous stable fill that contains no segregated pockets of large or small fragments or large unfilled rock fragments.
 - 5. Moisture content of the bedding material must be controlled to ensure that bulking of the sand material does not occur.
 - 6. Class III Compaction of Rockfill and Bedding – No compaction will be required beyond that resulting from the placing and spreading operations.
- D. Riprap for Pipe Outlets and Structural Streambank Stabilization must be placed in accordance with the Illinois Urban Manual construction Specification 61 Rock Riprap.
 - 1. The subgrade surfaces on which the rock riprap, filter, bedding or geotextile is to be placed must be cut or filled and graded to

the lines and grades as shown on the Drawings. When fill to subgrade lines is required, it must consist of approved materials and conform to the requirements of the specified class of earthfill. Rock riprap, filter, bedding or geotextile must not be placed until the foundation preparation is completed and the subgrade surfaces have been inspected and approved by the Commissioner.

2. Equipment–Placed Rock Riprap:

The rock riprap must be placed by equipment on the surfaces and to the depths specified. The rock riprap must be installed to the full course thickness in one operation and in such a manner as to avoid serious displacement of the underlying materials. The rock for riprap must be delivered and placed in a manner that will ensure that the riprap in-place will be reasonably homogeneous with the larger rocks uniformly distributed and firmly in contact one to another, with the smaller rocks and spalls filling the voids between the larger rocks. Some hand placing may be required to provide a neat and uniform surface. Rock riprap must be placed in a manner to prevent damage to structures. Hand placing will be required or necessary to prevent damage to any new and existing structures.

3. Hand–Placed Rock Riprap:

The rock riprap must be placed by hand on the surfaces and to the depths specified. It must be securely bedded with the larger rocks firmly in contact one to another without bridging. Spaces between the larger rocks must be filled with smaller rocks and spalls. Smaller rocks must not be grouped as a substitute for larger rock. Flat slab rock must be laid on its vertical edge; except where it is laid like paving stone and the thickness of the rock equals the specified depth of the riprap course.

4. When the Drawings specify filter, bedding or geotextile beneath the rock riprap, the designated material must be placed on the prepared surface as specified. Compaction of filter or bedding aggregate will not be required, but the surface of such material must be finished reasonably smooth and free of mounds, dips, or windrows.

3.14 MULCH AND EROSION CONTROL BLANKET

- A. Mulch must be installed immediately after seeding by conventional method or hydromulching, after seedbed preparation, when dormant seeding is to be provided and when temporary erosion control is to be attained. Mulch must be applied any time soil and site conditions are suitable for spreading and anchoring.

- B. The erosion control blanket (single, double net or TRM) must be installed in accordance with the Manufacturer's specification and requirements. The erosion control blanket must be in firm contact with the soil. It must be anchored per the Manufacturer's recommendation with the proper number and spacing of wire staples. The staples must be the proper width and length to meet the Manufacturer's specification. On slopes and in channels the blanket must be unrolled upstream to downstream parallel to the direction of flow. At the upstream end and at the top of the slope, each blanket must be anchored in a minimum 6-inch deep anchor trench. The blankets must be laid like shingles, i.e., ends and edges of blanket sections must be overlapped in rows in the direction of flow.
- C. The type of erosion blanket must be based on the flow velocity and shear force in the channel.

3.15 POLYMER AND FLOC LOG

- A. All vendors and suppliers of polyacrylamide (PAM), PAM mix or blends must present or supply a written toxicity report which verifies that the PAM, PAM mix or blend exhibits acceptable toxicity parameters which meet or exceed the requirements for the state and federal water quality standards. No Cationic formulations of PAM, PAM blends, polymers of Chitosan are allowed for use under this Specification.

The manufacturer or supplier must provide a product expiration date for anionic PAM mixtures based on product expiration date of PAM in pure form.

The application method must provide uniform coverage to the target area and avoid drift to non-target areas. The applicator of anionic PAM must document, at the time of application, the following:

1. Name of applicator
2. Application rate per acre
3. Date applied
4. Product type
5. Weather conditions during application
6. Method of application

Copies of this documentation must be entered into the Contractor's monitoring log or project diary and made available upon request.

Unused liquid anionic PAM mixtures must be minimized. Excess material will not be applied at a rate greater than the maximum application rate. Disposal must not occur in Waters of the U.S. (W.U.S.) and stormwater conveyance systems (i.e. storm sewer

manholes, storm sewer inlets, ditches, and culverts).

Anionic PAM mixtures must achieve $\geq 80\%$ reduction in soil loss as measured by a 1 hour storm duration 2 inch/hour rainfall simulator test performed in accordance with methods used by Bubenzer and Patterson (1982) as pre-qualification for field testing.

Performance of anionic PAM mixtures must be verified and field-tested. The manufacturer must provide a toxicological report for the Polymer Binder performed by a third-party, EPA approved laboratory.

Anionic PAM use must conform to all federal, state, and local laws, rules, and regulations regarding use, discharge, and disposal of chemical materials.

- B. Floc Log Application: A Floc Log is a semi-hydrated polyacrylamide block that when placed within storm water or construction site drainages will remove fine particles and reduce NTU values. Placement of the floc log should be as close to the source of particle suspension as possible. Ideal performance of the floc logs results when used in conjunction with other best management practices. Each floc log is formulated for the soil and water chemistry at the site. Soil and water samples, when tested, will determine which formula floc log is needed along with proper placement.

3.16 TEMPORARY SEEDING

- A. This work consists of the temporary seeding of unfinished, disturbed areas as designated by the Commissioner within the construction site.
- B. Except as provided in paragraphs 3.16C and 3.16D below, stabilization measures must be initiated immediately in portions of the site where construction activities have temporarily or permanently ceased.
 - 1. During dormant seasons (between June 15 and August 15 and between November 15 and December 31 or until the ground becomes frozen) mulch must be applied.
 - 2. Disturbed areas that will not be in the active work area for longer than one year must be seeded and fertilized in accordance with Section T-901 Seeding within 1 working day after suspension of work in the area with seedbed preparation
- C. Where the initiation of stabilization measures is precluded by snow cover, stabilization measures must be initiated as soon as practical.
- D. Where construction activity will resume on a portion of the site within 14 days from when activities ceased, (e.g. the total time period that construction activity is temporarily ceased is less than 14 days) then stabilization measures must be initiated on that portion of site within 1 day after construction activity temporarily ceased.

- E. Dates: Temporary seeding must occur between March 15 and October 1. If protection is required outside of these dates, mulch must be used.
- F. Seed Bed Preparation: Seedbed preparation must be as described in Section T-901 Seeding. A rough seedbed must be obtained with a minimum of one pass with a disc harrow.
- G. Fertilization of Temporary Vegetation. The Contractor must perform soil tests to determine the amount of fertilizer necessary. The following rates of fertilizer application are the benchmark application rates per acre, but the Contractor must aim to minimize the amount of fertilizer used, while still allowing for the healthy growth of the seed.
 - 1. Nitrogen (N) - 120 pounds of N
 - 2. Phosphorus (P) - 60 pounds of P₂O₅
 - 3. Potassium (K) - 60 pounds of K₂O

3.17 MAINTENANCE OF TEMPORARY CONCRETE WASHOUT FACILITY

- A. Perform washout of concrete trucks in designated areas only. Each temporary washout facility must have appropriate signage to inform concrete truck drivers and equipment operators of the proper washout locations. The concrete washout facility must be installed prior to any concrete placement on site.
- B. Each facility must be located in an area protected from possible damage from construction traffic and have stabilized access to prevent tracking onto streets. Washout facilities must be located on level ground a minimum of 50 feet from storm drain inlets and open drain facilities. For smaller sites where the distance criteria may not be practical, washout facilities must be located as far from drainage facilities as possible and additional inspections must be conducted to ensure no illicit discharges occur.
- C. Washout water from low volume facilities must be allowed to evaporate and not be discharged into the environment. Washout water from high volume facilities must be removed with a vacuum truck and taken back to the batch plant.
- D. Solidified concrete waste from washout facilities shall be considered Clean Construction or Demolition Debris (CCDD) as per the Illinois Environmental Protection Act (415 ILCS 5) and must be disposed of in accordance to the Act.
- E. Temporary concrete washout facilities must be maintained to provide adequate holding capacity with a minimum freeboard of 4 inches for above grade facilities and 12 inches for below grade facilities. Existing

facilities must be cleaned, or new facilities must be constructed and ready for use once the washout is two-thirds full.

- F. Maintaining temporary concrete washout facilities must include removing and disposing of hardened concrete or slurry and waste in accordance with Federal and State regulations or as directed by the Commissioner, and returning the facilities to a functional condition.
- G. When temporary concrete washout facilities are no longer required for the Work, the facilities must be removed from the site. Holes, depressions, or other ground disturbances caused by the removal must be restored to the satisfaction of the Commissioner. The disturbed area must be seeded and mulched or otherwise stabilized in a manner acceptable to the Commissioner.

3.18 CONSTRUCTION DETAILS

- A. The Contractor must incorporate all permanent erosion control features into the Project at the earliest practical time as outlined in the accepted schedule.
- B. Temporary erosion and pollution control measures must be used (1) to correct conditions that develop during construction that were not foreseen during the design stage; (2) where needed prior to installing permanent control features; or (3) to temporarily control erosion that develops during normal construction practices, but is not associated with permanent control features on the Project.
- C. Where erosion is likely to be a problem, clearing and grubbing operations should be scheduled and performed so that grading operations and permanent erosion control features can follow immediately thereafter if the Project conditions permit; otherwise, temporary erosion control measures may be required between successive construction stages.
- D. The Commissioner will limit the area of clearing and grubbing, excavation, borrow, and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures must be taken immediately to the extent feasible and justified.
- E. In the event that temporary erosion and pollution control measures are required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of the work as scheduled or are ordered by the Commissioner, such work must be performed by the Contractor at his/her own expense.

- F. The Commissioner may increase or decrease the area of erodible earth material to be exposed at one time as determined by analysis of Project conditions.
- G. The erosion control features installed by the Contractor must be maintained by the Contractor during the construction period to the satisfaction of the Commissioner.
- H. Whenever construction equipment must cross watercourses at frequent intervals, temporary structures must be provided.
- I. Pollutants such as fuels, lubricants, bitumen, raw sewage, wash water from concrete mixing operations, and other harmful materials must not be discharged into or near rivers, streams, and impoundments or into natural or manmade channels leading thereto. Contractor must dispose all materials properly at an approved location and according to the local regulations.

3.19 OPERATION AND MAINTENANCE

- A. All installed erosion control features must, at a minimum, be inspected at least once every 7 days and within 24 hours of a storm event that produces 0.5 inches of rain or more during a 24-hour period, in accordance with the NPDES permit.
- B. Removal. Unless incorporated into the permanent stormwater management system, all erosion control features must be removed and properly disposed of once final grading and stabilization have been completed, or at the direction of the Commissioner.
- C. Surplus or waste material. Surplus or waste material resulting from the riprap operations must be disposed of by the Contractor at his own expense.
- D. The Contractor must be solely responsible for the maintenance of all soil erosion devices installed by the Contractor. Maintenance must be completed as soon as possible with consideration to site conditions.
- E. For each specific Erosion and Sediment control measure maintenance and inspection, refer to the Illinois Urban Manual Standard practice.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Temporary erosion and pollution control work includes all labor and materials for installation, maintenance, and removal of each erosion control item. Temporary erosion and pollution control work required which is not attributed to the Contractor's negligence, carelessness, or failure to install permanent controls must be performed as scheduled or ordered by the Commissioner. Completed and accepted work will be measured as follows:

1. Silt Fence: This work must include furnishing, installing, maintaining and removing Silt Fence and will be measured for payment in linear feet in place.
2. Inlet and Pipe (Culvert) Protection: This work must include furnishing, installing, maintaining and removing Inlet and Pipe Protection barriers and will be measured for payment per each in place of the type specified.
3. Sediment Logs and/or Geosynthetic Check Structure: This work must include furnishing, placing, maintaining and removing Sediment Logs or Geosynthetic Check Structures and will be measured for payment in linear feet in place. Each Sediment Log barrier must cross the entire ditch or channel and will not exceed 25' in length.
4. Erosion Control Blanket (single or double net): This work must include furnishing, installing and maintaining Erosion Control Blanket and will be measured for payment in square yards in place, for the type specified.
5. Sediment Containment Filter bags: This work must include furnishing, bedding, maintaining, and disposing of Sediment Containment Filter bag and will be measured for payment per each, for the size specified.
6. Temporary Seeding: This work must include furnishing, installing, and maintaining seed for erosion control and will be measured for payment per acre installed for the seed mix specified.
7. Sediment Traps, Temporary Ditches, and Erosion Control Berms: Excavation required for construction of Temporary Sediment Traps, Temporary Ditches, and Erosion Control Berms will not be measured for payment, but will be considered included in the total erosion control work. Excavation to remove accumulated sediments in Sediment Traps and Temporary Ditches will not be paid for separately but will be considered included in maintenance efforts.
8. Pumping: Pumping water from excavated trenches or other areas will be considered included in the work item to which it pertains and will not be paid for separately.
9. Geotextile Fabric: Geotextile fabric required to construct erosion control items will not be paid for separately but will be considered as included in the appropriate coarse aggregate or riprap pay items.

10. Stabilized Construction Entrance / Road: This work must include furnishing, installing, maintaining, and removing Stabilized Construction Entrance / Exit as shown on Plans and will be measured for payment per square yard.
 11. Temporary Concrete Washout Facilities: Construction, maintenance, and removal of temporary concrete washout facilities will not be measured for payment; but will be considered included in the Contract. No separate payment will be made for temporary concrete washout facilities.
 12. Sump Pit: Construction, maintenance, and removal of temporary Dewatering Sumps and Sump Pits will not be measured for payment, but will be considered included in the Contract. No separate payment will be made for Dewatering Sumps and Sump Pits.
 13. Stabilization and erosion control of borrow sites will not be measured separately for payment but will be considered included and incidental to excavation work or the overall Project.
 14. Temporary Rock Check Dams: This work must including the furnishing, installing, maintaining and removing Temporary Rock Check Dams as shown on Plans and will be measured for payment per each.
 15. Allowance for Snow Fence: This work includes an allowance for additional snow fence installation not called out on the plans that may be required by the Commissioner or other Permitting Agency. Expenses from the Allowance will be subject to prior review and approval by the Commissioner.
 16. Allowance for Supplemental Erosion Control Measures: This work includes an allowance for additional erosion control measures not called out on the plans that may be required by the Commissioner or other Permitting Agency. Expenses from the Allowance will be subject to prior review and approval by the Commissioner.
- B. Control work performed for protection of construction areas outside the construction limits, such as borrow and waste areas, haul roads, equipment and material storage sites, and temporary plant sites, will not be measured and paid for directly but will be considered as a subsidiary obligation of the Contractor with costs included in the Contract prices bid for the items to which they apply. Routine maintenance of soil erosion control measures will not be paid for separately but must be considered included in the Contract pay items to which they apply. Soil erosion items damaged by Contractor must be immediately replaced at no additional cost to the Contract.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Accepted quantities of temporary water pollution, soil erosion, and sediment control work ordered by the Commissioner and measured as provided in paragraph 4.01 will be paid for under Part B.
- B. Item P-156-08 – Allowance for Snow Fence: The Contractor must receive written notice from the Commissioner and Chief Procurement Officer to proceed with the work. The work will be paid for as shown in General Conditions, Article X, Changes in the Work, 3. Time and Materials Basis. Any remaining balance from the Allowance will be retained by the City.
- C. Item P-156-09 – Allowance for Supplemental Erosion Control Measures: The Contractor must receive written notice from the Commissioner and Chief Procurement Officer to proceed with the work. The work will be paid for as shown in General Conditions, Article X, Changes in the Work, 3. Time and Materials Basis. Any remaining balance from the Allowance will be retained by the City.
- D. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
P-156-01	SILT FENCE	LF
P-156-02	INLET AND PIPE (CULVERT) PROTECTION	EA
P-156-03	DROP INLET INSERT BASKET PROTECTION	EA
P-156-04	SEDIMENT LOG AND/OR GEOSYNTHETIC CHECK STRUCTURE	EA
P-156-05	EROSION CONTROL BLANKET – SINGLE NET	SY
P-156-06	EROSION CONTROL BLANKET – DOUBLE NET	SY
P-156-07	TEMPORARY SEEDING	AC
P-156-08	ALLOWANCE FOR SNOW FENCE	AL
P-156-09	ALLOWANCE FOR SUPPLEMENTAL EROSION CONTROL MEASURES	AL

END OF ITEM P-156

TRENCH BACKFILLING

SECTION P-157

PART 1 DESCRIPTION

1.01 GENERAL

- A. This Section must consist of furnishing, transporting and placing stabilization stone, bedding material, fine aggregate for trench backfill and acceptable fill material for all trenches (pipes or duct banks) and structure excavations. The work under this Section is subject to the requirements of the Contract Documents.

1.02 RELATED WORK

- A. Related work specified elsewhere includes:
 - 1. 02637 – Sanitary Sewers
 - 2. Section D-701 – Pipe for Storm Drains
 - 3. Section D-705 – Pipe Underdrains for Airports
 - 4. Section D-751 – Manholes, Catch Basins, Inspection Holes, and Manhole Adjustments
 - 5. Section L-110 – Installation of Airport Underground Electrical Duct
 - 6. Section P-152 – Excavation and Embankment
 - 7. Section P-610 – Structural Portland Cement Concrete

1.03 REFERENCES

- A. Illinois Department of Transportation, Standard Specifications for Road and Bridge Construction (IDOT – SSRBC).

PART 2 PRODUCTS

2.01 MATERIALS

- A. Fine aggregate for trench backfill must consist of natural sand or washed crushed limestone having a FA-6 gradation conforming to Section 1003 of the Standard Specifications for Road and Bridge

Construction (S.S.R.B.C.), Illinois Department of Transportation, latest edition.

- B. Acceptable Fill must be as defined in Section P-152-1.03.A.1.a.
- C. Bedding Material, except for cathodically protected pipes, must be gravel, crushed gravel, crushed stone or crushed recycled concrete having a CA-7 or CA-11 gradation conforming to Section 1004 of the Standard Specifications for Road and Bridge Construction (S.S.R.B.C.), Illinois Department of Transportation, latest edition. Bedding Material for cathodically protected (coated and wrapped) pipes must be pea gravel having a CA-16 gradation.
- D. Stabilization Stone must be crushed stone or crushed recycled concrete having CA-1 gradation conforming to Section 1004 of the S.S.R.B.C., latest edition.
- E. CA-11 or CA-1 crushed recycled concrete must be produced on site by the Contractor by crushing Portland cement concrete from O'Hare stockpiles only. They must be crushed from clean rubble obtained from pavement removal or foundations from O'Hare Airport projects. Refer to relevant provisions of Section 02245 Recycled Crushed Concrete and Asphalt.
- F. Where required in the Drawings, geotextile filter fabric must be non-woven and must comply with the requirements of Section P-629 Geotextile Fabric and must be placed as detailed on the drawings.

PART 3 CONSTRUCTION METHODS

3.01 METHODS

- A. All trenches and excavations must be backfilled within a reasonable time after the pipes are installed, unless other protection of the pipe is directed by the Commissioner. The backfill material must be as specified herein. Backfill materials and compaction procedures must be acceptable to the Commissioner. In all backfilling, any compressible or destructible rubbish and refuse must be removed from the excavated space before backfilling is started, except that sheeting and bracing must be left in place or removed as the work progresses as specified or as directed by the Commissioner.
- B. Trenches excavated with sloped or benches walls must be backfilled for the full width of the trench, as herein specified.

- C. All backfill materials must be placed longitudinally along the trench. The backfill material must be brought up evenly on each side of the pipe or duct.

3.02 TRENCH STABILIZATION

- A. If the Commissioner finds that the materials encountered at the elevations specified are unstable and not suitable, or in case it is found desirable or necessary to go to an additional depth, the excavation must be carried to such additional depth as the Commissioner may direct in writing. The Contractor must refill such excavated space with Stabilization Stone. Stabilization Stone must be compacted to a firm but slightly yielding condition.

3.03 BEDDING

- A. The pipe laid in trenches must be bedded in accordance with the details shown on the Plans. Bedding material must be as shown, as specified or as directed by the Commissioner. Bedding must be to a minimum of spring line of the pipe. The bedding material must be placed over the stabilization stone or trench subgrade as applicable.

3.04 TRENCH BACKFILL

- A. The fine aggregate for trench backfill must be brought up evenly on each side of the pipe or structure to an elevation 1 foot over the top of the pipe. If the trench is to be under pavement, or within 2 feet of the proposed, future or existing pavement edge, then placement and compaction of the fine aggregate trench backfill must continue until the top of subgrade is reached. If the trench is not under, or adjacent to, existing, proposed or future pavement, then acceptable fill must be placed and compacted from an elevation 1 foot over the top of the pipe to top of subgrade.

3.05 MATERIALS PLACEMENT

- A. Material used as stabilization, bedding and fine aggregate trench backfill to 1 foot over the top of the pipe must be placed by hand in uniform layers not greater than 6 inches in loose thickness and thoroughly compacted in place. Special care must be taken to secure thorough compaction under the haunches and at the sides of the pipe.
- B. Each layer of bedding material and fine aggregate trench backfill to 1 foot over the top of the pipe must be thoroughly tamped and compacted in place with vibratory methods to not less than 90% of maximum dry density as determined by ASTM D 1557.

- C. If the backfill placed from 1 foot above the pipe is fine aggregate trench backfill, it must be placed in uniform layers not greater than 9 inches in loose thickness and thoroughly compacted in place with suitable equipment to not less than 95% of the maximum density as determined by ASTM D1557. If the backfill is Acceptable Fill it must be placed in uniform layers not greater than 12 inches in loose thickness and each layer compacted to 85 percent of maximum density as determined by ASTM D1557. Each lift of Acceptable Fill must be within +/- 2% of optimum moisture content before the succeeding lift is placed.
- D. The suitability of compacting equipment will be defined per Section P-152 Excavation and Embankment.
- E. Geotextile fabric must be installed and wrapped around the backfill as shown on the plans.

3.06 FINISH GRADES

- A. Finish grading must be performed in accordance with the completed contour elevations and grades shown in the plans, and must be made to blend into the existing or plan ground surfaces. All finished grading surfaces must be left smooth and free to drain. Finish grades must be brought to elevations within plus or minus 0.10 foot of elevations or contours shown.
- B. The top 4 inches of trench fill in areas to be landscaped must be topsoil in accordance with Section T-905 Topsoiling.
- C. Where necessary or where shown, finish grading must be extended to insure that water will be carried off and the site area left smooth and free from depressions holding water.
- D. Movement of construction machinery over a pipe or trench must be at the Contractor's risk. Any pipe damaged thereby must be replaced at the expense of the Contractor.
- E. Any depression which may develop from settlement in backfilled areas within 1 year after the work is fully completed and accepted is the responsibility of the Contractor. The Contractor must provide, as needed and at his own expense, additional backfill material, pavement base replacement, permanent pavement repairs or replacement. The Contractor must perform the necessary reconditioning and restoration work to bring such depressed areas to proper grade as acceptable to the Commissioner.

3.07 TESTING

- A. Trench backfill compaction must be tested and monitored by the Contractor a minimum of 1 test per 100 lineal feet of trench, each lift, a minimum of 3 tests per lift, or as directed by the Commissioner. All material and backfill operations are subjected to testing by the Commissioner with the assistance of the Contractor.
- B. Frequency of Testing
 - 1. Bedding Material
 - a. Sieve Analysis, ASTM C136 – Minimum 1 per source, or 1 per 5000 tons per aggregate type delivered, or a minimum of 1 test per week and if material changes as determined by the Commissioner.
 - 2. Native Backfill
 - a. Modified Proctor Density, ASTM D1557 – Minimum 1 per source or 1 per 2000 CY and if material changes as determined by the Commissioner.
 - b. Relative Density, ASTM D4253 – Minimum 1 per source and if material changes.
 - c. In-place Density, ASTM D2922 – Minimum 1 per 100 lineal feet of trench, each lift, minimum 3 tests per run.
 - 3. Trench backfill
 - a. Sieve Analysis, ASTM C136 – Minimum 1 per source, or 1 per 5000 tons per aggregate type delivered, or as a minimum of 1 test per week and if material changes as determined by the Commissioner.
 - b. Modified Proctor Density, ASTM D1557 – Minimum 1 per source or 1 per 10,000 tons per aggregate type delivered, or a minimum of 1 test per two weeks and if material changes as determined by the Commissioner.
 - c. As Relative Density, ASTM D4253– Minimum 1 per 100 lineal feet of trench, each lift, minimum 3 tests per run.
In-place Density, ASTM D 2922 – Minimum 1 per 100 lineal feet of trench, each lift, minimum 3 tests per run.
 - d. In-place Density, ASTM-2922 – Min. 1 per 100 linear feet of trench, each lift, minimum 3 tests per run.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. No separate measurement will be made for items described in this Section of the Specifications.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. No separate payment will be made for items described in this Section of the Specifications. All costs for this work will be considered included in the unit prices for the pay items requiring the various work items delineated in this Specification Section.

END OF SECTION P-157

LIME STABILIZED FROST PROTECTION COURSE

SECTION P-158

PART 1 GENERAL

1.01 DESCRIPTION

- A. This item will consist of constructing one or more courses of a lime stabilized Frost Protection Course (FPC), composed of “reactive soil,” lime, and water in accordance with this Specification, and in conformity with the lines, grades, thicknesses, and typical cross sections shown on the Plans.
- B. Reference Standards – The work is subject to the requirements of applicable sections of the following:
- C. Standard Specifications for Road and Bridge Construction prepared by the Illinois Department of Transportation, latest edition, is a separate book. The “Standard Specifications for Road and Bridge Construction” is referred to in the following Articles as the “Standard Specifications” and except as may be otherwise stated, the work to be done under this Section must conform to the requirements of said “Standard Specifications.” Contractor’s field office and laboratory is not a requirement.
- D. Where the “Standard Specifications” refer to the “Engineer” it will be understood to mean “Commissioner.”
- E. Where the “Standard Specifications” refer to the “Engineer” for required tests/inspections, it will be understood to mean “Contractor”.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials must be provided in accordance with the requirements of Paragraph 310.02 of the Standard Specifications.

2.02 EQUIPMENT

- A. Equipment must conform to the requirements of Paragraph 310.03 of the Standard Specifications.

PART 3 EXECUTION

3.01 GENERAL

- A. It is the primary requirement of this Specification to secure a completed Frost Protection Course (FPC) containing a uniform lime mixture, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth, and with a smooth surface suitable for placing subsequent courses. It will be the responsibility of the Contractor to regulate the sequence of his/her work, to use the proper amount of lime, maintain the work, and rework the courses as necessary to meet the above requirements.
- B. The area to be stabilized must have been constructed by the Site Preparation Contractor to an elevation approximately 2 inches above the finished elevation of the Lime Stabilized FPC. Prior to beginning any lime stabilization, the area must be brought to grade as specified in Section P-152, Excavation and Embankment and must be shaped to conform to the typical sections, lines and grades as shown on the Plans. The material to be stabilized must then be excavated to the secondary grade (proposed bottom of lime stabilization) and removed or windrowed to expose the secondary grade. Any wet or unstable materials below the secondary grade must be corrected, as directed by the Commissioner, by scarifying, adding lime, and compacting in accordance with the requirements of Item P-159 and P-152. The excavated material must then be spread to the desired cross section.
- C. If the Contractor elects to use a cutting and pulverizing machine that must remove the subgrade material accurately to the secondary grade and pulverize the material at the same time, he will not be required to expose the secondary grade nor windrow the material. However, the Contractor must be required to proof roll the subgrade, as directed by the Commissioner, and correct any soft areas that this rolling may reveal before using the pulverizing machine. This method will be permitted only where a machine is provided which must ensure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a smooth surface over the entire width of the cut. This machine must give visible indication at all times that it is cutting to the proper depth.

3.02 WEATHER LIMITATIONS AND EQUIPMENT

- A. The lime stabilized soil mixture must be constructed in accordance with the requirements of Paragraph 310.04 of the Standard Specifications.

3.03 PROPORTIONING

- A. The actual proportions of lime, soil and water will be determined by the Commissioner before work begins, utilizing the Project soil(s) and the intended lime for use. The right is reserved for the Commissioner to make such changes in the proportions during the progress of the work as becomes necessary. In no case will proportions or type of lime be changed during the progress of the work without written permission.
- B. Samples. The Contractor must, at his or her own expense, submit to the Commissioner a minimum of 25 pounds of lime and 200 pounds of subgrade soil, or as directed by the Commissioner, which the Contractor proposes for use in the mixture. The lime, when sampled, must be placed immediately in a sealed container and must be kept sealed. Samples must be delivered at least 45 days prior to the construction of the lime stabilized soil mixture. The samples as submitted must be tested for acceptance of the materials and used to determine preliminary proportions for the mixture composition.
- C. Design. The lime and soil must be proportioned within the limits of from three to five percent lime based on the dry weight of the soil. The mixture used must provide a minimum average laboratory compressive strength of 150 psi according to AASHTO T 208. Perform IBR test at design lime content and optimum moisture according to AASHTO T193 (as modified) with the amount of swell, after soaking in water for four (4) days, not to exceed 3.0%.

3.04 APPLICATION

- A. Lime must be applied in accordance with the requirements of Paragraph 310.07 of the Standard Specifications, except that two complete mixings/processings will be required.

3.05 MIXING

- A. The mixing procedure must conform to the requirements of Paragraph 310.08 of the Standard Specifications.

3.06 COMPACTION

- A. Compaction must be performed as outlined in Paragraph 310.09 of the Standard Specifications.

3.07 FINISHING AND CURING

- A. After finishing, any spoils from the finishing / trimming operation must be embanked within the project limits in accordance with Section P-

152 Excavation and Embankment, and will be considered incidental to the lime stabilized subgrade.

3.08 THICKNESS

- A. The thickness of the lime stabilized FPC must be determined by depth tests or cores taken at intervals so that each test must represent no more than 1,000 square yards. When the stabilized subgrade thickness deficiency is more than ½ inch, the Contractor must correct such areas in a manner satisfactory to the Commissioner. The Contractor must replace, at his/her expense, the stabilized material where borings are taken for test purposes.

3.09 CONSTRUCTION JOINTS

- A. Construction joints will not be required between each day's work unless there is a time lapse of seven days or more between the processing of adjacent sections. If construction joints are required, they must be formed by cutting back three (3) feet into the completed work to form a vertical face. Otherwise, damage to completed work will be avoided.

3.10 MAINTENANCE

- A. The Contractor must maintain, at his/her own expense, the entire lime stabilized subgrade in good condition from the start of work until all the work has been completed, cured, and accepted by the Commissioner.

3.11 QUALITY CONTROL

- A. The Contractor must include in his Quality Control plan the methods he intends to use for proof of application, and to obtain depth of mixing and the required compaction. A secondary check of proof of application in accordance with the mix design percentage must be verified daily by the Contractor QC by measuring the area and thickness covered and dividing by the amount of lime used to stabilize the area.
- B. The Contractor must not allow any standing water to sit on the lime stabilized FPC for any length of time. After completion of finishing, curing, and final trimming, the Contractor must conduct a proof roll of the lime stabilized FPC with a semi-truck loaded to the legal limit in the presence of the Commissioner immediately before paving the subsequent layers in order to detect any deficiencies.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. The quantity of lime stabilized FPC to be paid for will be the number of square yards completed and accepted.
- B. The amount of lime to be paid for will be the number of tons of hydrated lime or quicklime used as authorized.
- C. Lime will be measured for payment in tons. The lime will be measured in trucks or freight cars. The Contractor will furnish or arrange for use of scales of a type approved by the Commissioner. If the lime is shipped in trucks, it will be measured at the place of loading, at the place of unloading, or at such other place as the Commissioner may designate. The Commissioner may accept original signed freight bills in lieu of determining the mass (weight).

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment will be made at the Contract unit price per square yard for the lime stabilized FPC of the thickness specified. The price will be full compensation for all preparation, placement and mixing of these materials (soil, lime and water), compaction, placement and all labor, equipment, tools and all work necessary to complete this item.
- B. Payment will be made at the Contract unit price per ton for lime. This price will be full compensation for furnishing this material; for all delivery, and for all labor, equipment, tools, and all work necessary to complete this item.
- C. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
P-158-01	12" LIME STABILIZED FPC, IDOT, 12"-DEPTH	SY
P-158-02	LIME, IDOT	TON

END OF SECTION P-158

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LIME MODIFIED SOILS

SECTION P-159

PART 1 GENERAL

1.01 DESCRIPTION

- A. This work will consist of the construction of a lime modified soil layer composed of soil, lime and water.
- B. Reference Standards – The work is subject to requirements of applicable sections of the following:
 - 1. Standard Specifications for Road and Bridge Construction prepared by the Illinois Department of Transportation, latest edition, is a separate book. The “Standard Specifications for Road and Bridge Construction” is referred to in the following Articles as the “Standard Specifications” and except as may be otherwise stated, the work to be done under this Section must conform to the requirements of said “Standard Specifications.”
 - 2. Where the “Standard Specifications” refer to the “Engineer” it will be understood to mean “Commissioner.”
 - 3. Where the “Standard Specifications” refer to “Engineer” for required test and inspections, it will be understood to mean “Contractor”.
 - 4. When lime is to be used for modification, refer to Specification Section P-152.

PART 2 PRODUCTS

- 2.01 Materials must meet the requirements of the Standard Specifications for the following:
 - A. Water, Section 1002
 - B. Hydrated Lime, Section 1012.01
 - C. By-Product Lime for Lime Modified Soils, Section 1012.03
- 2.02 Quicklime will meet the requirements of AASHTO M216.
- 2.03 Equipment will meet the requirements of Paragraph 302.03 of the Standard Specifications.

PART 3 EXECUTION

- 3.01 Lime must not be applied to or mixed with frozen soil. The amount of lime modified soil constructed must be limited to that which can be covered with subbase, base or pavement within the same construction season, unless otherwise permitted by the Commissioner.

3.02 Proportioning

- A. Samples. The Contactor, at his or her own expense, must provide a minimum of 25 pounds of lime and 200 pounds of soil, or as directed by the Commissioner, proposed to be used at least 45 days prior to construction of the lime modified soils.
- B. Mix design. Lime will be proportioned within a range of two to six percent of the dry unit weight of the soil (oven dry basis). The actual proportions of lime, soil, and water will be determined by the Commissioner prior to construction using the submitted samples. Perform IBR test at design lime content and optimum moisture according to AASHTO T 193 (as modified) with the amount of swell, after soaking in water for four (4) days, not to exceed 3.0%. The Commissioner reserves the right to make such adjustments in proportions as are considered necessary during the progress of the work.
- C. Source or type of lime must not be changed during the progress of the work without written permission of the Commissioner.

3.03 Spreading of Lime.

- A. The surface of the grade must be lightly scarified or disked prior to distribution of the lime. Such diskings must break down any soil lumps so that at least 75% of the soil particles are less than one inch (1") in any dimension. The lime must then be distributed uniformly over the surface. The Commissioner may reject any procedure which does not provide even distribution of lime.
- B. Lime must not be applied when wind conditions are such that blowing lime becomes objectionable to adjacent property owners or creates a hazard to air traffic or to vehicular traffic on adjacent highways.
- C. The spreading of lime must be limited to that amount which can be incorporated into the soil within the same working day.
- D. The Contractor must include in his Quality Control Plan the methods to be used by the Contractor for proof of lime application of design amount (oven dry basis) thickness (if required) and the required compaction. A secondary check of proof of application in accordance with the mix design percentage must be verified daily by the Contractor QC by measuring the area and thickness covered and dividing by the amount of lime used to lime modify the area.

3.04 Mixing.

- A. The lime, soil and water (if necessary) must be thoroughly blended by rotary speed mixers or a disk harrow. The mixing must continue until it has been determined by the Commissioner that a homogeneous layer of the required thickness has been obtained. The loose thickness of a

single lime modified layer must not exceed eight inches (8") if a disk harrow is used, or fourteen inches (14") if a rotary speed mixer is used. The mixing procedure must conform to the requirements of Article 302.08 of the Standard Specifications.

3.05 Compaction.

- A. Compaction of the mixture must begin as soon as is practicable after mixing. In no case must compaction be started later than three (3) days after mixing unless approved by the Commissioner. If compaction is to be delayed, the surface of the lime modified soil must be crown-graded and sealed by either blade dragging or light rolling immediately after mixing. Compaction requirements must be in accordance with Section P-152, Excavation and Embankment. Aeration by means of further mixing, or the addition of water and further mixing, may be required by the Commissioner to achieve the required compaction.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Lime will be measured for payment in tons. The lime will be measured in trucks or freight cars. The Contractor will furnish or arrange for use of scales of a type approved by the Commissioner. If the lime is shipped in trucks, it will be measured at the place of loading, at the place of unloading, or at such other place as the Commissioner may designate. The Commissioner may accept original signed freight bills in lieu of determining the mass (weight).

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. This work will be paid for at the Contract unit price per ton for lime. The price will be full compensation for lime, by-product lime, water, preparation, scarification, mixing, compaction and all work necessary to complete the soil modification as required in this Section.
- B. Payment will be made under the following item:

ITEM NO.	DESCRIPTION	UOM
P-159-01	LIME MODIFICATION	TON

END OF SECTION P-159

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PLANT MIX BITUMINOUS PAVEMENTS (SUPERPAVE™)

SECTION P-401(SP)

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item must consist of a surface and a base course composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in accordance with these Specifications and must conform to the lines, grades, thicknesses, and typical cross sections shown on the Plans. The work under this Section is subject to the requirements of the Contract Documents.
- B. This Specification is suitable for use in constructing all runway, taxiway and apron surface pavements using mixtures designed with Superpave techniques.

1.02 REFERENCES

- A. Illinois Department of Transportation, Standard Specification for and Bridge Construction (SSRBC), latest edition.

PART 2 MATERIALS

2.01 AGGREGATE

- A. Aggregates must consist of crushed stone or crushed gravel with or without sand or other inert finely divided mineral aggregate conforming to the requirements of the Illinois Department of Transportation, Standard Specifications for Road and Bridge Construction (SSRBC), latest edition. The portion of materials retained on the No. 8 sieve is coarse aggregate. The portion passing the No. 8 sieve and retained on the No. 200 sieve is fine aggregate, and the portion passing the No. 200 sieve is mineral filler. All aggregate property tests must be conducted by an accredited laboratory that meets the requirements of Section 401SP-3.05. Aggregate test results must not be greater than six months old. If test results are provided on the combined blend, the Commissioner reserves the right to require tests on individual aggregates should a major change in the Job Mix Formula percentages occur.
- B. Coarse Aggregate: Coarse aggregate must consist of sound, tough, durable particles, free from adherent films of matter that would prevent thorough coating and bonding with the bituminous material and be free

from organic matter and other deleterious substances. Coarse aggregate must be quality Class B or better, or as modified by this Specification, conforming to the requirements of Article 1004 of the SSRBC. The percentage of wear must not be greater than 40 percent when tested in accordance with ASTM C 131. The sodium sulfate soundness loss must not exceed 10 percent, or the magnesium sulfate soundness loss must not exceed 13 percent, after five cycles, when tested in accordance with ASTM C 88.

1. The combined coarse aggregate material must contain at least 85 percent by weight having at least one fractured face and 80 percent by weight having a minimum of two (2) fractured faces. The fractured face percentage for any crushed gravel aggregate material, retained on the No. 8 sieve after crushing, must be determined in accordance with ASTM D 5821. The area of each face must be equal to at least 75 percent of the smallest midsectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures must be at least 30 degrees to count as two fractured faces. Fractured faces must be obtained by crushing.
2. The aggregate must not contain more than 8 percent, by weight, of flat or elongated pieces, when tested in accordance with ASTM D 4791 using a ratio of 5:1.

C. Fine Aggregate: Fine aggregate must consist of clean, sound, durable, angular shaped particles produced by crushing stone or gravel that meets the requirements for wear and soundness specified for coarse aggregate. Fine aggregate must be quality Class B or better, or as modified by this Specification, conforming to the requirements of Article 1003 of the SSRBC. The aggregate particles must be free from coatings of clay, silt, or other objectionable matter and must contain no clay balls. The fine aggregate, including any blended material for the fine aggregate, must have a plasticity index of not more than 6 and a liquid limit of not more than 25 when tested in accordance with ASTM D 4318.

1. Natural (nonmanufactured) sand may be used to obtain the gradation of the aggregate blend or to improve the workability of the mix. The amount of sand to be added must be adjusted to produce mixtures conforming to requirements of this Specification. The addition of natural sand must be limited such that the total combined material passing the #8 sieve does not contain more than 50% natural sand.
2. The fine aggregate must have sand equivalent value of 43 or greater when tested in accordance with ASTM D 2419. The fine aggregate material must have a Fine Aggregate Angularity

of not less than 45 when tested in accordance with AASHTO T304, Method A.

- D. Sampling: ASTM D 75 must be used in sampling coarse and fine aggregate, and ASTM C 183 must be used in sampling mineral filler.

2.02 MINERAL FILLER

- A. If filler, in addition to that naturally present in the aggregate, is necessary, it must meet the requirements of ASTM D 242.

2.03 BITUMINOUS MATERIAL

- A. The bituminous material must conform to the requirements of AASHTO MP1, performance graded binder designation SBS/SBR PG 70-22. A certificate of compliance from the manufacturer must be included with the mix design submittal.
- B. The Contractor must furnish vendor's certified test reports for each lot of bituminous material shipped to the Project. The vendor's certified test report for the bituminous material can be used for acceptance or the bituminous material may be tested independently by the Commissioner.

2.04 PRELIMINARY MATERIAL ACCEPTANCE

- A. Prior to delivery of materials to the job site, the Contractor must submit independent certified test reports, not more than 30 days old, to the Commissioner for the following materials:
 - 1. Coarse Aggregate
 - a. Percent of wear.
 - b. Soundness.
 - c. Coarse Aggregate Fractured Faces Determination (Coarse Aggregate Angularity).
 - d. Percent Absorption.
 - e. Percent flat and elongated particles.
 - 2. Fine Aggregate
 - a. Liquid limit.
 - b. Plastic index.
 - c. Sand equivalent.
 - d. Fine Aggregate Angularity.
 - 3. Mineral Filler
 - 4. Bituminous Material: The certification(s) must show the appropriate AASHTO test(s) for each material, the test results,

and a statement that the material meets the Specification requirement.

- a. The Contractor must submit independent certified test reports for all material under this Specification for every 10,000 tons of material placed. These test reports must not be more than 10 days old and are to be submitted to the Commissioner within 5 days of exceeding the 10,000 ton requirement.

PART 3 COMPOSITION

3.01 COMPOSITION OF MIXTURE

- A. The bituminous plant mix must be composed of a mixture of well-graded aggregate, filler if required, and bituminous material. The several aggregate fractions must be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF).

3.02 JOB MIX FORMULA

- A. No bituminous mixture for payment will be produced until a job mix formula has been approved in writing by the Commissioner. The bituminous mixture must be designed using procedures contained in Chapter 5, Superpave™ Mix Design of the Asphalt Institute's Manual Superpave™ Series No. 2 (SP-2), Superpave™ Mix Design, and must meet the requirements outlined below.
- B. The Tensile Strength Ratio (TSR) of the composite mixture must be greater than or equal to 80 when tested in accordance with ASTM D 4867 including the freeze-thaw conditioning cycle. Test specimens must have an air void content of 7 percent (+/- 0.5%) and a degree of saturation of 70 percent (+/- 5%). If an anti-stripping agent is required, it must be provided by the Contractor at no additional cost.
- C. The job mix formula must be submitted in writing by the Contractor to the Commissioner at least 30 days prior to the start of paving operations. The Job Mix Formula must have been developed no more than 3 months prior to submittal and must include as a minimum:
 1. Percent passing each sieve size for total combined gradation, individual gradation of all aggregate stockpiles and percentage by weight of each stockpile used in the JMF.
 2. Percent of asphalt cement.
 3. Asphalt Performance Grade.

4. Number of gyrations and air voids for N_{des}
 5. Mixing temperature.
 6. Compaction temperature.
 7. Temperature of mix when discharged from the mixer.
 8. Temperature-viscosity relationship of the asphalt cement.
 9. Plot of the combined gradation on the Federal Highway Administration (FHWA) 45 power gradation curve.
 10. Graphical plots of percent G_{mm} @ N_{design} , air voids, voids in the mineral aggregate, and unit weight versus asphalt content.
 11. Percent natural sand contained in material passing the number 8 sieve.
 12. Coarse Aggregate Angularity.
 13. Percent elongated particles.
 14. Tensile Strength Ratio (TSR).
 15. Antistrip agent (if required).
 16. Sand equivalent value of the fine aggregate for the combined blend.
 17. Fine aggregate angularity of the combined blend.
 18. Dust to asphalt ratio.
 19. Wet mixing time to achieve the required minimum percentage of coated particles.
- D. The Contractor must submit samples to the Commissioner, for job mix formula verification testing.
- E. The job mix formula for each mixture must be in effect until modified in writing by the Commissioner. Should a change in sources or properties of materials be made, a new job mix formula must be approved by the Commissioner before the new material is used.

TABLE 1

Superpave™ Design Criteria for IL-19.0 Nominal Maximum Aggregate Size

Test Property	IL-19.0 Nom.
Design Number of Gyrations (N_{des})	90
Air Voids @ N_{des}	4.0
Voids in Mineral Aggregate @ N_{des} , percent	13.0 min.

TABLE 1**Superpave™ Design Criteria for IL-19.0 Nominal Maximum Aggregate Size**

Test Property	IL-19.0 Nom.
Voids filled with Asphalt @ N _{des} , percent	65-75
Dust to Asphalt Ratio	1.0 Max
Fine Aggregate Angularity	45 min.

Table 2 - Reserved

- F. The mineral aggregate must be of such size that the percentage composition by weight, as determined by laboratory screens, must conform to the gradation or gradations specified in Table 3 when tested in accordance with ASTM Standard C 136 and C 117. Optimum gradations are approximately parallel to the Specification bands.
- G. The gradations in Table 3 represent the limits which must determine the suitability of aggregate for use from the sources of supply. The aggregate, as selected (and used in the JMF), must have a gradation within the limits designated in Table 3 and must not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but must be well graded from coarse to fine.
- H. Deviations from the final approved mix design for bitumen content and gradation of aggregates must be within the action limits for individual measurements as specified in paragraph 401SP-6.05.C, provided deviations fall inside the control points in Table 3.
- I. The nominal maximum size aggregate used must not be more than one-third of the thickness of the course being constructed. For example, when the nominal maximum size is 3/4", the thickness of the course being constructed must be 2-1/4" or more.

TABLE 3				
Aggregate – Bituminous Pavements IL-19.0 Nominal Maximum Size Aggregate				
Runway/Taxiway/Apron Pavements				
Gradation Limits				
Sieve Size		Min.	Max.	
1 in.		100	100	
3/4 in.		82	100	
1/2 in.		50	85	
No. 4		24	40	
No. 8		20	36	
No. 16		10	25	
No. 50		4	12	
No. 100		3	9	
No. 200		3	6	
Asphalt Cement Content (percent)		4.5	7.0	

- J. The aggregate gradations shown are based on aggregates of uniform specific gravity. The percentages passing the various sieves must be corrected when the specific gravity varies by 10 percent or more.

3.03 RECYCLED ASPHALT CONCRETE

- A. Reclaimed asphalt pavement will not be permitted to be used.

3.04 TEST SECTION

- A. Prior to full production, the Contractor must prepare and place a quantity of bituminous mixture according to the job mix formula at a location, other than the job site, selected by the Commissioner. The amount of mixture should be sufficient to construct a test section 300 feet long and two paver widths wide, with a longitudinal cold joint, and must be of the same depth specified for the construction of the course which it represents. A cold joint is defined as an exposed construction joint at least four hours old. The underlying grade or pavement structure upon which the test section is to be constructed must be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section must be the same on the remainder of the course represented by the test section.

If equipment is to be switched, it must be submitted in writing and approved by the Commissioner.

- B. The test section must be evaluated for acceptance as a single lot in accordance with the acceptance criteria in paragraph 401SP-5.01 and 401SP-6.03. As a minimum, the test section must consist of three sublots.
- C. The test section must be considered acceptable if:
 - 1. Mat density, air voids (percent G_{mm} @ N_{des}), and the joint density are 90 percent or more within limits on the PWL calculations;
 - 2. Gradation and asphalt content are within the action limits specified in paragraphs 401SP-6.05.C and 6.05.B;
 - 3. The Voids in Mineral Aggregate @ N_{des} , Voids filled with Asphalt @ N_{des} , and Dust Proportion are within the limits of Table 1.
- D. If the initial test section should prove to be unacceptable, the necessary adjustments to the job mix formula, plant operation, placing procedures, and/or rolling procedures must be made. A second test section must then be placed. If the second test section also does not meet Specification requirements, both sections must be removed at the Contractor's expense. Additional test sections, as required, must be constructed and evaluated for conformance to the Specifications. Any additional sections that are not acceptable must be removed at the Contractor's expense. Full production must not begin until an acceptable section has been constructed and accepted by the Commissioner. Only acceptable test section that meets Specification requirements will be paid for in accordance with paragraph 401SP-8.01.C.
- E. Job mix control testing must be performed by the Contractor at the start of plant production and in conjunction with the calibration of the plant for the job mix formula. It should be recognized that the aggregates produced by the plant may not satisfy the gradation requirements or produce a mix that exactly meets the JMF. In those instances, it will be necessary to reevaluate and redesign the mix using plant-produced aggregates. Specimens should be prepared and the optimum bitumen content determined in the same manner as for the original design tests. Until the plant is producing the desired mix consistency, frequent testing may be necessary.

3.05 TESTING LABORATORY

- A. The laboratory used to develop the job mix formula must meet the requirements of ASTM D 3666. A certification signed by the manager of the laboratory stating that it meets these requirements must be submitted to the Commissioner prior to the start of construction. The certification must contain as a minimum:
1. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.
 2. A listing of equipment to be used in developing the job mix.
 3. A copy of the laboratory's quality control system.
 4. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.
 5. Evidence that the laboratory is accredited, for the test methods required herein by a nationally recognized laboratory accreditation organization.

PART 4 CONSTRUCTION METHODS

4.01 PAVING PLAN

- A. The Contractor must submit a paving plan, for information only, to the Commissioner which outlines the means and methods to be utilized by the Contractor in meeting the requirements of Section 401SP Part 4.

4.02 WEATHER LIMITATIONS

- A. The bituminous mixture must not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 4. The temperature requirements may be waived by the Commissioner, if requested in writing and a cold weather paving plan has been submitted and approved by the Commissioner; however, all other requirements including compaction must be met.

TABLE 4
Base Temperature Limitations

Mat Thickness	Base Temperature Deg. F(Min)
3 in. or greater	40
Greater than 1 in. but less than 3 in.	45
1 in. or less	50

4.03 BITUMINOUS MIXING PLANT

- A. Plants must meet the requirements or the SSRBC (IDOT) Article 1102, inclusive of all Policy Memorandums thereof.

Additionally, Plants used for the preparation of bituminous mixtures must conform to the requirements of ASTM D 995 with the following changes:

1. Requirements for All Plants.
 - a. Truck Scales: The bituminous mixture must be weighed on approved scales furnished by the Contractor. Scales must be inspected and sealed as often as the Commissioner deems necessary to assure their accuracy.
 - b. Testing Facilities: The Contractor must provide laboratory facilities at the plant for the use of the Commissioner's acceptance testing and the Contractor's quality control testing, in accordance with paragraph 401SP-6.02.
 - c. Inspection of Plant: The Commissioner, or Commissioner's authorized representative, must have access, at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and material properties; and checking the temperatures maintained in the preparation of the mixtures.
 - d. Storage Bins and Surge Bins: Paragraph 3.9 of ASTM D 995 is deleted. Instead, the following applies. Use of surge bins or storage bins for temporary storage of hot bituminous mixtures will be permitted as follows:
 - (1) The bituminous mixture may be stored in surge bins for period of time not to exceed 3 hours.
 - (2) The bituminous mixture may be stored in insulated storage bins for a period of time not to exceed 24 hours.
 - (3) The bins must be such that mix drawn from them meets the same requirements as mix loaded directly into trucks.
 - (4) If the Commissioner determines that there is an excessive amount of heat loss, segregation or oxidation of the mixture due to temporary storage, no overnight storage will be allowed.

- (5) Surge bin weight will not be accepted for payment purposes.

4.04 HAULING EQUIPMENT

- A. Trucks used for hauling bituminous mixtures must have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, the truck beds must be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. The Contractor must submit the method of coating. Each truck must have and use a tarp cover to protect the mixture at all times. To ensure that the mixture must be delivered to the site at the specified temperature, truck beds must be insulated or heated and covers must be securely fastened during transport.

4.05 BITUMINOUS PAVERS

- A. Bituminous pavers must be self-propelled, with an activated screed, heated as necessary, and must be capable of spreading and finishing courses of bituminous plant mix material which will meet the specified thickness, smoothness, and grade. The paver must have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface.
- B. The paver must have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper must be equipped with a distribution system to place the mixture uniformly in front of the screed without segregation. The screed must effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture. The screed must be equal to the width of the pavement being placed. This may require installing hard extensions and augers as recommended by the Asphalt Institute MS-22.
- C. An automatic grade control device must be used. The paver must be equipped with a control system capable of automatically maintaining the specified screed elevation. The control system must be automatically actuated from either a reference line and/or through a system of mechanical sensors or sensor-directed mechanisms or devices which must maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller must be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent.
- D. The controls must be capable of working in conjunction with any of the following attachments:

1. Manufacturer recommended Ski-type device of not less than 30 feet in length.
2. Taut stringline (wire) set to grade.
3. Laser control.
4. Short ski or shoe.

4.06 MATERIAL TRANSFER DEVICE

- A. The Material Transfer Device must be used for the placement of the bituminous concrete base and bituminous concrete surface courses on the Runways and Taxiways. The Material Transfer Device speed must be adjusted to the speed of the paver to maintain a continuous, non-stop paving operation.
- B. The Material Transfer Device must have a minimum surge capacity of 25 tons, must be self propelled and capable of moving independently of the paver, and must be equipped with the following:
 1. Front Dump Hopper and Conveyor. The conveyor must provide a positive restraint along the sides of the conveyor to prevent material spillage.
 2. Paver Hopper Insert. The paver hopper insert must have a minimum capacity of 14 tons.
 3. Mixer/Agitator Mechanism. This re-mixing mechanism must consist of a segmented, anti-segregation, re-mixing auger or two full length longitudinal paddle mixers designed for the purpose of re-mixing the bituminous material. The longitudinal paddle mixers must be located in the paver hopper insert.

4.07 ROLLERS

- A. Rollers of the vibratory, steel wheel type must be used. They must be in good condition, capable of operating at slow speeds to avoid displacement of the bituminous mixture. The number, type, and weight of rollers must be detailed in the Construction Operations plan required by Section P-401SP-4.01 and must be sufficient to compact the mixture to the required density while it is still in a workable condition. Vibratory rollers, in the dynamic mode, must be operated at a minimum frequency of at least 1600 vpm and a minimum roller speed to produce at least 10 impacts per foot.
- B. The use of equipment which causes excessive crushing of the aggregate will not be permitted.

4.08 PREPARATION OF BITUMINOUS MATERIAL

- A. The bituminous material must be heated in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature. The temperature of the bituminous material delivered to the mixer must be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles, but must not exceed 325 degrees F, unless otherwise required by the manufacturer.

4.09 PREPARATION OF MINERAL AGGREGATE

- A. The aggregate for the mixture must be heated and dried prior to introduction into the mixer. The maximum temperature and rate of heating must be such that no damage occurs to the aggregates. The temperature of the aggregate and mineral filler must not exceed 350 degrees F when the asphalt is added. Particular care must be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature must not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

4.10 PREPARATION OF BITUMINOUS MIXTURE

- A. The aggregates and the bituminous material must be weighed or metered and introduced into the mixer in the amount specified by the job mix formula.
- B. The combined materials must be mixed until the aggregate obtains a uniform coating of bitumen and is thoroughly distributed throughout the mixture. Wet mixing time must be the shortest time that will produce a satisfactory mixture, but not less than 25 seconds for batch plants. The wet mixing time for all plants must be established by the Contractor, based on the procedure for determining the percentage of coated particles described in ASTM D 2489, for each individual plant and for each type of aggregate used. For continuous mix plants, the minimum mixing time must be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the mixer. The moisture content of all bituminous mix upon discharge must not exceed 0.5 percent.

4.11 PREPARATION OF THE UNDERLYING SURFACE

- A. Immediately before placing the bituminous mixture, the underlying course must be cleaned of all dust and debris. A prime coat or tack

coat must be applied in accordance with Item P-602 or P-603, as shown on the Plans or as directed by the Commissioner.

4.12 TRANSPORTING, PLACING, AND FINISHING

- A. The bituminous mixture must be transported from the mixing plant to the site in vehicles conforming to the requirements of paragraph 401SP-4.04. Deliveries must be scheduled so that placing and compacting of mixture is uniform with no stopping and starting of the paver. Adequate artificial lighting must be provided for night placements in accordance with Specification N-100. Hauling over freshly placed material will not be permitted until the material has been compacted, as specified, and allowed to cool to atmospheric temperature.
- B. The initial placement and compaction of the mixture must occur at a temperature suitable for obtaining density, surface smoothness, and other specified requirements but not less than 280 degrees F.
- C. Upon arrival, the mixture must be placed to the full width by a bituminous paver. It must be struck off in a uniform layer of such depth that, when the work is completed, it must have the required thickness and conform to the grade and contour indicated. The Contractor may place base course lifts of not more than 4 inches thick when compacted except that the top lift must have a minimum of 2 ¼ inch compacted thickness. The surface course must be placed to achieve a compacted thickness of 2 ¼ inches. The speed of the paver must be regulated to eliminate pulling and tearing of the bituminous mat but in no case must the speed of the paver exceed 40 feet per minute. Unless otherwise permitted, placement of the mixture must begin along the centerline of a crowned section or on the high side of areas with a one-way slope. The mixture must be placed in consecutive adjacent strips having a minimum width of 25 feet except where edge lanes require less width to complete the area. The longitudinal joint in one course must offset the longitudinal joint in the course immediately below by at least 1 foot; however, the joint in the surface top course must be at the centerline of the pavement. Transverse joints in one course must be offset by at least 10 feet from transverse joints in the previous course.
- D. Transverse joints in adjacent lanes must be offset a minimum of 10 feet.
- E. Continuous paving using the Material Transfer Device is required. No stopping during paving operations will be permitted.

- F. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by hand tools.

4.13 COMPACTION OF MIXTURE:

- A. After placing, the mixture must be thoroughly and uniformly compacted by rolling. The surface must be compacted as soon as possible when the mixture has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used must be at the discretion of the Contractor but the type and rolling pattern must be as established and approved by the Commissioner during placement of the test sections.
- B. The speed of the roller must, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, must be corrected at once. Vibratory rollers in the dynamic mode, must be operated at a minimum frequency of at least 1600 VPM and a minimum roller speed to produce at least 10 impacts per foot.
- C. Sufficient rollers must be furnished to handle the output of the plant. Rolling must continue until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained.
- D. To prevent adhesion of the mixture to the roller, the wheels must be kept properly moistened (and scrapers used), but excessive water will not be permitted. Rollers are not allowed to sit stationary on the hot mat.
- E. In areas not accessible to the roller, the mixture must be thoroughly compacted with hand tampers.
- F. All roller lines must be removed.
- G. Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way defective must be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work must be done at the Contractor's expense. Skin patching will not be allowed.

4.14 JOINTS

- A. The formation of all joints must be made in such a manner as to ensure a continuous bond between the courses and obtain the required density. All joints must have the same texture as other sections of the course and meet the requirements for smoothness and grade.
- B. The roller must not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint, it must be made by means of placing a bulkhead or by tapering the course. The edge of all joints must be cut back to their full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. All contact surfaces must be given a tack coat of bituminous material prior to placing any fresh mixture against the joint.
- C. Longitudinal joints which are irregular, damaged, uncompacted, or otherwise defective must be cut back to expose a clean, sound surface for full depth of the course. All contact surfaces must be given a tack coat of bituminous material prior to placing any fresh mixture against the joint.

PART 5 MATERIAL ACCEPTANCE

5.01 ACCEPTANCE SAMPLING AND TESTING

- A. Unless otherwise specified, all acceptance sampling and testing necessary to determine conformance with the requirements specified in this Section will be performed by the Commissioner at no cost to the Contractor. Testing organizations performing these tests must meet the requirements of ASTM D 3666. All equipment in Contractor furnished laboratories must be calibrated by the Contractor, and verified by the testing organization prior to the start of operations to meet the minimum ASTM requirements. The Contractor must be required to submit evidence of recalibration of all equipment in the Contractor furnished laboratory for every 25,000 tons of material placed. The calibration will be witnessed by the Commissioner's testing organization and must be documented. All Contractor personnel preparing laboratory compacted acceptance specimens must be state certified Superpave™ Field Testing Technicians or equivalent acceptable to the Commissioner.
- B. Plant-Produced Material: Plant-produced material must be tested for air voids on a lot basis. Sampling must be by the Contractor from material deposited into trucks at the plant in accordance with

paragraph 401SP-5.01.B.1 Sampling. Acceptance samples, for each lot, will not be obtained from the first 50 tons of plant-produced material unless multiple lots occur in one day of production. The first 50 tons of plant-produced material must be included in the requirements of paragraph 401SP-5.01.C. A lot must consist of:

- One day's production not to exceed 2,000 tons, but not less than 500 tons. Production runs less than 500 tons must be tested as a subplot and combined with and into the next production lot; or
 - A half day's production where a day's production is expected to consist of between 2,000 and 4,000 tons; or
 - Similar subdivisions for tonnages over 4,000 tons.
- Adjustments for lot size due to increases/decreases of estimated tonnage received from the Contractor must be at the Commissioner's discretion. The Contractor must notify the Commissioner, 12 hours in advance of placement, as to anticipated production time and tonnage.
 - Where more than one plant is simultaneously producing material for the job, the lot sizes must apply separately for each plant.

1. Sampling. Each lot must consist of four equal sublots. Sufficient material for preparation of test specimens for all testing must be sampled by the Contractor on a random basis, as provided by the Commissioner, in accordance with the procedures contained in ASTM D 3665, or a computer based program approved by the Commissioner. All samples must be obtained in accordance with ASTM D979. The Contractor must prepare, under the supervision of the Commissioner, the laboratory compacted test specimens and provide the Commissioner with a printout of all data generated by the gyratory compaction equipment. One set of laboratory compacted specimens must be prepared, at the design number of gyrations required by paragraph 401SP-3.02, Table 1, for each subplot, in accordance with the compaction procedures outlined in Chapter 5, Superpave™ Level 1 Mix Design, of the Asphalt Institute's Manual Superpave™ Series No. 2(SP-2) Superpave Mix Design. Each set of laboratory compacted specimens must consist of two test specimens prepared from the same sample increment. The Contractor is responsible for obtaining, splitting and transporting to the Commissioner's representative, at the Contractor's Laboratory, all samples

required for acceptance testing. All samples will be transferred with a Chain of Custody form provided by the Commissioner.

- a. The sample of bituminous mixture must be maintained at a temperature at or above the specified compaction temperature for a period of no less than 30 minutes. For mixtures containing aggregates with absorption values greater than 1.5 percent, the mixture must be maintained at a temperature at or above the specified compaction temperature for a period of no less than 60 minutes. If necessary, the sample must be placed in an oven for not more than 60 to 90 minutes to bring the samples to the proper compaction temperature. The compaction temperatures must be as specified in the job mix formula.
 - b. Lighting of the sampling area must meet the requirements of the N-100 Night Construction Section.
2. Testing. Air voids will be determined by the Commissioner in accordance with ASTM D 3203 for acceptance only. The Contractor must perform all quality control testing in accordance with the Specifications or as directed by the Commissioner.
- a. Prior to testing for air voids, the bulk specific gravity of each test specimen will be measured by the Commissioner in accordance with ASTM D 2726 using the procedure for laboratory-prepared thoroughly dry specimens, or ASTM D 1188, whichever is applicable, for use in computing air voids.
 - b. For air voids and pavement density, the theoretical maximum specific gravity of the mixture must be measured for each subplot in accordance with ASTM D 2041, Type C, D, or E container. The value used in the air voids computation for each subplot must be based on maximum specific gravity measurement for the subplot.
3. Acceptance. Acceptance of plant produced material for air voids will be determined by the Commissioner in accordance with the requirements of paragraph 401SP-5.02.E.
- C. Field Placed Material: Material placed in the field must be tested for mat and joint density on a lot basis.
1. Mat Density. The lot size must be the same as that indicated in paragraph 401SP-5.01.B and must be divided into four equal sublots. One 4-inch diameter core of finished, compacted materials must be taken by the Contractor from each subplot. Core locations will be determined by the Commissioner on a

random basis in accordance with procedures contained in ASTM D 3665. Cores must not be taken closer than one foot from a transverse or longitudinal joint.

2. Joint Density. The lot size must be the total length of longitudinal joints constructed by a lot of material as defined in paragraph 401SP-5.01.B. The lot must be divided into four equal sublots. One 4-inch diameter core of finished, compacted materials must be taken by the Contractor from each subplot. Core locations will be determined by the Commissioner on a random basis in accordance with procedures contained in ASTM D 3665. All coring must be centered on the joint.
3. Sampling. Samples must be neatly cut with a core drill within 72 hours of paving. The cutting edge of the core drill bit must be of hardened steel or other suitable material with diamond chips embedded in the metal cutting edge. The minimum diameter of the sample must be four inches. Samples that are clearly defective, as a result of sampling, must be discarded and another sample taken. The Contractor, by submission of the cores to the Commissioner for testing, acknowledges that the cores are not defective unless otherwise noted on the Chain of Custody form provided by the Commissioner. The Contractor must furnish all tools, labor, and materials for cutting samples and filling the cored pavement. Cored holes must be filled in a manner acceptable to the Commissioner immediately following the coring operation.
4. Testing. The bulk specific gravity of each cored sample will be measured by the Commissioner in accordance with ASTM D 2726 or ASTM D 1188, whichever is applicable. The percent compaction (density) of each sample must be determined by dividing the bulk specific gravity of each cored subplot sample by the maximum theoretical specific gravity for that subplot, as determined in paragraph 401SP-5.01.B.2. The maximum theoretical specific gravity used to determine the joint density at joints between two different lots must be the lower of the specific gravity values from the two different lots.
5. Acceptance. Acceptance of field placed material for mat density will be determined by the Commissioner in accordance with the requirements of paragraph 401SP-5.02.F. Acceptance for joint density will be determined in accordance with the requirements of paragraph 401SP-5.02.G.

- D. Partial Lots - Plant-Produced Material. When operational conditions cause a lot to be terminated before the specified number of tests have been made for the lot, or when the Contractor and Commissioner

agree in writing to allow overages or other minor tonnage placements to be considered as partial lots, the following procedure must be used to adjust the lot size and the number of tests for the lot.

1. The last batch produced where production is halted must be sampled and its properties must be considered as representative of the particular subplot from which it was taken. Where three sublots are produced, they must constitute a lot. Where one or two sublots are produced, they must be incorporated into the next lot and the total number of sublots must be used in the acceptance plan calculation, i.e., $n = 5$ or $n = 6$, for example.
- E. Partial Lots - Field Placed Material. The lot size for field placed material must correspond to that of the plant material, except that, in no cases, less than (3) cored samples must be obtained for the acceptance plan calculations, i.e., $n = 3$.

5.02 ACCEPTANCE CRITERIA:

- A. General: Acceptance will be based on the following characteristics of the bituminous mixture and completed pavement as well as the implementation of the Contractor's Quality Control plan and test results:
1. Air voids
 2. Mat density
 3. Joint density
 4. Thickness
 5. Smoothness
 6. Grade
- B. Air voids, mat density, and joint density will be evaluated for acceptance on a lot basis using the method of estimating percentage of material within specification limits (PWL). Acceptance using PWL considers the variability (standard deviation) of the material and the testing procedures, as well as the average (mean) value of the test results to calculate the percentage of material that is above the lower specification tolerance limit (L) or below the upper specification tolerance limit (U).
- C. Thickness will be evaluated by the Commissioner for compliance in accordance with paragraph 401SP-5.02.I.4. Acceptance for smoothness will be based on the criteria contained in paragraph

401SP-5.02.I.5. Acceptance for grade will be based on the criteria contained in paragraph 401SP-5.02.I.6.

- D. The Commissioner may at any time, notwithstanding previous plant acceptance, reject and require the Contractor to dispose of any batch of bituminous mixture which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or improper mix temperature. Such rejection may be based on only visual inspection or temperature measurements.
- E. Air Voids: Evaluation for acceptance of each lot of plant- produced material for air voids must be based on PWL. The Contractor must target production quality to achieve 90 PWL or higher. Consistently producing at a target air void content between 3.3 and 4.7 percent with a standard deviation of 0.65 percent will result in an average PWL of 90.
- F. Mat Density: Evaluation for acceptance of each lot of in-place pavement for mat density must be based on PWL. The Contractor must target production quality to achieve 90 PWL or higher. Consistently producing at a target mat density of 94.5 percent with a standard deviation of 1.3 percent will result in an average PWL of 90.
- G. Joint Density: Evaluation for acceptance of each lot of in-place pavement for joint density must be based on PWL. The Contractor must target production quality to achieve 90 PWL or higher. Consistently producing at a target joint density of 92.8 percent with a standard deviation of 1.8 percent will result in an average PWL of 90. Consistently producing at a target joint density of 92 percent with a standard deviation of 1.8 percent will result in an average PWL of 80. Consistently producing at a target joint density of 91.5 percent with a standard deviation of 1.8 percent will result in an average PWL of 71.
- H. Percentage of Material Within Specification Limits (PWL): The percentage of material within specification limits (PWL) must be determined in accordance with procedures specified in Section Q-110 Method of Estimating Percentage of Material Within Specification Limits (PWL) of these Specifications. The specification tolerance limits (L) and (U) are contained in Table 5.

TABLE 5
Acceptance Limits

Test Property	Specification Tolerance Limits	
	Lower	Upper

Air Voids, (percent @ N _{des})	2.5	5.5
Mat Density (percentG _{mm})	92.8	
Joint Density (percentG _{mm})	90.5	

I. Acceptance Criteria:

1. Mat Density and Air Voids: If the PWL of the lot equals or exceeds 90 percent, the lot will be acceptable. Acceptance and payment for the lot must be made in accordance with paragraph 401SP-8.01.
2. Paragraph reserved.
3. Joint Density: If the PWL of the lot is equal to or exceeds 90 percent, the lot must be considered acceptable. If the PWL is less than 90 percent, the Contractor must evaluate the reason and act accordingly. If the PWL is less than 80 percent, the Contractor must cease operations until the reason for poor compaction can be determined. If the PWL is less than 71 percent, the lot pay factor for the first lot used to complete the joint must be reduced by 5 percentage points. This lot pay factor reduction must be incorporated and evaluated in accordance with paragraph 401SP-8.01.
4. Thickness: Thickness must be evaluated for compliance by the Commissioner to the requirements shown on the Plans. Measurements of thickness will be made by the Commissioner using the cores extracted for each subplot for density measurement.
5. Smoothness: The finished surfaces of the pavement must not vary more than 3/8" for the base course nor 1/4" for the surface course. Each night's paving or lot must be evaluated with a 16-foot rolling straightedge furnished and used by the Contractor. Testing must be performed by the Contractor following final rolling. The lot size must be 2,000 square yards. Measurements will be made perpendicular and parallel to the centerline at distances not to exceed 50 feet. When more than 15 percent of all measurements within a production run or lot exceed the specified tolerance, the Contractor must remove the deficient area and replace with new material. Sufficient material must be removed to allow at least one inch of asphalt concrete to be placed. Skin patching will not be permitted. High points may be ground off.
6. Grade: The finished surface of the pavement must not vary from the gradeline elevations and cross sections shown on the Plans by more than 1/2 inch. The finished grade of each lot

must be determined by running levels at intervals of 50 feet or less longitudinally and transversely to determine the elevation of the completed pavement. The lot size must be 2,000 square yards. When more than 15 percent of all the measurements within a lot are outside the specified tolerance, the Contractor must remove the deficient area and replace with new material. Sufficient material must be removed to allow at least 1-½ inch of asphalt concrete to be placed. Skin patching for correcting low areas will not be permitted. High points may be ground off.

- J. Outliers. All individual tests for mat density and air voids must be checked for outliers (test criterion) in accordance with ASTM E 178, at a significance level of 5 percent. Outliers must be discarded, and the PWL must be determined using the remaining test values. The outlier provision is used on the entire lot or resampled lot size only.

5.03 RESAMPLING PAVEMENT

- A. General: Resampling of a lot of pavement for mat density only must be allowed if the Contractor requests, in writing, within 48 hours after receiving the written test results from the Commissioner. A retest must consist of all the sampling and testing procedures contained in paragraphs 401SP-5.01.C and 401SP-5.02.F. Only one resampling per lot will be permitted.
 - 1. A redefined PWL must be calculated for the resampled lot. The number of tests used to calculate the redefined PWL must include the initial tests made for that lot plus the retests.
 - 2. The cost for resampling and retesting must be borne by the Contractor.
- B. Payment for Resampled Lots: The redefined PWL for a resampled lot will be used to calculate the payment for that lot in accordance with Table 6.
- C. Outliers: If the tests within a lot include a very large or a very small value which appears to be outside the normal limits of variation, check for an outlier in accordance with ASTM E 178, at a significance level of 5 percent, to determine if this value should be discarded when computing the PWL. The outlier provision is used on the entire lot or resampled lot size only.

PART 6 CONTRACTOR QUALITY CONTROL

6.01 GENERAL

- A. The Contractor must develop a Quality Control Program in accordance with Section Q-100 Quality Control Program of these Specifications. The program will address all elements which effect the quality of the pavement including, but not limited to:
1. Mix Design
 2. Aggregate Grading
 3. Quality of Materials
 4. Stockpile Management
 5. Proportioning
 6. Mixing and Transportation
 7. Placing and Finishing
 8. Joints
 9. Compaction
 10. Surface smoothness
 11. Assignment of Personnel

6.02 TESTING LABORATORY

- A. The Contractor must provide a fully equipped asphalt laboratory located at the plant. It will be available for joint use by the Contractor for quality control testing and by the Commissioner for acceptance testing and must have adequate calibrated equipment for the performance of the tests required by these Specifications. The Commissioner will have priority in use of the equipment necessary for acceptance testing.
- B. The effective working area of the laboratory must be a minimum of 250 square feet with a ceiling height of not less than 7.5 feet (2.3 meters). Lighting must be adequate to illuminate all working areas. It must be equipped with heating and air conditioning units to maintain a temperature of 70 degrees F + 5 degrees. Toilet facilities must be provided. A desk with a suitable chair must be provided. Exterior Lighting must meet the requirements of Section N-100 Night Construction. Restroom facilities must be provided as well as a supply of drinking water.

- C. Laboratory facilities must be kept clean and dry, and all equipment must be maintained in proper working condition by the Contractor. The Commissioner will be permitted unrestricted access to inspect the Contractor's laboratory facility and witness quality control activities. The Commissioner will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting test results, the incorporation of the materials into the work must be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

6.03 QUALITY CONTROL TESTING

- A. The Contractor must perform all quality control tests necessary to control the production and construction processes applicable to these Specifications and as set forth in the Quality Control Program or as requested by the Commissioner. The testing program must include, but not necessarily be limited to, tests for the control of asphalt content, voids, aggregate gradation, temperatures, aggregate moisture, field compaction, and surface smoothness. A Quality Control Testing Plan must be developed as part of the Quality Control Program.
- B. Asphalt Content: A minimum of two extraction tests must be performed per lot in accordance with ASTM D 2172 or ASTM D 6307 for determination of asphalt content. The weight of ash portion of the extraction test, as described in ASTM D 2172, must be determined as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. The last weight of ash value obtained must be used in the calculation of the asphalt content for the mixture.
 - 1. The use of a binder ignition oven for determining asphalt content in accordance with ASTM D 6307 (formerly PS90) is permitted, provided that it is calibrated in accordance with ASTM D 6307 or IDOT requirements for the specific mix being used. The calibration must be done on laboratory specimens only. This calibration must be provided to the Commissioner and approved prior to the start of production. The Commissioner reserves the right to verify the calibration of any equipment and refuse the use of the ignition oven if calibration is not consistent with a reflux verification run weekly.
- C. Gradation: Aggregate gradations must be determined a minimum of twice per lot from mechanical analysis of extracted aggregate in

accordance with AASHTO T 30 and ASTM C 136 (Dry Sieve). Two (2) gradations per lot must be run from the combined cold belt in accordance with ASTM C 136. If the asphalt content is determined by the ignition method, aggregate gradations must be determined from a mechanical analysis of the combined virgin aggregate, taken just prior to introduction into the dryer drum or mixer, and tested in accordance with ASTM C117 and ASTM C136 (Dry Sieve).

- D. Air Voids: For quality control, the Contractor must determine air voids in accordance with ASTM D3203 at a frequency indicated below.
1. The bulk specific gravity of gyratory specimen must be determined one per half day of production for the first 2 days and one per day thereafter (first specimen of the day) in accordance with ASTM D2726.
 2. The maximum specific gravity of the mixture must be determined one per half day of production for the first 2 days and one per day thereafter (first specimen of the day) in accordance with ASTM D2041.
- E. Fine Aggregate Angularity: The fine aggregate angularity of the fine aggregate used for production must be determined with the Job Mix Formula submittal and once per ____ ton *{Designer to determine frequency based on estimated total tonnage}* in accordance with AASHTO T304, Method A.
- F. Moisture Content of Aggregate: The moisture content of the aggregate used for production must be determined once per day, prior to production, in accordance with ASTM C 566.
- G. Moisture Content of Mixture: The moisture content of the mixture must be determined once per day, on the first lot, in accordance with ASTM D 1461. If it exceeds 0.5 percent by weight of dry mix, the Contractor must cease production until an action acceptable to the Commissioner is taken.
- H. Temperatures: Temperatures must be checked, at least four times per lot, at necessary locations to determine the temperatures of the dryer, the bitumen in the storage tank, the mixture at the plant, and the mixture at the job site.
- I. In-Place Density Monitoring: The Contractor must conduct any necessary testing to ensure that the specified density is being achieved. A correlated nuclear gauge must be used to monitor the pavement density in accordance with ASTM D 2950.

- J. Monitoring: The Commissioner reserves the right to monitor any or all of the above testing.
- K. Aggregate Quality: The Contractor must perform specific gravity and absorption tests on all aggregates used. These tests will be run at least one per week. If the specific gravity parameters vary more than plus or minus 10 percent of the values obtained in the mix design, the Contractor will be required to submit a new job mix formula.

6.04 SAMPLING

- A. When directed by the Commissioner, the Contractor must sample and test any material which appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling must be in accordance with standard procedures specified.

6.05 CONTROL CHARTS

- A. The Contractor must maintain computerized linear control charts both for individual measurements and range (i.e., difference between highest and lowest measurements) for aggregate gradation and asphalt content.
- B. Control charts must be posted on the wall at the plant laboratory and at other locations satisfactory to the Commissioner and must be submitted daily with the Quality Control Test Reports and kept current. As a minimum, the control charts must identify the project number, the Contract item number, the test number, each test parameter, the Action and Suspension Limits applicable to each test parameter, date printed and the Contractor's test results. The Contractor must use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor's projected data during production indicates a problem and the Contractor is not taking satisfactory corrective action, the Commissioner may suspend production or acceptance of the material.
- C. Individual Measurements: Control charts for individual measurements must be established to maintain process control within tolerance for aggregate gradation and asphalt content. The control charts must use the job mix formula target values as indicators of central tendency for the following test parameters with associated Action and Suspension Limits:

Control Chart Limits for Individual Measurements

Surface Course and Base Course

Sieve	Action Limit	Suspension Limit
1 inch	0 percent	0 percent
3/4 inch	+/-6 percent	+/-9 percent
1/2 inch	+/-6 percent	+/-9 percent
3/8 inch	+/-6 percent	+/-9 percent
No.4	+/-6 percent	+/-9 percent
No.16	+/-5 percent	+/-7.5 percent
No. 50	+/-3 percent	+/-4.5 percent
No. 200	+/-2 percent	+/-3 percent
Asphalt Content	+/-0.40 percent	+/-0.60 percent

- D. Range: Control charts for range must be established to control process variability for the test parameters and Suspension Limits listed below. The range must be computed for each lot as the difference between the two test results for each control parameter. The Suspension Limits specified below are based on a sample size of $n = 2$. Should the Contractor elect to perform more than two tests per lot, the Suspension Limits must be adjusted by multiplying the Suspension Limit by 1.18 for $n = 3$ and by 1.27 for $n = 4$.

Control Chart Limits Based on Range (Based on $n=2$)

Surface Course and Base Course

Sieve	Suspension Limit
3/4 inch	11 percent
1/2 inch	11 percent
3/8 inch	11 percent
No. 4	11 percent
No. 16	9 percent
No. 50	6 percent
No. 200	3.5 percent
Asphalt Content	0.8 percent

- E. Corrective Action: The Quality Control Plan must indicate that appropriate action must be taken when the process is out of tolerance. The Plan must contain sets of rules to gauge when a process is out of

control and detail what action will be taken to bring the process into control. As a minimum, a process must be deemed out of control and production stopped and corrective action taken, if:

1. One point falls outside the Suspension Limit line for individual measurements or range; or
2. Two points in a row fall outside the Action Limit line for individual measurements; or
3. Any Limit that falls outside the control points in Table 3.

PART 7 METHOD OF MEASUREMENT

7.01 MEASUREMENT

- A. Plant mix bituminous concrete pavement will be measured by the number of tons of bituminous mixture used in the accepted work. Recorded truck scale weights will be used to determine the basis for the tonnage. However, measurement will not be made for bituminous concrete pavement in excess of 103 percent of the theoretical weight as established by the approved mix design in tons as computed by the Commissioner.

PART 8 BASIS OF PAYMENT

8.01 PAYMENT

- A. Payment for an accepted lot of bituminous concrete pavement will be made at the Contract unit price per ton for bituminous mixture adjusted according to paragraph 401SP-8.01.B, subject to the limitation that:
 1. The total Project payment for the plant mix bituminous concrete pavement will not exceed 106 percent of the product of the Contract unit price and the total number of tons of bituminous mixture used, in accordance with Section 401SP-7.01, in the accepted work (See Note 1 under Table 6).
 2. The price will be compensation for furnishing all materials, for all preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and all work necessary to complete the item.
- B. Basis of Adjusted Payment: The pay factor for each individual lot will be calculated in accordance with Table 6. A pay factor will be calculated for both mat density and air voids. The lot pay factor will be the higher of the two values when calculations for both mat density and air voids are 100 percent or higher. The lot pay factor will be the product of the two values when only one of the calculations for either

mat density or air voids is 100 percent or higher. The lot pay factor will be the lower of the two values when calculations for both mat density and air voids are less than 100 percent. The lot pay factor will be reduced as necessary per paragraph 401SP-5.02.I.3 Joint Density.

TABLE 6
Price Adjustment Schedule¹

Percentage of Material Within the Specification Limit (PWL)	Lot Pay Factor (Percent of Contract Unit Price)
96 – 100	106
90 – 95	PWL + 10
75 – 89	0.5 PWL + 55
55 – 74	1.4 PWL – 12
Below 55	Reject ²

¹ Although it is theoretically possible to achieve a pay factor of 106 percent for each lot, actual payment above 100 percent will be subject to the total Project payment limitations specified in paragraph 401SP-8.01.

² The lot will be removed and replaced. However, the City may decide to allow the rejected lot to remain. In that case, if the City and Contractor agree by Contract Modification that the lot will not be removed, it will be paid for at 50 percent of the Contract unit price and the total Project payment limitation will be reduced by the amount withheld for the rejected lot.

1. For each lot accepted, the adjusted Contract unit price will be the product of the lot pay factor for the lot and the Contract unit price. Payment will be subject to the total Project payment limitation specified in paragraph 401SP-8.01. Payment in excess of 100 percent for accepted lots of bituminous concrete pavement will be used to offset payment for accepted lots of bituminous concrete pavement that achieve a lot pay factor less than 100 percent.
- C. The price will be compensation for furnishing all materials, for all preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and all work necessary to complete the item.
- D. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
P-401-01	BITUMINOUS CONCRETE SURFACE COURSE, PG76-22	TON
P-401-02	BITUMINOUS CONCRETE BASE COURSE, PG64-22	TON

END OF SECTION P-401(SP)

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ASPHALT-TREATED PERMEABLE BASE

SECTION P-404

PART 1 GENERAL

1.01 DESCRIPTION

- A. This work must consist of the construction of an asphalt-treated permeable base (ATPB) course, composed of granular materials stabilized with an asphalt binder. The ATPB must be constructed in accordance with these Specifications, and in conformity with the dimensions and typical cross sections shown on the Plans, and the lines and grades established by the Commissioner.

PART 2 PRODUCTS

2.01 AGGREGATE

- A. Aggregates must consist of crushed stone or crushed gravel with or without sand or other inert finely divided mineral aggregate. The portion of materials retained on the No. 4 sieve must be known as the coarse aggregate. The portion passing the No. 4 sieve and retained on the No. 200 sieve must be known as the fine aggregate, and the portion passing the No. 200 sieve as mineral filler.
- B. Coarse Aggregate: Coarse aggregate must consist of sound, tough, durable particles, free from coatings of clay, organic matter and other deleterious substances that would prevent thorough coating with the bituminous material. The percentage of wear must not be greater than 40 percent when tested in accordance with ASTM C131 (aggregates below 1-1/2 inches). The sodium sulfate soundness loss must not exceed 20 percent, after five cycles, when tested in accordance with ASTM C88.
 - 1. The source of coarse aggregate must be from quarried rock or river gravel. No slag will be permitted. All aggregates must have demonstrated a satisfactory service record under similar conditions of service and exposure.
 - 2. Aggregate must contain at least 75 percent by weight of crushed pieces having two or more fractured faces and must contain at least 90 percent by weight of crushed pieces having at least one fractured face with the area of each face being equal to at least 75 percent of the smallest midsectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures must be at least 30 degrees to

count as two fractured faces. Fractured faces must be obtained by artificial crushing.

3. The aggregate must not contain more than 8 percent, by weight, of flat or elongated pieces. A flat particle is one having a ratio of width to thickness greater than five; an elongated particle is one having a ratio of length to width greater than five.

C. Fine Aggregate: Fine aggregate must consist of clean, sound, durable, angular particles produced by crushing stone or gravel that meets the requirements for wear and soundness specified for coarse aggregate. The aggregate particles must be free from coatings of clay, silt, or other objectionable matter and must contain no clay balls. The fine aggregate, including any blended filler, must have a plasticity index of not more than six (6) and a liquid limit of not more than twenty-five (25) when tested in accordance with ASTM D4318.

1. Natural sand may be used to obtain the gradation of the aggregate blend or to improve the workability of the mix. The amount of sand to be added must be adjusted to produce mixtures conforming to requirements of this Specification. The percentage of natural sand must be kept below fifteen (15) percent to obtain optimum pavement properties as the addition of natural sand tends to decrease stability of pavement.
2. The aggregate must have sand equivalent values of 30 or greater when tested in accordance with ASTM D2419. Contractor to submit test results to the Commissioner.

D. Sampling and Testing: All aggregate samples required for testing must be furnished by the Contractor and tested by an independent certified laboratory chosen by the Contractor and approved by the Commissioner. ASTM D75 must be used in sampling coarse aggregate and fine aggregate and ASTM C183 must be used in sampling mineral filler. Samples must be large enough to provide ample material to the satisfaction of the Commissioner. All tests for initial aggregate submittals necessary to determine compliance with requirements specified herein must be made by the Contractor and costs for testing will be borne by the Contractor. Sampling may be observed and supervised by the Commissioner. No aggregate will be used in the production of mixtures without prior approval.

E. Sources of Aggregates: Sources of aggregates must be selected well in advance of the time the materials are required in the work. When the aggregates are obtained from a previously approved source or from an existing source that has satisfactory service record in Airport bituminous pavement construction, samples must be submitted 14

days prior to start of production. An inspection of the producer's operation must be made by the Commissioner prior to production. When new sources are to be developed, the Contractor must indicate the sources and must submit a plan for operation 30 days in advance of starting production. The Contractor must submit all samples from test pits, borings, and other excavations at the same time. Approval of the source of aggregate does not relieve the Contractor in any way of the responsibility for delivery at the job site of aggregates that meet the requirements specified herein.

- F. Samples of Aggregates: The Contractor must furnish samples of aggregates at the start of production and at intervals of every 5,000 tons or as directed by the Commissioner during production of bituminous mixtures. The sampling points and intervals will be designated by the Commissioner. The samples shall be the basis of approval of specific lots of aggregates from the standpoint of the quality requirements of this Section.

2.02 BITUMINOUS MATERIAL

- A. Bituminous material must conform to the following requirement:

Type and Grade Asphalt Cement	Specification
PG 64 – 22	AASHTO MP1

- B. In no case will mixing be permitted at a temperature of less than 275 degrees or greater than 325 degrees F.
- C. The Contractor must furnish vendor's certified test reports for each tankload of bitumen shipped to the Project. The report must be delivered to the Commissioner before permission is granted for use of the material. The furnishing of the vendor's certified test report for the bituminous material must be the basis for final acceptance.

2.03 COMPOSITION OF MIXTURE

- A. The bituminous plant mix must be composed of a mixture of aggregate and bituminous material. The several aggregate fractions must be sized, uniformly graded, and combined in such portions that the resulting mixture meets the grading requirements of the job mix formula.

2.04 JOB MIX FORMULA

- A. No bituminous mixture for payment will be produced until a job mix formula has been approved by the Commissioner. The formula must

be submitted in writing by the Contractor to the Commissioner at least 20 days prior to the start of paving operations and must indicate the definite percentage of each sieve fraction of aggregate, the percentage of bitumen, and the temperature of the completed mixture when discharged from the mixer. All test data used to develop the job mix formula must also be submitted. The job mix formula for each mixture must be in effect until modified in writing by the Commissioner. Should a change in sources of materials be made, a new job mix formula must be established before the new material is used.

- B. Reclaimed Asphalt Pavement (RAP), Fractionated RAP (FRAP), and Reclaimed Asphalt Shingles (RAS) may be used subject to the applicable requirements of the IDOT Special Provision *Reclaimed Asphalt Pavement and Reclaimed Asphalt Shingles (BDE)* Effective: November 1, 2012; Revised: April 1, 2014 or latest, except as amended herein:
1. Description, production, stockpiling, and testing of RAP, FRAP, and RAS (Type 1 and Type 2) shall meet all requirements of the IDOT Special Provision.
 2. The percentage of virgin asphalt binder replacement when RAP is used alone or RAP is used in conjunction with RAS, shall not exceed the amounts listed in the Table for RAP/RAS Maximum Asphalt Binder Replacement (ABR) Percentage for the given N Design, and base/binder or surface course designations.
 3. The percentage of virgin asphalt binders replacement when FRAP is used alone or FRAP is used in conjunction with RAS, shall not exceed the amounts listed in the Table for FRAP/RAS Maximum Asphalt Binder Replacement (ABR) Percentage for the given N Design, and base/binder or surface course designations.
 4. When the RAP/RAS ABR or the FRAP/RAS ABR exceed 20 percent, the high and low virgin asphalt binder grades shall each be reduced by one grade (i.e., 21 percent ABR would require a virgin asphalt binder grade of PG64-22 to be reduced to PG58-28).
 5. The total bitumen content percentage by weight for the entire ATPB mix must be in accordance with Table 2 herein.
- C. All aggregate samples required for testing must be furnished by the Contractor at his/her own expense. Sampling must be in accordance with ASTM D75 and will be observed by the Commissioner if required. No aggregate will be used in production of mixtures without the

Commissioner's prior approval. The aggregate must have the properties shown in Table 1.

TABLE 1
ATPB Aggregate Properties

Property	Acceptable	ASTM Test
Effective Porosity	0.25	C29, C127

- D. The ATPB must conform to the gradation and bitumen content limits specified in Table 2.

TABLE 2
ATPB Aggregate Gradation and Bitumen Content

Sieve Size	Percentage by Weight Passing Sieves
1-1/2 inch	100
1 inch	90-100
1/2 inch	25-60
No. 4	0-10
No. 8	0-5
No. 200	0-4
Bitumen Content	1.0 - 3.5 percent

- E. The Contractor must establish the percent of bitumen to be used in the ATPB based on the results of tests of aggregate and based on the observed performance and plant and field tests on the ATPB during the test section specified hereinafter. Further, the Commissioner reserves the right to vary the percent of bitumen of all bituminous mixtures during production as necessary to provide for full coating of all aggregate particles yet provide minimum draindown of bitumen. The bitumen content may be adjusted within the limits of Table 1 without adjustments in the Contract unit price.
- F. The Contractor must use an approved heat-stable anti-stripping additive. The anti-stripping additive will meet the approval of the Commissioner based on the results of laboratory tests. The additive must be added to the asphalt tank at the recommended dosage (0.5 to 1.0 percent by weight of asphalt cement) and must be thoroughly mixed by circulation of the asphalt for at least 4 hours prior to being incorporated into the mix.

- G. The job mix tolerance shown in Table 3 must be applied to the job mix formula to establish a job control grading band. The full tolerances still must apply if application of the job mix tolerances results in a job control grading band outside the master grading band based on Table 2, except the upper three sieve sizes in each column must be within the master band.

TABLE 3
Job Mix Formula Tolerances
(Based on a Single Test)

Material	Tolerance- plus or minus
Aggregate passing No. 4 sieve or larger	7 percent
Aggregate passing No. 8 and 16 sieves	6 percent
Aggregate passing No. 30 and 50 sieves	5 percent
Aggregate passing No. 100 and 200 sieves	2 percent
Bitumen Content (Individual Tests)	0.45 percent
Bitumen Content (Moving avg. of last 5)	0.25 percent variation
Temperature of mix	20 Degrees F

- H. The aggregate gradation may be adjusted within the limits of Table 3 as directed, without adjustments in the Contract unit prices.
- I. Deviation from the final approved design for bitumen content and gradation of aggregates will not be greater than the tolerances permitted and must be based on daily plant reflux extraction. Reflux extraction tests for bitumen content and aggregate gradation must be made at least twice daily for AC content and gradation by the Contractor. The mixtures must be tested for bitumen content in accordance with ASTM D2172 and for aggregate gradation in accordance with AASHTO T30. Should a change in sources of materials be made, a new job mix formula must be established before the new material is used. This will require a new submittal and test section.

2.05 TEST SECTION

- A. Prior to full production, the Contractor must prepare a quantity of bituminous mixture according to the job adjusted mix formula. The amount of mixture should be sufficient to construct a test section 300 feet long and 2 pavers wide and must be of the same depth specified for the construction as the course which it represents. If the Project involves P-401SP Plant Mix Bituminous Pavement (Superpave) that

must be constructed on the ATPB, the size of the test section area for the ATPB must match that of the P-401SP test section. The underlying grade or pavement structure upon which the test section is to be constructed must be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section must be the same as that to be used on the remainder of the course represented by the test section. If equipment must change, it must be submitted and will be audited by the Commissioner for approval prior to its use.

- B. For the ATPB, plant material must be taken to determine aggregate gradation and bitumen content. Density tests need not be performed. In no case will the plant-produced mix be considered acceptable if the mix properties of the test section do not meet the requirements of the mix design criteria.
- C. If the test section should prove to be unsatisfactory, the necessary adjustments to the mix design, plant operation, and/or rolling procedures must be made. Additional test sections, as required, must be constructed and evaluated for conformance to the Specifications. When test sections do not conform to Specification requirements, the pavement must be removed and replaced at the Contractor's expense. A marginal quality test section that has been placed in an area of little or no traffic may be left in place at the discretion of the Commissioner. If a second test section also does not meet Specification requirements, both sections must be removed at the Contractor's expense. Full production will not begin without the Commissioner's approval of the test section. The test section that conforms to the Specifications requirements will be paid for in accordance with Paragraph 5.01.

2.06 QUALITY CONTROL

- A. General: The Commissioner must provide and maintain a quality assurance system that will require the Contractor to provide quality materials and completed construction submitted for acceptance in conformance with to the Contract requirements whether manufactured or processed by the Contractor, or procured from Subcontractors or vendors.
- B. A job mix must be required by Paragraph 2.03 of this Specification, prior to start of production and whenever a change in materials warrants retesting.
- C. Quality Control Deficiencies: The Contractor must take prompt action to correct any errors, equipment malfunction, process changes, or

other assignable causes which have resulted or could result in submission of materials and completed construction which do not conform to the requirements of the Specifications.

- D. Tolerances: After the adjusted job mix formula is approved, the Contractor must control the aggregate gradations, the percent bitumen, and the mix temperature within the tolerances specified herein. Failure to meet the control tolerances must be cause to suspend production until the Contractor has identified and corrected the operation to within the job mix tolerances. Continued production without correction may result in rejection and removal of the material.

2.07 TESTING LABORATORY

The independent certified testing laboratory hired by the Contractor to develop the job mix formula and to perform the tests required by this Specification must meet the requirements of ASTM D3666. A certification that the laboratory meets these requirements will be submitted to the Commissioner.

PART 3 EXECUTION

3.01 WEATHER LIMITATION

- A. The bituminous mixture must not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 4. The temperature requirements may be waived, but only at the discretion of the Commissioner, if requested in writing by the Contractor.

TABLE 4
Base Temperature Limitations

Mat Thickness	Base Temperature (Minimum) Degrees F
3 inches or greater	40
Greater than 1 inch but less than 3 inches	45

3.02 BITUMINOUS MIXING PLANT

- A. Plants used for the preparation of bituminous mixtures must conform to the requirements of ASTM D995 with the following changes:
1. All plants must conform to Article 1102.01 of the IDOT SSRBC, latest edition. The plants must be subjected to the prequalification procedures for all mix types and classes. The

plants must meet all requirements of the latest issues of the IDOT "Policy Memorandums" and permissive use for each mix type to be produced.

2. Requirements for all Plants.

- a. Truck scales. The bituminous mixture must be weighed on approved scales furnished by the Contractor, onsite or otherwise, at the Contractor's expense. Such scales must be inspected and sealed by the Department of Agriculture as often as the Commissioner deems necessary to assure their accuracy. Surge bin weight will not be used or accepted for any payment items.
- b. Testing Laboratory. The Contractor or producer must provide laboratory facilities for control and acceptance testing functions during periods of mix production, sampling, and testing and whenever materials subject to the provisions of these Specifications are being supplied or tested. The laboratory must provide adequate equipment, space, and utilities as required for the performance of the specified tests.
- c. Inspection of Plant. The Commissioner or authorized representative, must have access, at all times, to all parts of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and character of materials; and checking the temperatures maintained in the preparation of the mixtures.
- d. Storage Bins and Surge Bins. Paragraph 3.9 of ASTM D995 is deleted. Instead, the following applies. Use of surge bins or storage bins for temporary storage of hot bituminous mixtures will be permitted as follows:
 - (1) The bituminous mixture may be stored in surge bins as directed by the Commissioner for a period of time not to exceed 3 hours.
 - (2) The bituminous mixture may NOT be stored in insulated storage bins.

3.03 HAULING EQUIPMENT

- A. Trucks used for hauling bituminous mixtures must have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, the truck beds must be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Each truck must

have tarps to protect the mixture from adverse weather. When necessary, to ensure that the mixture must be delivered to the site at the specified temperature, truck beds must be insulated or heated and covers must be securely fastened.

3.04 BITUMINOUS PAVERS

- A. Bituminous pavers must be self-contained, power-propelled units with an activated screed or strike-off assembly, heated if necessary, and must be capable of spreading and finishing courses of bituminous plant mix material which will meet the specified thickness, smoothness, and grade. Pavers used for shoulders and similar construction must be capable of spreading and finishing courses of bituminous plant mix material in widths shown on the Plans.
- B. The paver must have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper must be equipped with a distribution system to place the mixture uniformly in front of the screed. The screed or strike-off assembly must effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.
- C. The paver must be capable of operating at forward speeds of not more than 40 feet per minute consistent with satisfactory laying of the mixture and placing the ATPB in one 6-inch lift.
- D. The paver must be equipped with a control system capable of automatically maintaining the specified screed elevation. The control system must be automatically actuated from either a reference line or surface through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller must be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent.
- E. The controls must be capable of working in conjunction with the following attachments:
 - 1. Ski-type device of not less than 30 feet in length or as directed by the Commissioner
 - 2. Taut stringline (wire) set to grade
 - 3. Laser
 - 4. Short ski or shoe

3.05 ROLLERS

- A. An approved steel wheel roller, weighing not less than 8 tons nor more than 12 tons and having a unit compression on the drive wheels of not less than 250 nor more than 400 pounds per inch of roller width, must be used to compact the mix. Vibratory rollers meeting the above requirements may be used to compact the ATPB provided the vibratory unit is turned off. Rollers must be in good condition, capable of operating at slow speeds to avoid displacement of the bituminous mixture. The number, type, and weight of rollers must be sufficient to compact the mixture to the required density while it is still in a workable condition.
- B. The use of equipment which causes excessive crushing of the aggregate will not be permitted.

3.06 PREPARATION OF BITUMINOUS MATERIAL

- A. Bituminous material must be heated in a manner that must avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature. The temperature of the bituminous material delivered to the mixer must be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles but must not exceed 325 degrees F.

3.07 PREPARATION OF MINERAL AGGREGATE

- A. The aggregate for the mixture must be dried and heated to the temperature designated by the job formula within the job tolerance specified. The maximum temperature and rate of heating must be such that no permanent damage occurs to the aggregates. Particular care must be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature must not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

3.08 PREPARATION OF BITUMINOUS MIXTURES

- A. The aggregates and the bituminous material must be weighed or metered and introduced into the mixer in the amount specified by the job mix formula.
- B. The combined materials must be mixed until the aggregate obtains a uniform coating of bitumen and is thoroughly distributed throughout the mixture. Wet mixing time must be the shortest time that must produce

a satisfactory mixture. It must be established by the Contractor, based on the procedure for determining the percentage of coated particles described in ASTM D2489, and approved by the Commissioner for each individual plant and for each type of aggregate used. The minimum mixing time must be 25 seconds. The mixing time must be set to achieve uniform coating of the particles. For continuous mix plants, the minimum mixing time must be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the mixer. The moisture content of the mix must not exceed 1.0 percent.

3.09 TRANSPORTING, SPREADING, AND FINISHING

- A. The mixture must be transported from the mixing plant to the point of use in vehicles conforming to the requirements of Paragraph 3.03. Deliveries must be scheduled so that spreading and rolling of all mixture prepared for one day's run can be completed during daylight, unless adequate artificial lighting is provided. Hauling over freshly placed material will not be permitted until the material has been compacted, as specified, and allowed to cool to atmospheric temperature.
- B. Immediately before placing the bituminous mixture, the underlying course must be cleared of all debris with power blowers, power brooms, or hand brooms or as directed by the Commissioner to achieve a clean, dry surface.
- C. The mix must be placed at a temperature of not less than 250 degrees F. In addition, the ATPB must be spread only when the atmospheric temperature is above 40 degrees F.
- D. Upon arrival, the ATPB must be spread to the full width by an approved bituminous paver. The ATPB must be placed and compacted in a single lift and must conform to the grade and contour indicated on the Drawings. Automatic grade control must be used for placement of the permeable base. Grade control must be wire or string reference lines for elevation and alignment. When string lines are required, they must consist of piano wire or other approved material. The string lines must be supported at a minimum of 25-foot centers. Additional supports must be installed to prevent sag, if required. The horizontal alignment of the string lines must be within $\pm 1/4$ inch per 10 feet. The Contractor must provide a satisfactory method of securing the string line where vertical curves are constructed to maintain the proper grade.
- E. After the first lane is constructed, the joint matcher (short ski) must be

used on the previously laid lane. The free edge must be controlled as specified herein. The automatic transverse grade control device must be used only when one paving lane of each side of the high point of the pavement is to be constructed. Example: One lane pavement or two lane crowned pavement.

- F. The control system must be automatically actuated from the reference line through a system of mechanical sensors or sensor-directed mechanisms or devices which must maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The speed of a paver must be regulated to eliminate pulling and tearing of the bituminous mat. Unless otherwise directed, placement of the mixture must begin along the centerline of a crowned section or on the high side of areas with a one-way slope. The mixture must be placed in consecutive adjacent strips having a minimum width of 25 feet except where edge lanes require less width to complete the area. Additional wings and augers must be used. Transverse joints in adjacent lanes must be offset a minimum of 10 feet.
- G. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread, raked, and luted by hand tools.

3.10 COMPACTION OF MIXTURE

- A. After spreading, the mixture must be thoroughly and uniformly compacted by rolling. Rolling of the ATPB must begin when the temperature of the mixture is less than 150 degrees F and must be completed before the mixture is less than 100 degrees F. Water must not be used to cool the mixture. The sequence of rolling operations must be at the discretion of the Contractor. The Commissioner reserves the right to increase or decrease the specified number of roller coverages and the specified temperature limits for rolling during construction based on observed performance from the test section or production placement of the ATPB.
- B. Sufficient rollers must be furnished to handle the output of the plant. Rolling must continue until all roller marks are eliminated, the surface is of uniform texture and true to grade and cross section. In areas not accessible to the roller, the mixture must be thoroughly compacted with hot hand tampers.
- C. The speed of the roller must, at all times, be sufficiently slow to avoid displacement of the hot mixture. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause,

must be corrected at once. To prevent adhesion of the mixture to the roller, the wheels must be kept properly moistened, but excessive water will not be permitted.

- D. Any mixture that becomes loose and broken, mixed with dirt, or in any way defective must be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work must be done at the Contractor's expense. Skin patching will not be allowed.

3.11 JOINTS

- A. The formation of all joints must be made in such a manner as to ensure a continuous bond between old and new sections of the course. All joints must have the same texture, density, and smoothness as other sections of the course.
- B. The roller must not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint, it must be made by means of placing a bulkhead or by tapering the course, in which case the edge must be cut back to its full depth and width on a straight line to expose a vertical face. In both methods all contact surfaces must be given a tack coat of bituminous material before placing any fresh mixture against the joint.
- C. Longitudinal joints which are irregular, damaged, or otherwise defective must be cut back to expose a clean, sound surface for the full depth of the course. All contact surface must be given a tack coat of bituminous material prior to placing any fresh mixture against the joint.

3.12 SURFACE TESTS

- A. Tests for conformity with the specified crown and grade must be made by the Contractor immediately after initial compaction. Any variation must be corrected by the removal or addition of materials and by continuous rolling as described in this Section. Tabular summary of straight edge records and location will be given to the Commissioner.
- B. After the ATPB has been compacted, the surface must be tested by the Contractor and furnished to the Commissioner for smoothness and conformance to the elevations shown on the Drawings. The finished surface must not vary more than 3/8 inch when tested with a 16-foot straightedge supplied by the Contractor, applied parallel with and at right angles to the centerline at a distance not to exceed 50 feet, nor

more than 0.05 feet from the elevations shown on the Drawings.

- C. An ATPB with a surface higher than 0.05 feet above the plan elevation or with a surface variation exceeding the specified tolerances must be removed and replaced with ATPB which complies with these Specifications. If approved by the Commissioner, the high spots may be removed to within specified tolerance by any method that does not produce contaminating fines nor damage the ATPB to remain in place. Grinding will not be permitted.
- D. Hardened ATPB with a surface lower than 0.05 feet below plan elevations shown must be removed and replaced with ATPB which complies with these Specifications, unless approved by the Commissioner.

3.13 PROTECTION OF ATPB

- A. Care must be exercised to prevent contamination or damage to previously completed ATPB. The Contractor must only place an amount of ATPB that can be covered by the overlying course in 5 days.
- B. Construction equipment other than hauling and paving equipment necessary for placement of the overlying course must not operate on the finished ATPB. Material hauling trucks and other equipment must be operated in a manner to minimize the amount of mud and dirt carried onto the ATPB. If necessary, equipment must be cleaned of mud and dirt prior to operation on the ATPB.
- C. Equipment must be operated in a manner to prevent damage to the completed ATPB. Equipment must avoid rapid acceleration, hard braking, or sharp turning.
- D. Any ATPB which, in the opinion of the Commissioner, has become contaminated or damaged must be removed and replaced by the Contractor with ATPB which conforms to these Specification requirements, at the Contractor's sole expense.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. ATPB will be measured by the number of tons of bituminous mixture used in the accepted work. Recorded truck scale weights will be used to determine the basis for the tonnage.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment for an accepted ATPB will be made at the Contract unit price per ton. The price will be full compensation for furnishing all materials, for all preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and all work necessary to complete the item.
- B. Payment will be made under the following item:

ITEM NO.	DESCRIPTION	UOM
P-404-01	ASPHALT TREATED PERMEABLE BASE COURSE	TON

END OF SECTION P-404

BITUMINOUS CONCRETE PAVEMENTS

SECTION P-405

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Work under this Section is subject to the requirements of the Contract Documents.
- B. Furnish and install all Bituminous Concrete Pavements as shown on the Drawings and as specified herein, including but not limited to the following:

Furnishing, placing and compacting bituminous base, binder and surface courses.

This work will apply to the base course under the PCC pavement and the bituminous components of the runway and taxiway shoulders, blast pads and the snow equipment staging area. This work also applies to roadways, parking areas, and temporary bituminous pavement.

1.02 RELATED WORK

- A. Section P-602 - Bituminous Prime Coat
- B. Section P-603 - Bituminous Tack Coat

1.03 REFERENCES

- A. "Standard Specifications for Road and Bridge Construction" (SSRBC), Illinois Department of Transportation, latest edition.

1.04 IDOT Special Provision *Reclaimed Asphalt Pavement and Reclaimed Asphalt Shingles (BDE)* Effective: November 1, 2012; Revised: April 1, 2014 SUBMITTALS

- A. Submit the following:
 - 1. Mix Designs for Base, Binder and Surface courses
 - 2. Current material certifications from IDOT

1.05 SPECIAL REQUIREMENTS

- A. Reference Standards - The work is subject to the requirements of applicable portions of Section 355 (Base Course), Section 406 (Binder

and Surface Courses), Section 1030, Section 1031 and other articles referenced within Sections 355, 406, 1030, 1031 or other Sections or Articles cited elsewhere in this Specifications of the following:

1. "Standard Specifications for Road and Bridge Construction" prepared by the Illinois Department of Transportation, latest edition, and the supplemental Specifications and recurring special provisions (separate book). The "Standard Specifications for Road and Bridge Construction" is referred to in the following Articles as the "Standard Specifications" and except as may be otherwise stated, the work to be done under this Section must conform to the requirements of said "Standard Specifications."
2. Where the "Standard Specifications" refer to the "Engineer" it will be understood to mean "Commissioner", except in cases where it is deemed to be QC testing by the Contractor.
3. This work is subject to applicable provisions of the latest IDOT special provision on requirements for Hamburg Wheel and Tensile Strength testing during the mix design and during production. Refer to the latest *IDOT Hot Mix Asphalt-Mix Design Verification and Production (BDE)* Effective November 1, 2013 for the Hamburg Wheel and Tensile Strength tests criteria.
4. The work is subject to provisions of the IDOT Special Provision on *Reclaimed Asphalt Pavement and Reclaimed Asphalt Shingles (BDE)* Effective: November 1, 2012; Revised: April 1, 2014 or latest.
5. Prime coat and tack coat must be in accordance with Sections P-602 Bituminous Prime Coat and P-603 Bituminous Tack Coat, respectively.
6. Standard Specifications articles referring to "Method of Measurement" and Basis of Payment" are not applicable.
7. Asphalt plants must meet the requirements of SSRBC Article 1102.01 for hot-mix asphalt (HMA) inclusive of policy memoranda and permissive use per mix Class I or otherwise.

1.06 QUALITY CONTROL AND QUALITY ASSURANCE (QC/QA)

- A. QC/QA for the work must be in accordance with Article 1030.05 of the Standard Specifications.

1. Quality control of bituminous production and paving including providing testing laboratory at the plant, all QC tests and inspections at the plant and in the field, corrective actions, maintenance of QC plan and control charts and other quality control activities required in Article 1030.05 of the Standard Specifications will be performed by the Contractor. The cost for all QC testing will be borne by the Contractor and included in the price for the bituminous concrete pavements.
2. Quality assurance bituminous paving inspections and tests specified herein, or deemed required by the Commissioner, will be performed by a testing laboratory employed by the Commissioner. The Contractor must cooperate with said testing laboratory in every respect by providing samples for testing and necessary facilities at the job site for field tests and sample procurement. Patch all cuts made for test samples. The cost for QA testing will be paid by the Commissioner.
3. Tests must include analysis and determination of the quality of various bituminous compositions, base material, and compaction of bituminous paving, verifying design as indicated or required.

1.07 WARRANTIES AND GUARANTEES

- A. The Contractor must repair or replace defective materials and workmanship during the Contract Period and for one (1) year from the date of Substantial Completion of the Project.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials must be of the best quality throughout, using approved aggregates and bituminous materials.

Coarse and fine aggregates must be supplied from sources certified per the Aggregate Gradations Control System (AGCS) by the IDOT Bureau of Materials and Physical Research. Certifications must be submitted to the Commissioner.

It is the intent of the Specifications to indicate the standards of construction desired and the Contractor must, before starting this work, submit to the Commissioner for approval, mix proportions he intends to use and the means and methods of construction he intends to employ. The Contractor must provide a certified technician to

monitor the rolling pattern and compaction of the bituminous courses and control the paving process to maintain the complete installation within Specifications.

- B. Reclaimed Asphalt Pavement (RAP) may be used subject to applicable requirements of the IDOT Special Provision *Reclaimed Asphalt Pavement and Reclaimed Asphalt Shingles (BDE)* Effective: November 1, 2012; Revised: April 1, 2014 or latest.
 - 1. Description, production, stockpiling, and testing of RAP shall meet all requirements of the IDOT Special Provision.
 - 2. The percentage of virgin asphalt binder replacement when RAP is used alone or RAP is used in conjunction with RAS, shall not exceed the amounts listed in the Table for RAP/RAS Maximum Asphalt Binder Replacement (ABR) Percentage for the given N Design, and base/binder or surface course designations.
 - 3. When the RAP exceed 20 percent, the high and low virgin asphalt binder grades shall each be reduced by one grade (i.e., 21 percent ABR would require a virgin asphalt binder grade of PG64-22 to be reduced to PG58-28).
- C. Bituminous base course under runway and taxiway concrete mainline pavements must be in accordance with Section 355 of the "Standards Specifications."
- D. Bituminous surface course on runway shoulders and taxiway shoulders must be in accordance with Section 406 of the "Standards Specifications."
- E. Bituminous concrete base course for runway shoulders and taxiway shoulders must be as specified in Section 355 of the "Standards Specifications."
- F. Bituminous mixes for airside and landside roadways and pavements must be in accordance with Section 406 (for surface and binder courses) and Section 355 (for base course) of the "Standard Specifications."
- G. Protection - Protect materials against damage from mechanical abuse, salts, acids, and other foreign matter by an approved means during transportation, storage and placement and until completion of construction work. All unsatisfactory materials must be removed from the premises, and all damaged materials replaced with new.

P-405 BITUMINOUS CONCRETE PAVEMENT MIX DESIGN PARAMETERS

AIRFIELD (AIRSIDE) PAVEMENTS							
PAVEMENT USAGE	N DESIGN	IDOT MIX DESIGNATION	BASE/BINDER/SURFACE COURSE	THICKNESS (Inches)	AIR VOIDS	ASPHALT BINDER	MAX. ABR for RAP, RAP/RAS, FRAP, FRAP/RAS (1)
Taxiway Base Course Under PCC Pavement	50	IL-19.0	Base	6	4%	PG 58-22	(1)
Runway/Taxiway Shoulders, Blast Pad	70	IL-9.5 or IL-12.5	Surface	3	4%	PG 64-22	(1)
	50	IL-19.0	Base	4	2%	PG 58-22	(1)
Airside Service Road	70	IL-9.5 or IL-12.5	Surface	2	4%	PG 64-22	(1)
	70	IL-19.0	Binder	3	4%	PG 64-22	(1)
	50	IL-19.0	Base	6	2%	PG 58-22	(1)
	70	IL-19.0	Binder	6	4%	PG 64-22	(1)
Perimeter Road	70	IL-9.5 or IL-12.5	Surface	1 1/2	4%	PG 64-22	(1)
	70	IL-19.0	Binder	2 1/2	4%	PG 64-22	(1)
(1) Maximum ABR for RAP, RAP/RAS, FRAP, FRAP/RAS as allowed per IDOT Special Provision <i>Reclaimed Asphalt Pavement and Reclaimed Asphalt Shingles (BDE)</i> Effective: November 1, 2012; Revised: April 1, 2014 or latest							

PART 3 EXECUTION

3.01 INSPECTION

- A. The Contractor must not commence bituminous paving work in this Section until the underlying course has been accepted by the Commissioner. This must be agreed to in a written document by the Contractor and the Commissioner.

3.02 MATERIAL TRANSFER DEVICE

- A. The Material Transfer Device must be used for the placement of the bituminous concrete base, binder and surface courses on the Taxiways, and Shoulders. The Material Transfer Device speed must be adjusted to the speed of the paver to maintain a continuous, nonstop paving operation.
- B. The Material Transfer Device must have a minimum surge capacity of 25 tons, must be self-propelled and capable of moving independently of the paver, and must be equipped with the following:

1. Front Dump Hopper and Conveyor. The conveyor must provide a positive restraint along the sides of the conveyor to prevent material spillage.
2. Paver Hopper Insert. The paver hopper insert must have a minimum capacity of 14 tons.
3. Mixer/Agitator Mechanism. This re-mixing mechanism must consist of a segmented, anti-segregation, re-mixing auger or two full length longitudinal paddle mixers designed for the purpose of re-mixing the bituminous material. The longitudinal paddle mixers must be located in the paver hopper insert.

3.03 INSTALLATION

- A. The pavements must be finished to indicated grades, slopes and elevations and must meet existing or established grades as applicable. All work required to adapt to existing conditions to obtain proper transition between the new work and the existing must be performed. No depressions or waves will be permitted over 1/4 inch in 10 feet, non-cumulative. Bituminous concrete must not be placed upon a wet surface or when the temperature of the underlying course is less than specified in Table 1. The temperature requirements may be waived by the Commissioner, if requested in writing and a cold weather paving plan has been submitted and approved; however, all other requirements including compaction must be met.

TABLE 1
Base Temperature Limitations

Mat Thickness	Base Temperature Deg. F
3 in. or greater	40
Greater than 1 in. but less than 3 in.	45
1 in. or less	50

- B. The underlying course must have been previously placed and compacted as specified in the applicable Sections of the Specifications. Before proceeding, the Contractor must carefully examine the underlying course and must perform any minor grading, shaping, filling or other preparatory work required, in the opinion of the testing laboratory or the Commissioner, to properly install the bituminous pavement.
- C. Bituminous concrete base course under runway shoulders and taxiway shoulders must be placed as Specified in Section 355 of the "Standard Specifications."

- D. Bituminous concrete binder and surface courses must be placed as specified in Section 406 of the "Standard Specifications." Rolling must be done on each of the separate courses by utilizing a test strip to determine the maximum obtainable density and must be continued until the required density is obtained. If there is any doubt as to the adequacy of the bituminous courses, cores must be taken and density checked as specified in Section 406 of the Standard Specifications to determine if the placed mix conforms to the approved mix.
- E. Protection - Adequate barriers must be provided to prevent the movement of traffic over the bituminous pavement until it has set for at least 24 hours. Also, the Contractor must be responsible for any damage to adjacent pavements caused by the paving operations.
- F. Inspection - All thicknesses shown on the Plans are measured after compaction and are subject to inspection and approval. The Contractor must patch any cuts made for inspection and density tests, as part of the work. Tolerances in surface must be as specified.

3.04 GENERAL CLEAN-UP

- A. All rubbish and debris resulting from the Work of this Section must be collected, removed from the site and disposed of legally.
- B. All work areas must be left in a broom clean condition.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Bituminous Concrete Pavements will be measured by the number of tons of each bituminous mixture used in the accepted work in accordance with SSRBC Article 406.13. Recorded truck scale weights will be used to determine the basis for the tonnage. However, payment will not be made for bituminous mixture in excess of 103% of the theoretical weight in tons as computed by the Commissioner.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment for Bituminous Concrete Pavements will be made at the Contract unit price per ton for each bituminous mixture placed and accepted by the Commissioner. The price will be full compensation for furnishing all materials, for all preparation, mixing and placing of those materials, and for all labor, equipment, tools and all work necessary to complete the item.

B. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
P-405-01	BITUMINOUS CONCRETE BASE COURSE (IDOT BINDER IL-19.0, N50)	TON
P-405-02	BITUMINOUS CONCRETE BINDER COURSE (IDOT BINDER IL-19.0, N70)	TON
P-405-03	BITUMINOUS CONCRETE SURFACE COURSE (IDOT SURFACE IL-9.5, N70)	TON
P-405-04	BITUMINOUS CONCRETE SURFACE COURSE - SHOULDERS (IDOT SURFACE IL- 9.5, N70)	TON

END OF SECTION P-405

PORTLAND CEMENT CONCRETE (PCC) PAVEMENT

ITEM P-501

PART 1 DESCRIPTION

1.01 GENERAL

- A. This work must consist of pavement composed of Portland cement concrete (PCC), with reinforcement or without reinforcement, constructed on a prepared underlying surface in accordance with these specifications and must conform to the lines, grades, thickness, and typical cross-sections shown on the plans.

PART 2 MATERIALS

2.01 AGGREGATES

- A. Reactivity. Fine and Coarse aggregates to be used in all concrete must be evaluated and tested by the Contractor for alkali-aggregate reactivity in accordance with both ASTM C1260 and ASTM C1567. Aggregate and mix proportion reactivity tests must be performed for each project.
 - 1. Coarse and fine aggregate must be tested separately in accordance with ASTM C1260. The aggregate must be considered innocuous if the expansion of test specimens, tested in accordance with ASTM C1260, does not exceed 0.10% at 28 days (30 days from casting).
 - 2. Combined coarse and fine aggregate must be tested in accordance with ASTM C1567, modified for combined aggregates, using the proposed mixture design proportions of aggregates, cementitious materials, and/or specific reactivity reducing chemicals. If lithium nitrate is proposed for use with or without supplementary cementitious materials, the aggregates must be tested in accordance with Corps of Commissioners (COE) Concrete Research Division (CRD) C662. If lithium nitrate admixture is used, it must be nominal 30% \pm 0.5% weight lithium nitrate in water.
 - 3. If the expansion of the proposed combined materials test specimens, tested in accordance with ASTM C1567, modified for combined aggregates, or COE CRD C662, does not exceed 0.10% at 28 days, the proposed combined materials will be accepted. If the expansion of the proposed combined materials

test specimens is greater than 0.10% at 28 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10% at 28 days, or new aggregates must be evaluated and tested.

- B. Fine aggregate. Fine aggregate must conform to the requirements of ASTM C33. Grading of the fine aggregate, as delivered to the mixer, must conform to the requirements of ASTM C33 and must have a fineness modulus of not less than 2.50 nor more than 3.40. The soundness loss must not exceed 10% when sodium sulfate is used or 15% when magnesium sulfate is used, after five cycles, when tested per ASTM C88.

The amount of deleterious material in the fine aggregate must not exceed the following limits:

Limits for Deleterious Substances in Fine Aggregate for Concrete

Deleterious material	ASTM	Percentage by Mass
Clay Lumps and friable particles	ASTM C142	1.0
Material finer than 0.075mm (No. 200 sieve)	ASTM C117	3.0
Lightweight particles	ASTM C123 using a medium with a density of Sp. Gr. of 2.0	0.5
Total of all deleterious Material		3.0

- C. Coarse aggregate. Gradation, within the separated size groups, must meet the coarse aggregate grading requirements of ASTM C33 when tested in accordance with ASTM C136. When the nominal maximum size of the aggregate is greater than one inch (25 mm), the aggregates must be furnished in two size groups.

Aggregates delivered to the mixer must consist of crushed stone, crushed or uncrushed gravel, air-cooled iron blast furnace slag, crushed recycled concrete pavement, or a combination. The aggregates should be free of ferrous sulfides, such as pyrite, that would cause "rust" staining that can bleed through pavement markings. Steel blast furnace slag must not be permitted. The aggregate must be composed of clean, hard, uncoated particles. Dust and other coating must be removed from the aggregates by washing.

The percentage of wear must be no more than **40 percent** when tested in accordance with ASTM C131.

The quantity of flat, elongated, and flat and elongated particles in any size group coarser than 3/8 sieve (9 mm) must not exceed 8% by weight when tested in accordance with ASTM D4791. A flat particle is defined as one having a ratio of width to thickness greater than 5. An elongated particle is one having a ratio of length to width greater than 5.

The soundness loss must not exceed 12% when sodium sulfate is used or 18% when magnesium sulfate is used, after five cycles, when tested per ASTM C88.

The amount of deleterious material in the coarse aggregate must not exceed the following limits:

Limits for Deleterious Substances in Coarse Aggregate for Concrete

Deleterious material	ASTM	Percentage by Mass
Clay Lumps and friable particles	ASTM C142	1.0
Material finer than No. 200 sieve (0.075mm)	ASTM C117	1.0
Lightweight particles	ASTM C123 using a medium with a density of Sp. Gr. of 2.0	0.5
Chert (less than 2.40 Sp Gr.)	ASTM C123 using a medium with a density of Sp. Gr. of 2.0)	1.0
Total of all deleterious Material		3.0

**Table 1. Gradation For Coarse Aggregate
(ASTM C33)**

Sieve Designations (square openings)		Percentage by Weight Passing Sieves	
		From 1-1/2 inch to No. 4 (38mm – 4.75mm)	
		#4 1-1/2 inch – 3/4 inch	#67 3/4 inch – No. 4
inch	mm		
2-1/2	60	---	---
2	50	100	---
1-1/2	38	90-100	---
1	25	20-55	100
3/4	19	0-15	90-100
1/2	13	---	---
3/8	9	0-5	20-55
No. 4	4.75	---	0-10

Sieve Designations (square openings)		Percentage by Weight Passing Sieves	
		From 1-½ inch to No. 4 (38mm – 4.75mm)	
		#4 1-½ inch – ¾ inch	#67 ¾ inch – No. 4
inch	mm		
No. 8	2.36	---	0-5

1. Aggregate susceptibility to durability (D) cracking.

Aggregates that have a history of D-cracking must not be used.

Coarse aggregate may be accepted from sources that have a 20 year service history for the same gradation to be supplied with no durability issues. Aggregates that do not have a record of 20 years of service without major repairs (less than 5% of slabs replaced) in similar conditions without D-cracking must not be used unless it meets the following:

- a. Material currently being produced must have a durability factor ≥ 95 using ASTM C666 procedure B. Coarse aggregates that are crushed granite, calcite cemented sandstone, quartzite, basalt, diabase, rhyolite or trap rock are considered to meet the D-cracking test but must meet all other quality tests. Aggregates meeting State Highway Department material specifications may be acceptable.
- b. The Contractor must submit a current certification that the aggregate does not have a history of D-cracking and that the aggregate meets the state specifications for use in PCC pavement for use on interstate highways. Certifications, tests and any history reports must be for the same gradation as being proposed for use on the project. Certifications which are not dated or which are over one (1) year old or which are for different gradations will not be accepted. Test results will only be accepted when tests were performed by a State Department of Transportation (DOT) materials laboratory or an accredited laboratory.

2. Combined aggregate gradation. If substituted for the grading requirements specified for coarse aggregate and for fine aggregate and when approved by the Commissioner, the combined aggregate grading must meet the following requirements:

- a. The materials selected and the proportions used must be such that when the Coarseness Factor (CF) and the Workability Factor (WF) are plotted on a diagram as

described in d. below, the point thus determined must fall within the parallelogram described therein.

- b. The CF must be determined from the following equation:

$$CF = (\text{cumulative percent retained on the } 3/8 \text{ in. sieve})(100) / (\text{cumulative percent retained on the No. 8 sieve})$$

- c. The Workability Factor WF is defined as the percent passing the No. 8 (2.36 mm) sieve based on the combined gradation. However, WF must be adjusted, upwards only, by 2.5 percentage points for each 94 pounds (42 kg) of cementitious material per cubic meter yard greater than 564 pounds per cubic yard (335 kg per cubic meter).
- d. A diagram must be plotted using a rectangular scale with WF on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram a parallelogram must be plotted with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-40), (CF-45, WF-32.5), and (CF-45, WF-44.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, the grading of each size of aggregate used and the proportions selected must be changed as necessary.

2.02 CEMENT

- A. Cement must conform to the requirements of ASTM C150 Type I.
- B. If aggregates are deemed innocuous when tested in accordance with paragraph 2.01.a.1 and accepted in accordance with paragraph 2.01.a.2, higher equivalent alkali content in the cement may be allowed if approved by the Commissioner and FAA. If cement becomes partially set or contains lumps of caked cement, it must be rejected. Cement salvaged from discarded or used bags must not be used.

2.03 CEMENTITIOUS MATERIALS

- A. **Fly ash.** Fly ash must meet the requirements of ASTM C618, with the exception of loss of ignition, where the maximum must be less than 6%. Fly ash for use in mitigating alkali-silica reactivity must have a Calcium Oxide (CaO) content of less than 13% and a total available alkali content less than 3% per ASTM C311. Fly ash produced in furnace operations using liming materials or soda ash (sodium carbonate) as an additive must not be acceptable. The Contractor must furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the mix design, and must

furnish each additional report as they become available during the project. The reports can be used for acceptance or the material may be tested independently by the Commissioner.

- B. **Slag cement (ground granulated blast furnace (GGBF)).** Slag cement must conform to ASTM C989, Grade 100 or Grade 120. Slag cement must be used only at a rate between 25% and 55% of the total cementitious material by mass.
- C. **Raw or calcined natural pozzolan.** Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and must have a loss on ignition not exceeding 6%. Class N pozzolan for use in mitigating Alkali-Silica Reactivity must have a total available alkali content less than 3%.
- D. **Ultrafine fly ash and ultrafine pozzolan.** UltraFine Fly Ash (UFFA) and UltraFine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:
 - 1. The strength activity index at 28 days of age must be at least 95% of the control specimens.
 - 2. The average particle size must not exceed 6 microns.

2.04 JOINT SEAL

- A. The joint seal for the joints in the concrete pavement must meet the requirements of Item P-605 and must be of the type specified in the plans.

2.05 ISOLATION JOINT FILLER

- A. Premolded joint filler for isolation joints must conform to the requirements of ASTM D1752, Type II or III and must be where shown on the plans. The filler for each joint must be furnished in a single piece for the full depth and width required for the joint, unless otherwise specified by the Commissioner. When the use of more than one piece is required for a joint, the abutting ends must be fastened securely and held accurately to shape by stapling or other positive fastening means satisfactory to the Commissioner.

2.06 STEEL REINFORCEMENT

- A. Reinforcing must consist of welded steel wire fabric conforming to the requirements of ASTM 185. Welded wire fabric must be furnished in flat sheets only.

2.07 DOWEL AND TIE BARS

- A. Dowel bars must be plain steel bars conforming to ASTM A615 and must be free from burring or other deformation restricting slippage in the concrete. Before delivery to the construction site each dowel bar

must be epoxy coated per ASTM A1078. The dowels must be coated with a bond-breaker recommended by the manufacturer. Dowel sleeves or inserts are not permitted. Grout retention rings must be fully circular metal or plastic devices capable of supporting the dowel until the grout hardens.

- B. Tie bars must be deformed steel bars and conform to the requirements of ASTM A615. Tie bars designated as Grade 60 in ASTM A615 or ASTM A706 must be used for construction requiring bent bars.

2.08 WATER

- A. Water used in mixing or curing must be potable, clean, free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product, except that non-potable water, or water from concrete production operations, may be used if it meets the requirements of ASTM C1602.

2.09 MATERIAL FOR CURING CONCRETE

- A. Curing materials must conform to one of the following specifications:
 - 1. Liquid membrane-forming compounds for curing concrete must conform to the requirements of ASTM C309, Type 2, Class B, or Class A if wax base only.
 - 2. White polyethylene film for curing concrete must conform to the requirements of ASTM C171.
 - 3. White burlap-polyethylene sheeting for curing concrete must conform to the requirements of ASTM C171.
 - 4. Waterproof paper for curing concrete must conform to the requirements of ASTM C171.

2.10 ADMIXTURES

- A. The Contractor must submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the Commissioner may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests may be made of samples taken by the Commissioner from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.
 - 1. **Air-entraining admixtures.** Air-entraining admixtures must meet the requirements of ASTM C260 and must consistently entrain the air content in the specified ranges under field conditions. The air-entrainment agent and any water reducer admixture must be compatible.

2. **Water-reducing admixtures.** Water-reducing admixture must meet the requirements of ASTM C494, Type A, B, or D. ASTM C494, Type F and G high range water reducing admixtures and ASTM C1017 flowable admixtures must not be used.
3. **Other admixtures.** The use of set retarding, and set-accelerating admixtures must be approved by the Commissioner. Retarding must meet the requirements of ASTM C494, Type A, B, or D and set-accelerating must meet the requirements of ASTM C494, Type C. Calcium chloride and admixtures containing calcium chloride must not be used.
4. **Lithium Nitrate.** The lithium admixture must be a nominal 30% aqueous solution of Lithium Nitrate, with a density of 10 pounds/gallon (1.2 kg/L), and must have the approximate chemical form as shown below:

<u>Constituent</u>	<u>Limit (Percent by Mass)</u>
LiNO ₃ (Lithium Nitrate)	30 ±0.5
SO ₄ (Sulfate Ion)	0.1 (max)
Cl (Chloride Ion)	0.2 (max)
Na (Sodium Ion)	0.1 (max)
K (Potassium Ion)	0.1 (max)

Provide a trained manufacturer's representative to supervise the lithium nitrate admixture dispensing and mixing operations.

2.11 EPOXY-RESIN

- A. All epoxy-resin materials must be two-component materials conforming to the requirements of ASTM C881, Class as appropriate for each application temperature to be encountered, except that in addition, the materials must meet the following requirements:
 1. Material for use for embedding dowels and anchor bolts must be Type IV, Grade 3.
 2. Material for use as patching materials for complete filling of spalls and other voids and for use in preparing epoxy resin mortar must be Type III, Grade as approved.
 3. Material for use for injecting cracks must be Type IV, Grade 1.
 4. Material for bonding freshly mixed Portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete must be Type V, Grade as approved.

2.12 MATERIAL ACCEPTANCE

- A. Prior to use of materials, the Contractor must submit certified test reports to the Commissioner for those materials proposed for use during construction. The certification must show the appropriate ASTM test for each material, the test results, and a statement that the material passed or failed.
- B. The Commissioner may request samples for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

PART 3 MIX DESIGN

3.01 GENERAL.

- A. No concrete must be placed until the mix design has been submitted to the Commissioner for review and the Commissioner has taken appropriate action. The Commissioner's review must not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

3.02 PROPORTIONS

- A. The laboratory preparing the mix design must be accredited in accordance with ASTM C1077. The mix design for all Portland cement concrete placed under P-501 must be stamped or sealed by the responsible professional Engineer of the laboratory. Concrete must be proportioned to achieve a 28-day flexural strength that meets or exceeds the acceptance criteria contained in paragraph 5.02 for a flexural strength of 625 psi per ASTM C78. The mix must be developed using the procedures contained in the Portland Cement Association's (PCA) publication, "Design and Control of Concrete Mixtures".
- B. The minimum cementitious material must be adequate to ensure a workable, durable mix. The minimum cementitious material (cement plus fly ash, or slag cement) must be 517 pounds per cubic yard. The ratio of water to cementitious material, including free surface moisture on the aggregates but not including moisture absorbed by the aggregates must not be more than 0.45 by weight.
- C. Flexural strength test specimens must be prepared in accordance with ASTM C192 and tested in accordance with ASTM C78. The mix determined must be workable concrete having a maximum allowable slump between one and two inches as determined by ASTM C 143. For slip-form concrete, the slump must be between ½ inch and 1- ½ inch. At the start of the project, the Contractor must determine a maximum allowable slump for slip-form pavement which will produce in-place pavement to control the edge slump. The selected slump must be applicable to both pilot and fill-in lanes.

- D. Before the start of paving operations and after approval of all material to be used in the concrete, the Contractor must submit a mix design showing the proportions and flexural strength obtained from the concrete at seven (7) and 28 days. The mix design must include copies of test reports, including test dates, and a complete list of materials including type, brand, source, and amount of cement, fly ash, ground slag, coarse aggregate, fine aggregate, water, and admixtures. The mix design must be submitted to the Commissioner at least 30 days prior to the start of operations. The submitted mix design must not be more than 90 days old. Production must not begin until the mix design is approved in writing by the Commissioner.
- E. If a change in sources is made, or admixtures added or deleted from the mix, a new mix design must be submitted to the Commissioner for approval.
- F. The results of the mix design must include a statement giving the maximum nominal coarse aggregate size and the weights and volumes of each ingredient proportioned on a one cubic yard (meter) basis. Aggregate quantities must be based on the mass in a saturated surface dry condition. The recommended mixture proportions must be accompanied by test results demonstrating that the proportions selected will produce concrete of the qualities indicated. Trial mixtures having proportions, slumps, and air content suitable for the work must be based on methodology described in PCA's publication, Design and Control of Concrete Mixtures, modified as necessary to accommodate flexural strength.
- H. The submitted mix design must be stamped or sealed by the responsible professional Engineer of the laboratory and must include the following items as a minimum:
 - 1. Coarse, fine, and combined aggregate gradations and plots including fineness modulus of the fine aggregate.
 - 2. Reactivity Test Results.
 - 3. Coarse aggregate quality test results, including deleterious materials.
 - 4. Fine aggregate quality test results, including deleterious materials.
 - 5. Mill certificates for cement and supplemental cementitious materials.
 - 6. Certified test results for all admixtures, including Lithium Nitrate if applicable.

7. Specified flexural strength, slump, and air content.
8. Recommended proportions/volumes for proposed mixture and trial water-cementitious materials ratio, including actual slump and air content.
9. Flexural and compressive strength summaries and plots, including all individual beam and cylinder breaks.
10. Correlation ratios for acceptance testing and Contractor Quality Control testing, when applicable.
11. Historical record of test results documenting production standard deviation, when applicable.

3.03 CEMENTITIOUS MATERIALS.

- A. **Fly ash.** When fly ash is used as a partial replacement for cement, the replacement rate must be determined from laboratory trial mixes, and must be between 20 and 30% by weight of the total cementitious material. If fly ash is used in conjunction with slag cement the maximum replacement rate must not exceed 10% by weight of total cementitious material.
- B. **Slag cement (ground granulated blast furnace (GGBF)).** Slag cement may be used. The slag cement, or slag cement plus fly ash if both are used, may constitute between 25 to 55% of the total cementitious material by weight. If the concrete is to be used for slipforming operations and the air temperature is expected to be lower than 55°F (13°C) the percent slag cement must not exceed 30% by weight.
- C. **Raw or calcined natural pozzolan.** Natural pozzolan may be used in the mix design. When pozzolan is used as a partial replacement for cement, the replacement rate must be determined from laboratory trial mixes, and must be between 20 and 30% by weight of the total cementitious material. If pozzolan is used in conjunction with slag cement the maximum replacement rate must not exceed 10% by weight of total cementitious material.
- D. **Ultrafine fly ash (UFFA) and ultrafine pozzolan (UFP).** UFFA and UFP may be used in the mix design with the Commissioner's approval. When UFFA and UFP is used as a partial replacement for cement, the replacement rate must be determined from laboratory trial mixes, and must be between seven (7) and 16% by weight of the total cementitious material.

3.04 ADMIXTURES

- A. **Air-entraining admixtures.** Air-entraining admixture are to be added in such a manner that will ensure uniform distribution of the agent

throughout the batch. The air content of freshly mixed air-entrained concrete must be based upon trial mixes with the materials to be used in the work adjusted to produce concrete of the required plasticity and workability. The percentage of air in the mix must be 6.0 percent. Air content must be determined by testing in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag and other highly porous coarse aggregate.

- B. **Water-reducing admixtures.** Water-reducing admixtures must be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements. Tests must be conducted on trial mixes, with the materials to be used in the work, in accordance with ASTM C494.
- C. **Other admixtures.** Set controlling, and other approved admixtures must be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements. Tests must be conducted on trial mixes, with the materials to be used in the work, in accordance with ASTM C 494.
- D. **Lithium nitrate.** Lithium nitrate must be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements in accordance with paragraph 501-2.10A4.

3.05 CONCRETE MIX DESIGN LABORATORY

- A. The Contractor's laboratory used to develop the concrete mix design must be accredited in accordance with ASTM C1077. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for developing the concrete mix design must be listed on the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods must be submitted to the Commissioner prior to start of construction

PART 4 CONSTRUCTION METHODS

4.01 EQUIPMENT

- A. Equipment necessary for handling materials and performing all parts of the work must be approved by the Commissioner, but does not relieve the Contractor of the responsibility for the proper operation of equipment and maintaining the equipment in good working condition. The equipment must be at the jobsite sufficiently ahead of the start of paving operations to be examined thoroughly and approved.
- B. The batch plant and equipment must conform to the requirements of ASTM C94.

C. Mixers and transportation equipment.

1. General. Concrete may be mixed at a central plant, or wholly or in part in truck mixers. Each mixer must have attached in a prominent place a manufacturer's nameplate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.
2. Central plant mixer. Central plant mixers must conform to the requirements of ASTM C94. The mixer must be examined daily for changes in condition due to accumulation of hard concrete or mortar or wear of blades. The pickup and throwover blades must be replaced when they have worn down 3/4 inch (19 mm) or more. The Contractor must have a copy of the manufacturer's design on hand showing dimensions and arrangement of blades in reference to original height and depth.
3. Truck mixers and truck agitators. Truck mixers used for mixing and hauling concrete and truck agitators used for hauling central-mixed concrete must conform to the requirements of ASTM C94.
4. Nonagitator trucks. Nonagitating hauling equipment must conform to the requirements of ASTM C94.
5. Transfer and spreading equipment. Equipment for transferring concrete from the transporting equipment to the paving lane in front of the paver must be specially manufactured, self-propelled transfer equipment which will accept the concrete outside the paving lane and will transfer and spread it evenly across the paving lane in front of the paver and strike off the surface evenly to a depth which permits the paver to operate efficiently.

D. Finishing equipment. The standard method of constructing concrete pavements must be with an approved slip-form paving equipment designed and operated to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine so that the end result is a dense and homogeneous pavement which is achieved with a minimum of hand finishing. The paver-finisher must be a heavy duty, self-propelled machine designed specifically for paving and finishing high quality concrete pavements. It must weigh at least 2,200 lbs per foot (3274 kg/m) of paving lane width and powered by an engine having at least 6.0 horsepower per foot of lane width.

On projects requiring less than 500 square yard (418 sq m) of cement concrete pavement or requiring individual placement areas of less than 500 square yard (418 sq m), or irregular areas at locations inaccessible to slip-form paving equipment, concrete pavement may be placed with approved placement and finishing equipment using

stationary side forms. Hand screeding and float finishing may only be used on small irregular areas as allowed by the Commissioner.

- E. Vibrators. Vibrator must be the internal type. Operating frequency for internal vibrators must be between 8,000 and 12,000 vibrations per minute. Average amplitude for internal vibrators must be 0.025-0.05 inch (0.06 - 0.13 cm).

The number, spacing, and frequency must be as necessary to provide a dense and homogeneous pavement and meet the recommendations of American Concrete Institute (ACI) 309, Guide for Consolidation of Concrete. Adequate power to operate all vibrators must be available on the paver. The vibrators must be automatically controlled so that they must be stopped as forward motion ceases. The Contractor must provide an electronic or mechanical means to monitor vibrator status. The checks on vibrator status must occur a minimum of two times per day or when requested by the Commissioner.

Hand held vibrators may be used in irregular areas only, but must meet the recommendations of ACI 309R, Guide for Consolidation of Concrete.

- F. Concrete saws. The Contractor must provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions. The Contractor must provide at least one standby saw in good working order and a supply of saw blades at the site of the work at all times during sawing operations. Early-entry saws may be used, subject to demonstration and approval of the Commissioner.
- G. Side forms. Straight side forms must be made of steel and must be furnished in sections not less than 10 feet (3 m) in length. Forms must have a depth equal to the pavement thickness at the edge, and a base width equal to or greater than the depth. Flexible or curved forms of proper radius must be used for curves of 100-foot (31 m) radius or less. Forms must be provided with adequate devices for secure settings so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms with battered top surfaces and bent, twisted or broken forms must not be used. Built-up forms must not be used, except as approved by the Commissioner. The top face of the form must not vary from a true plane more than 1/8 inch (3 mm) in 10 feet (3 m), and the upstanding leg must not vary more than 1/4 inch (6 mm). The forms must contain provisions for locking the ends of abutting sections together tightly for secure setting. Wood forms may be used under special conditions, when approved by the Commissioner.
- H. Pavers. The paver must be fully energized, self-propelled, and designed for the specific purpose of placing, consolidating, and

finishing the concrete pavement, true to grade, tolerances, and cross-section. It must be of sufficient weight and power to construct the maximum specified concrete paving lane width as shown in the plans, at adequate forward speed, without transverse, longitudinal or vertical instability or without displacement. The paver must be equipped with electronic or hydraulic horizontal and vertical control devices.

4.02 FORM SETTING

- A. Forms must be set sufficiently in advance of the concrete placement to ensure continuous paving operation. After the forms have been set to correct grade, the underlying surface must be thoroughly tamped, either mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms must be staked into place sufficiently to maintain the form in position for the method of placement.
- B. Form sections must be tightly locked and must be free from play or movement in any direction. The forms must not deviate from true line by more than 1/8 inch (3 mm) at any joint. Forms must be so set that they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms must be cleaned and oiled prior to the placing of concrete.
- C. The alignment and grade elevations of the forms must be checked and corrections made by the Contractor immediately before placing the concrete.

4.03 CONDITIONING OF UNDERLYING SURFACE

- A. The compacted underlying surface on which the pavement will be placed must be widened approximately 3 feet (1 m) to extend beyond the paving machine track to support the paver without any noticeable displacement. After the underlying surface has been placed and compacted to the required density, the areas that will support the paving machine and the area to be paved must be trimmed or graded to the plan grade elevation and profile by means of a properly designed machine. The grade of the underlying surface must be controlled by a positive grade control system using lasers, stringlines, or guide wires. If the density of the underlying surface is disturbed by the trimming operations, it must be corrected by additional compaction and retested at the option of the Commissioner before the concrete is placed except when stabilized subbases are being constructed. If damage occurs on a stabilized subbase, it must be corrected full depth by the Contractor. If traffic is allowed to use the prepared grade, the grade must be checked and corrected immediately before the placement of concrete. The prepared grade must be moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from concrete. The underlying surface

must be protected so that it will be entirely free of frost when concrete is placed.

4.04 CONDITIONING OF UNDERLYING SURFACE, SIDE-FORM AND FILL-IN LANE CONSTRUCTION.

- A. The prepared underlying surface must be moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from the concrete. Damage caused by hauling or usage of other equipment must be corrected and retested at the option of the Commissioner. If damage occurs to a stabilized subbase, it must be corrected full depth by the Contractor. A template must be provided and operated on the forms immediately in advance of the placing of all concrete. The template must be propelled only by hand and not attached to a tractor or other power unit. Templates must be adjustable so that they may be set and maintained at the correct contour of the underlying surface. The adjustment and operation of the templates must be such as will provide an accurate retest of the grade before placing the concrete thereon. All excess material must be removed and wasted. Low areas must be filled and compacted to a condition similar to that of the surrounding grade. The underlying surface must be protected so that it will be entirely free from frost when the concrete is placed. The use of chemicals to eliminate frost in the underlying surface must not be permitted.
- B. The template must be maintained in accurate adjustment, at all times by the Contractor, and must be checked daily.

4.05 HANDLING, MEASURING, AND BATCHING MATERIAL

- A. The batch plant site, layout, equipment, and provisions for transporting material must assure a continuous supply of material to the work. Stockpiles must be constructed in such a manner that prevents segregation and intermixing of deleterious materials. Aggregates from different sources must be stockpiled, weighed and batched separately at the concrete batch plant.
- B. Aggregates that have become segregated or mixed with earth or foreign material must not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, must be stockpiled or binned for draining at least 12 hours before being batched. Rail shipments requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage.
- C. Batching plants must be equipped to proportion aggregates and bulk cement, by weight, automatically using interlocked proportioning devices of an approved type. When bulk cement is used, the Contractor must use a suitable method of handling the cement from weighing hopper to transporting container or into the batch itself for

transportation to the mixer, such as a chute, boot, or other approved device, to prevent loss of cement. The device must be arranged to provide positive assurance that the cement content specified is present in each batch.

4.06 MIXING CONCRETE

- A. The concrete may be mixed at the work site, in a central mix plant or in truck mixers. The mixer must be of an approved type and capacity. Mixing time must be measured from the time all materials, except water, are emptied into the drum. All concrete must be mixed and delivered to the site in accordance with the requirements of ASTM C94.
- B. Mixed concrete from the central mixing plant must be transported in truck mixers, truck agitators, or non-agitating trucks. The elapsed time from the addition of cementitious material to the mix until the concrete is deposited in place at the work site must not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 90 minutes when the concrete is hauled in truck mixers or truck agitators. Retempering concrete by adding water or by other means will not be permitted. With transit mixers additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements provided the addition of water is performed within 45 minutes after the initial mixing operations and provided the water/cementitious ratio specified in the approved mix design is not exceeded, and approved by the Commissioner.

4.07 LIMITATIONS ON MIXING AND PLACING

- A. No concrete must be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.
 - 1. Cold weather. Unless authorized in writing by the Commissioner, mixing and concreting operations must be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F (4°C) and must not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F (2°C).

The aggregate must be free of ice, snow, and frozen lumps before entering the mixer. The temperature of the mixed concrete must not be less than 50°F (10°C) at the time of placement. Concrete must not be placed on frozen material nor must frozen aggregates be used in the concrete.

When concreting is authorized during cold weather, water and/or the aggregates may be heated to not more than 150°F (66°C). The apparatus used must heat the mass uniformly and must be

arranged to preclude the possible occurrence of overheated areas which might be detrimental to the materials.

2. Hot weather. During periods of hot weather when the maximum daily air temperature exceeds 85°F (30°C), the following precautions must be taken.

The forms and/or the underlying surface must be sprinkled with water immediately before placing the concrete. The concrete must be placed at the coolest temperature practicable, and in no case must the temperature of the concrete when placed exceed 90°F (32°C). The aggregates and/or mixing water must be cooled as necessary to maintain the concrete temperature at or not more than the specified maximum.

The finished surfaces of the newly laid pavement must be kept damp by applying a water-fog or mist with approved spraying equipment until the pavement is covered by the curing medium. When necessary, wind screens must be provided to protect the concrete from an evaporation rate in excess of 0.2 psf (0.98 kg/m² per hour) per hour. When conditions are such that problems with plastic cracking can be expected, and particularly if any plastic cracking begins to occur, the Contractor must immediately take such additional measures as necessary to protect the concrete surface. Such measures must consist of wind screens, more effective fog sprays, and similar measures commencing immediately behind the paver. If these measures are not effective in preventing plastic cracking, paving operations must be immediately stopped.

3. Temperature management program. Prior to the start of paving operation for each day of paving, the Contractor must provide the Commissioner with a Temperature Management Program for the concrete to be placed to assure that uncontrolled cracking is avoided. As a minimum the program must address the following items:
 - a. Anticipated tensile strains in the fresh concrete as related to heating and cooling of the concrete material.
 - b. Anticipated weather conditions such as ambient temperatures, wind velocity, and relative humidity; and anticipated evaporation rate using Figure 11-8, PCA, Design and Control of Concrete Mixtures.
 - c. Anticipated timing of initial sawing of joint.
 - d. Anticipated number and type of saws to be used.

4.08 PLACING CONCRETE

- A. At any point in concrete conveyance, the free vertical drop of the concrete from one point to another or to the underlying surface must not exceed 3 feet. The finished concrete product must be dense and homogeneous, without segregation and conforming to the standards in this specification. Backhoes and grading equipment must not be used to distribute the concrete in front of the paver. Front end loaders will not be used. All concrete must be consolidated without voids or segregation, including under and around all load-transfer devices, joint assembly units, and other features embedded in the pavement. Hauling equipment or other mechanical equipment can be permitted on adjoining previously constructed pavement when the concrete strength reaches a flexural strength of 550 psi, based on the average of four field cured specimens per 2,000 cubic yards of concrete placed. Also, subgrade and sub-base planers, concrete pavers, and concrete finishing equipment may be permitted to ride upon the edges of previously constructed pavement when the concrete has attained a minimum flexural strength of 400 psi.
- B. The Contractor must have available materials for the protection of the concrete during inclement weather. Such protective materials must consist of rolled polyethylene sheeting at least 4 mils thick of sufficient length and width to cover the plastic concrete slab and any edges. The sheeting may be mounted on either the paver or a separate movable bridge from which it can be unrolled without dragging over the plastic concrete surface. When rain appears imminent, all paving operations must stop and all available personnel must begin covering the surface of the unhardened concrete with the protective covering.
- C. Slip-form construction:
 - 1. The concrete must be distributed uniformly into final position by a self-propelled slip-form paver without delay. The alignment and elevation of the paver must be regulated from outside reference lines established for this purpose. The paver must vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration must be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well defined edges. The sliding forms must be rigidly held together laterally to prevent spreading of the forms. The plastic concrete must be effectively consolidated by internal vibration with transverse vibrating units for the full width of the pavement and/or a series of equally placed longitudinal vibrating units. The space from the outer edge of the pavement to longitudinal unit must not exceed 9 inches (23 cm) for slipform and at the end of the dowels for the fill-in lanes The

spacing of internal units must be uniform and must not exceed 18 inches (0.5 m).

2. The term internal vibration means vibrating units located within the specified thickness of pavement section.
3. The rate of vibration of each vibrating unit must be within 8000 to 12000 cycles per minute and the amplitude of vibration must be sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating unit and for a distance of at least one foot (30 cm). The frequency of vibration or amplitude must vary proportionately with the rate of travel to result in a uniform density and air content. The paving machine must be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.
4. The concrete must be held at a uniform consistency. The slip-form paver must be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete must be coordinated to provide uniform progress with stopping and starting of the paver held to a minimum. If for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements must also be stopped immediately. No tractive force must be applied to the machine, except that which is controlled from the machine.
5. When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement must be equipped with protective pads on crawler tracks or rubber-tired wheels on which the bearing surface is offset to run a sufficient distance from the edge of the pavement to avoid breaking the pavement edge.
6. Not more than 15% of the total free edge of each 500 foot (150 m) segment of pavement, or fraction thereof, must have an edge slump exceeding 1/4 inch (6 mm), and none of the free edge of the pavement must have an edge slump exceeding 3/8 inch (9 mm). (The total free edge of 500 feet (150 m) of pavement will be considered the cumulative total linear measurement of pavement edge originally constructed as nonadjacent to any existing pavement; that is, 500 feet (150 m) of paving lane originally constructed as a separate lane will have 1,000 feet (300 m) of free edge, 500 feet (150 m) of fill-in lane will have no free edge, etc.). The area affected by the downward movement of the concrete along the pavement edge must be limited to not more than 18 inches (0.5 m) from the edge. When excessive edge slump cannot be corrected before

the concrete has hardened, the area with excessive edge slump must be removed and replaced at the expense of the Contractor as directed by the Commissioner.

D. Side-form construction:

1. Side form sections must be straight, free from warps, bends, indentations, or other defects. Defective forms must be removed from the work. Metal side forms must be used except at end closures and transverse construction joints where straight forms of other suitable material may be used.
2. Side forms may be built up by rigidly attaching a section to either top or bottom of forms. If such build-up is attached to the top of metal forms, the build-up must also be metal.
3. Width of the base of all forms must be equal to or greater than the specified pavement thickness.
4. Side forms must be of sufficient rigidity, both in the form and in the interlocking connection with adjoining forms, that springing will not occur under the weight of subgrading and paving equipment or from the pressure of the concrete. The Contractor must provide sufficient forms so that there will be no delay in placing concrete due to lack of forms.
5. Before placing side forms, the underlying material must be at the proper grade. Side forms must have full bearing upon the foundation throughout their length and width of base and must be placed to the required grade and alignment of the finished pavement. They must be firmly supported during the entire operation of placing, compacting, and finishing the pavement.
6. Forms must be drilled in advance of being placed to line and grade to accommodate tie bars where these are specified.
7. Immediately in advance of placing concrete and after all subbase operations are completed, side forms must be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing.
8. Side forms must remain in place at least 12 hours after the concrete has been placed, and in all cases until the edge of the pavement no longer requires the protection of the forms. Curing compound must be applied to the concrete immediately after the forms have been removed.
9. Side forms must be thoroughly cleaned and oiled each time they are used and before concrete is placed against them.

10. Concrete must be spread, screeded, shaped and consolidated by one or more self-propelled machines. These machines must uniformly distribute and consolidate concrete without segregation so that the completed pavement will conform to the required cross-section with a minimum of handwork.
11. The number and capacity of machines furnished must be adequate to perform the work required at a rate equal to that of concrete delivery.
12. Concrete for the full paving width must be effectively consolidated by internal vibrators without causing segregation. Internal type vibrators' rate of vibration must be not less than 7,000 cycles per minute. Amplitude of vibration must be sufficient to be perceptible on the surface of the concrete more than one foot (30 cm) from the vibrating element. The Contractor must furnish a tachometer or other suitable device for measuring and indicating frequency of vibration.
13. Power to vibrators must be connected so that vibration ceases when forward or backward motion of the machine is stopped.
14. The provisions relating to the frequency and amplitude of internal vibration must be considered the minimum requirements and are intended to ensure adequate density in the hardened concrete.

E. Consolidation:

1. Concrete must be consolidated with the specified type of lane-spanning, gang-mounted, mechanical, immersion type vibrating equipment mounted in front of the paver, supplemented, in rare instances as specified, by hand-operated vibrators. The vibrators must be inserted into the concrete to a depth that will provide the best full-depth consolidation but not closer to the underlying material than inches (50 mm). Excessive vibration must not be permitted. If the vibrators cause visible tracking in the paving lane, the paving operation must be stopped and equipment and operations modified to prevent it. Concrete in small, odd-shaped slabs or in isolated locations inaccessible to the gang-mounted vibration equipment must be vibrated with an approved hand-operated immersion vibrator operated from a bridge spanning the area. Vibrators must not be used to transport or spread the concrete. Hand-operated vibrators must not be operated in the concrete at one location for more than 20 seconds. Insertion locations for hand-operated vibrators must be between 6 to 15 inches (150 to 400 mm) on centers. For each paving train, at least one additional vibrator spud, or sufficient parts for rapid replacement and repair of vibrators

must be maintained at the paving site at all times. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) must require the immediate stopping of the paving operation and adjustment of the equipment or procedures as approved by the Commissioner.

2. If a lack of consolidation of the concrete is suspected by the Commissioner, referee testing may be required. Referee testing of hardened concrete will be performed by the Commissioner by cutting cores from the finished pavement after a minimum of 24 hours curing. Density determinations will be made by the Commissioner based on the water content of the core as taken. ASTM C642 must be used for the determination of core density in the saturated-surface dry condition. When required, referee cores will be taken at the minimum rate of one for each 500 cubic yards (382 m²) of pavement, or fraction. The Contractor must be responsible for all referee testing cost if they fail to meet the required density.
3. The average density of the cores must be at least 97% of the original mix design density, with no cores having a density of less than 96% of the original mix design density. Failure to meet the referee tests will be considered evidence that the minimum requirements for vibration are inadequate for the job conditions. Additional vibrating units or other means of increasing the effect of vibration must be employed so that the density of the hardened concrete conforms to the above requirements.

4.09 STRIKE-OFF OF CONCRETE AND PLACEMENT OF REINFORCEMENT

- A. Following the placing of the concrete, it must be struck off to conform to the cross-section shown on the plans and to an elevation that when the concrete is properly consolidated and finished, the surface of the pavement must be at the elevation shown on the plans. When reinforced concrete pavement is placed in two layers, the bottom layer must be struck off to such length and depth that the sheet of reinforcing steel fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement must then be placed directly upon the concrete, after which the top layer of the concrete must be placed, struck off, and screeded. If any portion of the bottom layer of concrete has been placed more than 30 minutes without being covered with the top layer or if initial set has taken place, it must be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be positioned in

advance of concrete placement or it may be placed in plastic concrete by mechanical or vibratory means after spreading.

- B. Reinforcing steel, at the time concrete is placed, must be free of mud, oil, or other organic matter that may adversely affect or reduce bond. Reinforcing steel with rust, mill scale or a combination of both will be considered satisfactory, provided the minimum dimensions, weight, and tensile properties of a hand wire-brushed test specimen are not less than the applicable ASTM specification requirements.

4.10 JOINTS

- A. Joints must be constructed as shown on the plans and in accordance with these requirements. All joints must be constructed with their faces perpendicular to the surface of the pavement and finished or edged as shown on the plans. Joints must not vary more than 1/2 inch (12 mm) from their designated position and must be true to line with not more than 1/4 inch (6 mm) variation in 10 feet (3 m). The surface across the joints must be tested with a 12 feet (3 m) straightedge as the joints are finished and any irregularities in excess of 1/4 inch (6 mm) must be corrected before the concrete has hardened. All joints must be so prepared, finished, or cut to provide a groove of uniform width and depth as shown on the plans.
- B. Construction. Longitudinal construction joints must be slip-formed or formed against side forms as shown in the plans.

Transverse construction joints must be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for more than 30 minutes or it appears that the concrete will obtain its initial set before fresh concrete arrives. The installation of the joint must be located at a planned contraction or expansion joint. If placing of the concrete is stopped, the Contractor must remove the excess concrete back to the previous planned joint.
- C. Contraction. Contraction joints must be installed at the locations and spacing as shown on the plans. Contraction joints must be installed to the dimensions required by forming a groove or cleft in the top of the slab while the concrete is still plastic or by sawing a groove into the concrete surface after the concrete has hardened. When the groove is formed in plastic concrete the sides of the grooves must be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish must be according to the manufacturer's instructions. The groove must be finished or cut clean so that spalling will be avoided at intersections with other joints. Grooving or sawing must produce a slot at least 1/8 inch (3 mm) wide and to the depth shown on the plans.

- D. Isolation (expansion). Isolation joints must be installed as shown on the plans. The premolded filler of the thickness as shown on the plans, must extend for the full depth and width of the slab at the joint, except for space for sealant at the top of the slab. The filler must be securely staked or fastened into position perpendicular to the proposed finished surface. A cap must be provided to protect the top edge of the filler and to permit the concrete to be placed and finished. After the concrete has been placed and struck off, the cap must be carefully withdrawn leaving the space over the premolded filler. The edges of the joint must be finished and tooled while the concrete is still plastic. Any concrete bridging the joint space must be removed for the full width and depth of the joint.
- E. Tie bars. Tie bars must consist of deformed bars installed in joints as shown on the plans. Tie bars must be placed at right angles to the centerline of the concrete slab and must be spaced at intervals shown on the plans. They must be held in position parallel to the pavement surface and in the middle of the slab depth. When tie bars extend into an unpaved lane, they may be bent against the form at longitudinal construction joints, unless threaded bolt or other assembled tie bars are specified. Tie bars must not be painted, greased, or enclosed in sleeves. When slip-form operations call for tie bars, two-piece hook bolts can be installed.
- F. Dowel bars. Dowel bars or other load-transfer units of an approved type must be placed across joints as shown on the plans. They must be of the dimensions and spacings as shown and held rigidly in the middle of the slab depth in the proper horizontal and vertical alignment by an approved assembly device to be left permanently in place. The dowel or load-transfer and joint devices must be rigid enough to permit complete assembly as a unit ready to be lifted and placed into position. The dowels must be coated with a bond-breaker or other lubricant recommended by the manufacturer and approved by the Commissioner.
- Dowels bars at longitudinal construction joints must be bonded in drilled holes.
- G. Placing dowels and tie bars. The method used in installing and holding dowels in position must ensure that the error in alignment of any dowel from its required horizontal and vertical alignment after the pavement has been completed will not be greater than 1/8 inch per feet. Except as otherwise specified below, horizontal spacing of dowels must be within a tolerance of $\pm 5/8$ inch. The vertical location on the face of the slab must be within a tolerance of $\pm 1/2$ inch. The vertical alignment of the dowels must be measured parallel to the designated top surface of the pavement, except for those across the crown or other grade

change joints. Dowels across crowns and other joints at grade changes must be measured to a level surface. Horizontal alignment must be checked perpendicular to the joint edge. The horizontal alignment must be checked with a framing square. Dowels must not be placed closer than 0.6 times the dowel bar length to the planned joint line. If the last regularly spaced longitudinal dowel is closer than that dimension, it must be moved away from the joint to a location 0.6 times the dowel bar length, but not closer than 6 inches to its nearest neighbor. The portion of each dowel intended to move within the concrete or expansion cap must be wiped clean and coated with a thin, even film of lubricating oil or light grease before the concrete is placed. Dowels must be installed as specified in the following subparagraphs.

1. Contraction joints. Dowels and tie bars in longitudinal and transverse contraction joints within the paving lane must be held securely in place, as indicated, by means of rigid metal frames or basket assemblies of an approved type. The basket assemblies must be held securely in the proper location by means of suitable pins or anchors. Do not cut or crimp the dowel basket tie wires. At the Contractor's option, in lieu of the above, dowels and tie bars in contraction joints must be installed near the front of the paver by insertion into the plastic concrete using approved equipment and procedures. Approval will be based on the results of a preconstruction demonstration, showing that the dowels and tie bars are installed within specified tolerances.
2. Construction joints. Install dowels and tie bars by the cast-in-place or the drill-and-dowel method. Installation by removing and replacing in preformed holes will not be permitted. Dowels and tie bars must be prepared and placed across joints where indicated, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms. The spacing of dowels and tie bars in construction joints must be as indicated.
3. Dowels installed in isolation joints and other hardened concrete. Install dowels for isolation joints and in other hardened concrete by bonding the dowels into holes drilled into the hardened concrete. The concrete must have cured for seven (7) days or reached a minimum flexural strength of 450 psi before drilling commences. Holes 1/8 inch greater in diameter than the dowels must be drilled into the hardened concrete using rotary-core drills. Rotary-percussion drills may be used, provided that excessive spalling does not occur to the concrete joint face. Modification of the equipment and operation must be required if,

in the Commissioner's opinion, the equipment and/or operation is causing excessive damage. Depth of dowel hole must be within a tolerance of $\pm 1/2$ inch of the dimension shown on the drawings. On completion of the drilling operation, the dowel hole must be blown out with oil-free, compressed air. Dowels must be bonded in the drilled holes using epoxy resin. Epoxy resin must be injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel will not be permitted. The dowels must be held in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic grout retention ring fitted around the dowel. Dowels required to be installed in any joints between new and existing concrete must be grouted in holes drilled in the existing concrete, all as specified above.

- H. Sawing of joints. Joints must be cut as shown on the plans. Equipment must be as described in paragraph 501-4.1. The circular cutter must be capable of cutting a groove in a straight line and must produce a slot at least 1/8 inch (3 mm) wide and to the depth shown on the plans. The top of the slot must be widened by sawing to provide adequate space for joint sealers as shown on the plans. Sawing must commence, without regard to day or night, as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing and before uncontrolled shrinkage cracking of the pavement occurs and must continue without interruption until all joints have been sawn. The joints must be sawn at the required spacing. All slurry and debris produced in the sawing of joints must be removed by vacuuming and washing. Curing compound or system must be reapplied in the initial sawcut and maintained for the remaining cure period.

4.11 FINISHING

- A. Finishing operations must be a continuing part of placing operations starting immediately behind the strike-off of the paver. Initial finishing must be provided by the transverse screed or extrusion plate. The sequence of operations must be transverse finishing, longitudinal machine floating if used, straightedge finishing, texturing, and then edging of joints. Finishing must be by the machine method. The hand method must be used only on isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. Supplemental hand finishing for machine finished pavement must be kept to an absolute minimum. Any machine finishing operation which requires appreciable hand finishing, other than a moderate amount of straightedge finishing, must be immediately stopped and proper adjustments made or the equipment replaced. Any

operations which produce more than 1/8 inch (3 mm) of mortar-rich surface (defined as deficient in plus U.S. No. 4 (4.75 mm) sieve size aggregate) must be halted immediately and the equipment, mixture, or procedures modified as necessary. Compensation must be made for surging behind the screeds or extrusion plate and settlement during hardening and care must be taken to ensure that paving and finishing machines are properly adjusted so that the finished surface of the concrete (not just the cutting edges of the screeds) will be at the required line and grade. Finishing equipment and tools must be maintained clean and in an approved condition. At no time must water be added to the surface of the slab with the finishing equipment or tools, or in any other way, except for fog (mist) sprays specified to prevent plastic shrinkage cracking.

1. Machine finishing with slipform pavers. The slipform paver must be operated so that only a very minimum of additional finishing work is required to produce pavement surfaces and edges meeting the specified tolerances. Any equipment or procedure that fails to meet these specified requirements must immediately be replaced or modified as necessary. A self-propelled non-rotating pipe float may be used while the concrete is still plastic, to remove minor irregularities and score marks. Only one pass of the pipe float must be allowed. If there is concrete slurry or fluid paste on the surface that runs over the edge of the pavement, the paving operation must be immediately stopped and the equipment, mixture, or operation modified to prevent formation of such slurry. Any slurry which does run down the vertical edges must be immediately removed by hand, using stiff brushes or scrapers. No slurry, concrete or concrete mortar must be used to build up along the edges of the pavement to compensate for excessive edge slump, either while the concrete is plastic or after it hardens.
2. Machine finishing with fixed forms. The machine must be designed to straddle the forms and must be operated to screed and consolidate the concrete. Machines that cause displacement of the forms must be replaced. The machine must make only one pass over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, the operation must be immediately stopped and the equipment, mixture, and procedures adjusted as necessary.
3. Other types of finishing equipment. Clary screeds, other rotating tube floats, or bridge deck finishers are not allowed on mainline paving, but may be allowed on irregular or odd-shaped slabs,

and near buildings or trench drains, subject to the Commissioner's approval.

Bridge deck finishers must have a minimum operating weight of 7500 pounds (3400 kg) and must have a transversely operating carriage containing a knock-down auger and a minimum of two immersion vibrators. Vibrating screeds or pans must be used only for isolated slabs where hand finishing is permitted as specified, and only where specifically approved.

4. Hand finishing. Hand finishing methods will not be permitted, except under the following conditions: (1) in the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade and (2) in areas of narrow widths or of irregular dimensions where operation of the mechanical equipment is impractical. Use hand finishing operations only as specified below.
 - a. Equipment and screed. In addition to approved mechanical internal vibrators for consolidating the concrete, provide a strike-off and tamping screed and a longitudinal float for hand finishing. The screed must be at least one foot (30 cm) longer than the width of pavement being finished, of an approved design, and sufficiently rigid to retain its shape, and must be constructed of metal or other suitable material shod with metal. The longitudinal float must be at least 10 feet (3 m) long, of approved design, and rigid and substantially braced, and must maintain a plane surface on the bottom. Grate tampers (jitterbugs) must not be used.
 - b. Finishing and floating. As soon as placed and vibrated, the concrete must be struck off and screeded to the crown and cross-section and to such elevation above grade that when consolidated and finished, the surface of the pavement will be at the required elevation. In addition to previously specified complete coverage with handheld immersion vibrators, the entire surface must be tamped with the strike-off and tamping template, and the tamping operation continued until the required compaction and reduction of internal and surface voids are accomplished. Immediately following the final tamping of the surface, the pavement must be floated longitudinally from bridges resting on the side forms and spanning but not touching the concrete. If necessary, additional concrete must be placed, consolidated and screeded, and the float operated until a satisfactory surface has been produced.

The floating operation must be advanced not more than half the length of the float and then continued over the new and previously floated surfaces.

5. Straightedge testing and surface correction. After the pavement has been struck off and while the concrete is still plastic, it must be tested for trueness with a Contractor furnished 12-foot (3.7-m) straightedge swung from handles 3 feet (1 m) longer than one-half the width of the slab. The straightedge must be held in contact with the surface in successive positions parallel to the centerline and the whole area gone over from one side of the slab to the other, as necessary. Advancing must be in successive stages of not more than one-half the length of the straightedge. Any excess water and laitance in excess of 1/8 inch (3 mm) thick must be removed from the surface of the pavement and wasted. Any depressions must be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas must be cut down and refinished. Special attention must be given to assure that the surface across joints meets the smoothness requirements of paragraph 501-5.2e(3). Straightedge testing and surface corrections must continue until the entire surface is found to be free from observable departures from the straightedge and until the slab conforms to the required grade and cross-section. The use of long-handled wood floats must be confined to a minimum; they may be used only in emergencies and in areas not accessible to finishing equipment. This straight-edging is not a replacement for the straightedge testing of paragraph 501-5.2e(3), Smoothness.

4.12 SURFACE TEXTURE

- A. The surface of the pavement must be finished with either a brush or broom, burlap drag, or artificial turf finish for all newly constructed concrete pavements. It is important that the texturing equipment not tear or unduly roughen the pavement surface during the operation. Any imperfections resulting from the texturing operation must be corrected to the satisfaction of the Commissioner.
- B. Brush. If the pavement surface texture is to be a type of brush, it must be applied when the water sheen has practically disappeared. The equipment must operate transversely across the pavement surface, providing corrugations that are uniform in appearance and approximately 1/16 inch (2 mm) in depth.

4.13 CURING

- A. Immediately after finishing operations are completed and marring of the concrete will not occur, the entire surface of the newly placed concrete must be cured for a 7-day cure period in accordance with one

of the methods below. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, must be cause for immediate suspension of concreting operations. The concrete must not be left exposed for more than 1/2 hour during the curing period.

- B. When a two-sawcut method is used to construct the contraction joint, the curing compound must be applied to the sawcut immediately after the initial cut has been made. The sealant reservoir must not be sawed until after the curing period has been completed. When the one cut method is used to construct the contraction joint, the joint must be cured with wet rope, wet rags, or wet blankets. The rags, ropes, or blankets must be kept moist for the duration of the curing period.
- C. Impervious membrane method. The entire surface of the pavement must be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place. The curing compound must not be applied during rainfall. Curing compound must be applied by mechanical sprayers under pressure at the rate of one gallon (4 liters) to not more than 150 sq ft (14 sq m). The spraying equipment must be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound must be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application the compound must be stirred continuously by mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. When hand spraying is approved by the Commissioner, a double application rate must be used to ensure coverage. The curing compound must be of such character that the film will harden within 30 minutes after application. Should the film become damaged from any cause, including sawing operations, within the required curing period, the damaged portions must be repaired immediately with additional compound or other approved means. Upon removal of side forms, the sides of the exposed slabs must be protected immediately to provide a curing treatment equal to that provided for the surface. Curing must be applied immediately after the bleed water is gone from the surface.
- D. White burlap-polyethylene sheets. The surface of the pavement shall be entirely covered with the sheeting. The sheeting used shall be such length (or width) that it will extend at least twice the thickness of the pavement beyond the edges of the slab. The sheeting shall be placed so that the entire surface and both edges of the slab are completely covered. The sheeting shall be placed and weighted to remain in contact with the surface covered, and the covering shall be maintained

fully saturated and in position for seven (7) days after the concrete has been placed.

- E. Water method. The entire area shall be covered with burlap or other water absorbing material. The material shall be of sufficient thickness to retain water for adequate curing without excessive runoff. The material shall be kept wet at all times and maintained for seven (7) days. When the forms are stripped, the vertical walls shall also be kept moist. It shall be the responsibility of the Contractor to prevent ponding of the curing water on the subbase.
- F. Concrete protection for cold weather. The concrete must be maintained at an ambient temperature of at least 50°F (10°C) for a period of 72 hours after placing and at a temperature above freezing for the remainder of the curing time. The Contractor must be responsible for the quality and strength of the concrete placed during cold weather; and any concrete damaged must be removed and replaced at the Contractor's expense.
- G. Concrete protection for hot weather. Concrete should be continuously moisture cured for the entire curing period and must commence as soon as the surfaces are finished and continue for at least 24 hours. However, if moisture curing is not practical beyond 24 hours, the concrete surface must be protected from drying with application of a liquid membrane-forming curing compound while the surfaces are still damp. Other curing methods may be approved by the Commissioner.

4.14 REMOVING FORMS

- A. Unless otherwise specified, forms must not be removed from freshly placed concrete until it has hardened sufficiently to permit removal without chipping, spalling, or tearing. After the forms have been removed, the sides of the slab must be cured as per the methods indicated in paragraph 501-4.13. Major honeycombed areas must be considered as defective work and must be removed and replaced in accordance with paragraph 501-5.2(f).

4.15 SAW-CUT GROOVING

- A. If shown on the plans, grooved surfaces must be provided in accordance with the requirements of Item P-621.

4.16 SEALING JOINTS

- A. The joints in the pavement must be sealed in accordance with Item P-605.

4.17 PROTECTION OF PAVEMENT

- A. The Contractor must protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor's

employees and agents until accepted by the Commissioner. This must include watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, crossovers, and protection of unsealed joints from intrusion of foreign material, etc. Any damage to the pavement occurring prior to final acceptance must be repaired or the pavement replaced at the Contractor's expense.

Aggregates, rubble, or other similar construction materials must not be placed on airfield pavements. Traffic must be excluded from the new pavement by erecting and maintaining barricades and signs until the concrete is at least seven (7) days old, or for a longer period if directed by the Commissioner.

In paving intermediate lanes between newly paved pilot lanes, operation of the hauling and paving equipment will be permitted on the new pavement after the pavement has been cured for seven (7) days and the joints have been sealed or otherwise protected, and the concrete has attained a minimum field cured flexural strength of 550 psi and approved means are furnished to prevent damage to the slab edge.

All new and existing pavement carrying construction traffic or equipment must be continuously kept completely clean, and spillage of concrete or other materials must be cleaned up immediately upon occurrence.

Damaged pavements must be removed and replaced at the Contractor's expense. Slabs must be removed to the full depth, width, and length of the slab.

4.18 OPENING TO CONSTRUCTION TRAFFIC

- A. The pavement must not be opened to traffic until test specimens molded and cured in accordance with ASTM C31 have attained a flexural strength of 550 lb / square inch when tested in accordance with ASTM C78. If such tests are not conducted, the pavement must not be opened to traffic until 14 days after the concrete was placed. Prior to opening the pavement to construction traffic, all joints must either be sealed or protected from damage to the joint edge and intrusion of foreign materials into the joint. As a minimum, backer rod or tape may be used to protect the joints from foreign matter intrusion.

4.19 REPAIR, REMOVAL, OR REPLACEMENT OF SLABS

- A. General. New pavement slabs that are broken or contain cracks or are otherwise defective or unacceptable must be removed and replaced or repaired, as directed by the Commissioner and as specified hereinafter at no cost to the Owner. Spalls along joints must be repaired as specified. Removal of partial slabs is not permitted. Removal and replacement must be full depth, must be full width of the slab, and the

limit of removal must be normal to the paving lane and to each original transverse joint. The Commissioner will determine whether cracks extend full depth of the pavement and may require cores to be drilled on the crack to determine depth of cracking. Such cores must be 4 inch (100 mm) diameter, must be drilled by the Contractor and must be filled by the Contractor with a well consolidated concrete mixture bonded to the walls of the hole with epoxy resin, using approved procedures. Drilling of cores and refilling holes must be at no expense to the Owner. All epoxy resin used in this work must conform to ASTM C881, Type V. Repair of cracks as described in this section must not be allowed if in the opinion of the Commissioner the overall condition of the pavement indicates that such repair is unlikely to achieve an acceptable and durable finished pavement. No repair of cracks must be allowed in any panel that demonstrates segregated aggregate with an absence of coarse aggregate in the upper 1/8 inch (3 mm) of the pavement surface.

- B. Shrinkage cracks. Shrinkage cracks, which do not exceed 4 inches (100 mm) in depth, must be cleaned and then pressure injected with epoxy resin, Type IV, Grade 1, using procedures as approved by the Commissioner. Care must be taken to assure that the crack is not widened during epoxy resin injection. All epoxy resin injection must take place in the presence of the Commissioner. Shrinkage cracks, which exceed 4 inches (100 mm) in depth, must be treated as full depth cracks in accordance with paragraphs 4.19b and 4.19c.
- C. Slabs with cracks through interior areas. Interior area is defined as that area more than 6 inches (150 mm) from either adjacent original transverse joint. The full slab must be removed and replaced at no cost to the Owner, when there are any full depth cracks, or cracks greater than 4 inches (100 mm) in depth, that extend into the interior area.
- D. Cracks close to and parallel to joints. All cracks essentially parallel to original joints, extending full depth of the slab, and lying wholly within 6 inches (150 mm) either side of the joint must be treated as specified here. Any crack extending more than 6 inches (150 mm) from the joint must be treated as specified above in subparagraph c.
 - 1. Full depth cracks present, original joint not opened. When the original un-cracked joint has not opened, the crack must be sawed and sealed, and the original joint filled with epoxy resin as specified below. The crack must be sawed with equipment specially designed to follow random cracks. The reservoir for joint sealant in the crack must be formed by sawing to a depth of 3/4 inches (19 mm), $\pm 1/16$ inch (2 mm), and to a width of 5/8 inch (16 mm), $\pm 1/8$ inch (3 mm). Any equipment or procedure which causes raveling or spalling along the crack must be

modified or replaced to prevent such raveling or spalling. The joint sealant must be a liquid sealant as specified. Installation of joint seal must be as specified for sealing joints or as directed. If the joint sealant reservoir has been sawed out, the reservoir and as much of the lower saw cut as possible must be filled with epoxy resin, Type IV, Grade 2, thoroughly tooled into the void using approved procedures.

If only the original narrow saw cut has been made, it must be cleaned and pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures. If filler type material has been used to form a weakened plane in the transverse joint, it must be completely sawed out and the saw cut pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures. Where a parallel crack goes part way across paving lane and then intersects and follows the original joint which is cracked only for the remained of the width, it must be treated as specified above for a parallel crack, and the cracked original joint must be prepared and sealed as originally designed.

2. Full depth cracks present, original joint also cracked. At a joint, if there is any place in the lane width where a parallel crack and a cracked portion of the original joint overlap, the entire slab containing the crack must be removed and replaced for the full lane width and length.

- E. Removal and replacement of full slabs. Where it is necessary to remove full slabs, unless there are dowels present, all edges of the slab must be cut full depth with a concrete saw. All saw cuts must be perpendicular to the slab surface. If dowels, or tie bars are present along any edges, these edges must be sawed full depth just beyond the end of the dowels or tie bars. These joints must then be carefully sawed on the joint line to within one inch (25 mm) of the depth of the dowel or tie bar.

The main slab must be further divided by sawing full depth, at appropriate locations, and each piece lifted out and removed. Suitable equipment must be used to provide a truly vertical lift, and approved safe lifting devices used for attachment to the slabs. The narrow strips along doweled edges must be carefully broken up and removed using light, hand-held jackhammers, 30 lb (14 kg) or less, or other approved similar equipment.

Care must be taken to prevent damage to the dowels, tie bars, or to concrete to remain in place. The joint face below dowels must be suitably trimmed so that there is not abrupt offset in any direction greater than 1/2 inch (12 mm) and no gradual offset greater than one

inch (25 mm) when tested in a horizontal direction with a 12-foot (3.7-m) straightedge.

No mechanical impact breakers, other than the above hand-held equipment must be used for any removal of slabs. If underbreak between 1-1/2 and 4 inches (38 and 100 mm) deep occurs at any point along any edge, the area must be repaired as directed before replacing the removed slab. Procedures directed will be similar to those specified for surface spalls, modified as necessary.

If underbreak over 4 inches (100 mm) deep occurs, the entire slab containing the underbreak must be removed and replaced. Where there are no dowels or tie bars, or where they have been damaged, dowels or tie bars of the size and spacing as specified for other joints in similar pavement must be installed by epoxy grouting them into holes drilled into the existing concrete using procedures as specified. Original damaged dowels or tie bars must be cut off flush with the joint face. Protruding portions of dowels must be painted and lightly oiled. All four (4) edges of the new slab must contain dowels or original tie bars.

Placement of concrete must be as specified for original construction. Prior to placement of new concrete, the underlying material (unless it is stabilized) must be re-compacted and shaped as specified in the appropriate section of these specifications. The surfaces of all four joint faces must be cleaned of all loose material and contaminants and coated with a double application of membrane forming curing compound as bond breaker. Care must be taken to prevent any curing compound from contacting dowels or tie bars. The resulting joints around the new slab must be prepared and sealed as specified for original construction.

- F. Repairing spalls along joints. Where directed, spalls along joints of new slabs, and along parallel cracks used as replacement joints, must be repaired by first making a vertical saw cut at least one inch (25 mm) outside the spalled area and to a depth of at least 2 inch (50 mm). Saw cuts must be straight lines forming rectangular areas. The concrete between the saw cut and the joint, or crack, must be chipped out to remove all unsound concrete and at least 1/2 inch (12 mm) of visually sound concrete. The cavity thus formed must be thoroughly cleaned with high-pressure water jets supplemented with compressed air to remove all loose material. Immediately before filling the cavity, a prime coat of epoxy resin, Type III, Grade I, must be applied to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. The prime coat must be applied in a thin coating and scrubbed into the surface with a stiff-bristle brush. Pooling of epoxy resin must be avoided. The cavity must be filled with low slump Portland cement

concrete or mortar or with epoxy resin concrete or mortar. Concrete must be used for larger spalls, generally those more than 1/2 cu. ft. (0.014 m³) in size, and mortar must be used for the smaller ones. Any spall less than 0.1 cu. ft. (0.003 m³) must be repaired only with epoxy resin mortar or a Grade III epoxy resin. Portland cement concrete and mortar mixtures must be proportioned as directed and must be mixed, placed, consolidated, and cured as directed. Epoxy resin mortars must be made with Type III, Grade 1, epoxy resin, using proportions and mixing and placing procedures as recommended by the manufacturer and approved by the Commissioner. The epoxy resin materials must be placed in the cavity in layers not over 2 inches (50 mm) thick. The time interval between placement of additional layers must be such that the temperature of the epoxy resin material does not exceed 140°F (60°C) at any time during hardening. Mechanical vibrators and hand tampers must be used to consolidate the concrete or mortar. Any repair material on the surrounding surfaces of the existing concrete must be removed before it hardens. Where the spalled area abuts a joint, an insert or other bond-breaking medium must be used to prevent bond at the joint face. A reservoir for the joint sealant must be sawed to the dimensions required for other joints, or as required to be routed for cracks. The reservoir must be thoroughly cleaned and sealed with the sealer specified for the joints. If any spall penetrates half the depth of the slab or more, the entire slab must be removed and replaced as previously specified. If any spall would require over 25% of the length of any single joint to be repaired, the entire slab must be removed and replaced. Repair of spalls as described in this section must not be allowed if in the opinion of the Commissioner the overall condition of the pavement indicates that such repair is unlikely to achieve an acceptable and durable finished pavement. No repair of spalls must be allowed in any panel that demonstrates segregated aggregate with a significant absence of coarse aggregate in the upper one-eighth (1/8th) inch of the pavement surface.

- G. Diamond grinding of PCC surfaces. Diamond grinding of the hardened concrete with an approved diamond grinding machine should not be performed until the concrete is 14 days or more old and concrete has reached full minimum strength. When required, diamond grinding must be accomplished by sawing with saw blades impregnated with industrial diamond abrasive. The saw blades must be assembled in a cutting head mounted on a machine designed specifically for diamond grinding that will produce the required texture and smoothness level without damage to the pavement. The saw blades must be 1/8-inch (3-mm) wide and there must be a minimum of 55 to 60 blades per 12 inches (300 mm) of cutting head width; the actual number of blades will be determined by the Contractor and depend on the hardness of the aggregate. Each machine must be capable of cutting a path at least 3

feet (0.9 m) wide. Equipment that causes ravels, aggregate fractures, spalls or disturbance to the joints will not be permitted. The area corrected by diamond grinding the surface of the hardened concrete should not exceed 10% of the total area of any subplot. The depth of diamond grinding must not exceed 1/2 inch (13 mm) and all areas in which diamond grinding has been performed will be subject to the final pavement thickness tolerances specified. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. All pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified above, may require removing and replacing in conformance with paragraph 501-4.19.

4.20 EXISTING CONCRETE PAVEMENT REMOVAL AND REPAIR

- A. All operations must be carefully controlled to prevent damage to the concrete pavement and to the underlying material to remain in place. All saw cuts must be made perpendicular to the slab surface.
- B. Removal of existing pavement slab. When it is necessary to remove existing concrete pavement and leave adjacent concrete in place, the joint between the removal area and adjoining pavement to stay in place, including dowels or tie bars, must first be cut full depth with a standard diamond-type concrete saw. If dowels are present at this joint, the saw cut must be made full depth just beyond the end of dowels. The edge must then be carefully sawed on the joint line to within one inch of the top of the dowel. Next, a full depth saw cut must be made parallel to the joint at least 24 inches from the joint and at least 12 inches from the end of any dowels. All pavement between this last saw cut and the joint line must be carefully broken up and removed using hand-held jackhammers, 30 lb or less, or the approved light-duty equipment which will not cause stress to propagate across the joint saw cut and cause distress in the pavement which is to remain in place. Where dowels are present, care must be taken to produce an even, vertical joint face below the dowels. If the Contractor is unable to produce such a joint face, or if underbreak or other distress occurs, the Contractor must saw the dowels flush with the joint. The Contractor must then install new dowels, of the size and spacing used for other similar joints, by epoxy resin bonding them in holes drilled in the joint face as specified in paragraph 501-4.10G. All this must be at no additional cost to the Owner. Dowels of the size and spacing indicated must be installed as shown on the drawings by epoxy resin bonding them in holes drilled in the joint face as specified in paragraph 501-4.10 G. The joint face must be sawed or otherwise trimmed so that there is no abrupt offset in any direction greater than 1/2 inches and no gradual offset greater than one inch when tested in a horizontal direction with a 12-foot straightedge.

- C. Edge repair. The edge of existing concrete pavement against which new pavement abuts must be protected from damage at all times. Areas that are damaged during construction must be repaired at no cost to the Owner.
1. Spall repair. Spalls must be repaired where indicated and where directed by the Commissioner. Repair materials and procedures must be as previously specified in subparagraph 501-4.19f.
 2. Underbreak repair. All underbreak must be repaired. First, all delaminated and loose material must be carefully removed. Next, the underlying material must be recompact, without addition of any new material. Finally, the void must be completely filled with paving concrete, thoroughly consolidated. Care must be taken to produce an even joint face from top to bottom. Prior to placing concrete, the underlying material must be thoroughly moistened. After placement, the exposed surface must be heavily coated with curing compound.
 3. Underlying material. The underlying material adjacent to the edge and under the existing pavement which is to remain in place must be protected from damage or disturbance during removal operations and until placement of new concrete, and must be shaped as shown on the drawings or as directed. Sufficient material must be kept in place outside the joint line to prevent disturbance (or sloughing) of material under the pavement that is to remain in place. Any material under the portion of the concrete pavement to remain in place, which is disturbed or loses its compaction must be carefully removed and replaced with concrete as specified in paragraph 501-4.20b(2). The underlying material outside the joint line must be thoroughly compacted and moist when new concrete is placed.

PART 5 MATERIAL ACCEPTANCE

5.01 ACCEPTANCE SAMPLING AND TESTING

- A. All acceptance sampling and testing necessary to determine conformance with the requirements specified in this section, with the exception of coring for thickness determination, will be performed by the Commissioner at no cost to the Contractor. The Contractor must bear the cost of providing curing facilities for the strength specimens, per paragraph 501-5.1a(3), and coring and filling operations, per paragraph 501-5.1b(1). Testing organizations performing these tests must be accredited in accordance with ASTM C1077. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for acceptance sampling and testing must be listed on the lab accreditation. A copy of the

laboratory's current accreditation and accredited test methods must be submitted to the Commissioner prior to start of construction.

Concrete must be accepted for strength and thickness on a lot basis.

- B. A lot must consist of a day's production not to exceed 4,000 square yards.
- C. Flexural strength.
 - 1. Sampling. Each lot must be divided into four equal sublots. One sample must be taken for each subplot from the plastic concrete delivered to the job site. Sampling locations must be determined by the Commissioner in accordance with random sampling procedures contained in ASTM D3665. The concrete must be sampled in accordance with ASTM C172.
 - 2. Testing. Two (2) specimens must be made from each sample. Specimens must be made in accordance with ASTM C31 and the flexural strength of each specimen must be determined in accordance with ASTM C78. The flexural strength for each subplot must be computed by averaging the results of the two test specimens representing that subplot.

Immediately prior to testing for flexural strength, the beam must be weighed and measured for determination of a sample unit weight. Measurements must be made for each dimension; height, depth, and length, at the mid-point of the specimen and reported to the nearest 1/10 inch (3 mm). The weight of the specimen must be reported to the nearest 0.1 pound (45 gm). The sample unit weight must be calculated by dividing the sample weight by the calculated volume of the sample. This information must be reported as companion information to the measured flexural strength for each specimen.

The samples will be transported while in the molds. The curing, except for the initial cure period, will be accomplished using the immersion in saturated lime water method.

Slump, air content, and temperature tests will also be conducted by the quality assurance laboratory for each set of strength test samples, per ASTM C31.

- 3. Curing. The Contractor must provide adequate facilities for the initial curing of beams. During the 24 hours after molding, the temperature immediately adjacent to the specimens must be maintained in the range of 60° to 80°F (16° to 27°C), and loss of moisture from the specimens must be prevented. The specimens may be stored in tightly constructed wooden boxes, damp sand pits, temporary buildings at construction sites, under

wet burlap in favorable weather, or in heavyweight closed plastic bags, or using other suitable methods, provided the temperature and moisture loss requirements are met.

4. Acceptance. Acceptance of pavement for flexural strength will be determined by the Commissioner in accordance with paragraph 5.02B.

D. Pavement thickness.

1. Sampling. Each lot must be divided into four equal sublots and one core must be taken by the Contractor for each subplot. Sampling locations must be determined by the Commissioner in accordance with random sampling procedures contained in ASTM D3665. Areas, such as thickened edges, with planned variable thickness, must be excluded from sample locations.

Cores must be neatly cut with a core drill. The Contractor must furnish all tools, labor, and materials for cutting samples and filling the cored hole. Core holes must be filled by the Contractor with a non-shrink grout approved by the Commissioner within one day after sampling.

2. Testing. The thickness of the cores must be determined by the Commissioner by the average caliper measurement in accordance with ASTM C174.
3. Acceptance. Acceptance of pavement for thickness must be determined by the Commissioner in accordance with paragraph 5.02C.

- E. Partial lots. When operational conditions cause a lot to be terminated before the specified number of tests have been made for the lot, or when the Contractor and Commissioner agree in writing to allow overages or minor placements to be considered as partial lots, the following procedure will be used to adjust the lot size and the number of tests for the lot.

Where three sublots have been produced, they must constitute a lot. Where one or two sublots have been produced, they must be incorporated into the next lot or the previous lot and the total number of sublots must be used in the acceptance criteria calculation, that is, $n=5$ or $n=6$.

- F. Outliers. All individual flexural strength tests within a lot must be checked for an outlier (test criterion) in accordance with ASTM E178, at a significance level of 5%. Outliers must be discarded, and the percentage of material within specification limits (PWL) must be determined using the remaining test values.

5.02 ACCEPTANCE CRITERIA

- A. General. Acceptance will be based on the following characteristics of the completed pavement discussed in paragraph 501-5.2e:

- a. Flexural strength
- b. Thickness
- c. Smoothness
- d. Grade
- e. Edge slump

Flexural strength and thickness must be evaluated for acceptance on a lot basis using the method of estimating PWL. Acceptance using PWL considers the variability (standard deviation) of the material and the testing procedures, as well as the average (mean) value of the test results to calculate the percentage of material that is above the lower specification tolerance limit (L).

Acceptance for flexural strength will be based on the criteria contained in accordance with paragraph 5.02 E 1. Acceptance for thickness will be based on the criteria contained in paragraph 5.02 E 2. Acceptance for smoothness will be based on the criteria contained in paragraph 5.02 E 3. Acceptance for grade will be based on the criteria contained in paragraph 5.02 E 4.

The Commissioner may at any time, notwithstanding previous plant acceptance, reject and require the Contractor to dispose of any batch of concrete mixture which is rendered unfit for use due to contamination, segregation, or improper slump. Such rejection may be based on only visual inspection. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the Commissioner, and if it can be demonstrated in the laboratory, in the presence of the Commissioner, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

- B. Flexural strength. Acceptance of each lot of in-place pavement for flexural strength must be based on PWL. The Contractor must target production quality to achieve 90 PWL or higher.
- C. Pavement thickness. Acceptance of each lot of in-place pavement must be based on PWL. The Contractor must target production quality to achieve 90 PWL or higher.
- D. Percentage of material within limits (PWL). The PWL must be determined in accordance with procedures specified in Section 110 of Part Three of Three, Technical Specifications.

The lower specification tolerance limit (L) for flexural strength and thickness must be:

Lower Specification Tolerance Limit (L)

Flexural Strength	$0.93 \times$ strength specified in paragraph 501-3.1
Thickness	Lot Plan Thickness in inches, - 0.50 in

E. Acceptance criteria.

1. Flexural Strength. If the PWL of the lot equals or exceeds 90%, the lot must be acceptable. Acceptance and payment for the lot must be determined in accordance with paragraph 501-8.01.
2. Thickness. If the PWL of the lot equals or exceeds 90%, the lot must be acceptable. Acceptance and payment for the lot must be determined in accordance with paragraph 501-8.01.
3. Smoothness. As soon as the concrete has hardened sufficiently, but not later than 48 hours after placement, the surface of each lot must be tested in both longitudinal and transverse directions for smoothness to reveal all surface irregularities exceeding the tolerances specified. The Contractor must furnish paving equipment and employ methods that produce a surface for each section of pavement having an average profile index meeting the requirements of paragraph 501-8.01 C when evaluated with a profilograph; and the finished surface of the pavement must not vary more than 1/4 inch (6mm) when evaluated with a 12-foot straightedge. When the surface smoothness exceeds specification tolerances which cannot be corrected by diamond grinding of the pavement, full depth removal and replacement of pavement must be to the limit of the longitudinal placement. Corrections involving diamond grinding will be subject to the final pavement thickness tolerances specified.
 - a. Transverse measurements. Transverse measurements will be taken for each lot placed. Transverse measurements will be taken perpendicular to the pavement centerline each 50 feet or more often as determined by the Commissioner.
 - (i) Testing must be continuous across all joints, starting with one-half the length of the straight edge at the edge of pavement section being tested and then moved ahead one-half the length of the straight edge for each successive measurement. Smoothness readings will not be made across grade changes or cross slope transitions; at these

transition areas, the straightedge position must be adjusted to measure surface smoothness and not design grade or cross slope transitions. The amount of surface irregularity must be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. Deviations on final pavement > 1/4 inch (6mm) in transverse direction must be corrected with diamond grinding per paragraph 501-4.19G or by removing and replacing full depth of pavement. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area and these areas must be retested after grinding.

- (ii) The joint between lots must be tested separately to facilitate smoothness between lots. The amount of surface irregularity must be determined by placing the freestanding (unleveled) straightedge on the pavement surface, with half the straightedge on one side of the joint and the other half of the straightedge on the other side of the joint. Measure the maximum gap between the straightedge and the pavement surface in the area between these two high points. One measurement must be taken at the joint every 50 feet or more often if directed by the Commissioner. Maximum gap on final pavement surface > 1/4 inch in transverse direction must be corrected with diamond grinding per paragraph 501-4.19G or by removing and replacing full depth of surface. Each measurement must be recorded and a copy of the data must be furnished to the Commissioner at the end of each days testing.

- b. Longitudinal measurements. Longitudinal measurements will be taken for each lot placed. Longitudinal tests will be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet; and at the one third points of paving lanes when widths of paving lanes are 20 ft or greater.

- (i) Longitudinal Short Sections. Longitudinal Short Sections are when the longitudinal lot length is less than 200 feet and areas not requiring a profilograph. When approved by the Commissioner, the first and last 15 feet of the lot can also be considered as short sections for smoothness. The finished surface must not vary more than 1/4 inch when evaluated with a 12-foot straightedge. Smoothness readings will not be made across grade changes or cross slope transitions, at these transition areas, the straightedge position must be adjusted to measure surface smoothness and not design grade or cross slope transitions. Testing must be continuous across all joints, starting with one-half the length of the straight edge at the edge of pavement section being tested and then moved ahead one-half the length of the straight edge for each successive measurement. The amount of surface irregularity must be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. Deviations on final pavement surface > 1/4 inch in longitudinal direction will be corrected with diamond grinding per paragraph 501-4.19 G or by removing and replacing full depth of surface. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area and these areas must be retested after grinding.
- (ii) Profilograph Testing. Profilograph testing must be performed by the contractor using approved equipment and procedures as described as ASTM E1274. The equipment must utilize electronic recording and automatic computerized reduction of data to indicate "must grind" bumps and the Profile Index for the pavement using a 0.2 inch blanking band. The bump template must span one inch with an offset of 0.4 inches. The profilograph must be calibrated prior to use and operated by a factory or State DOT approved

operator. Profilograms must be recorded on a longitudinal scale of one inch equals 25 feet and a vertical scale of one inch equals one inch. A copy of the reduced tapes must be furnished to the Commissioner at the end of each days testing.

The pavement must have an average profile index meeting the requirements of paragraph 501-8.1c. Deviations on final surface in longitudinal direction must be corrected with diamond grinding per paragraph 501-4.19G or by removing and replacing full depth of pavement. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area and these areas must be retested after grinding.

Where corrections are necessary, second profilograph runs must be performed to verify that the corrections produced an average profile index of 15 inches per mile or less. If the initial average profile index was less than 15 inches, only those areas representing greater than 0.4 inch deviation will be re-profiled for correction verification.

4. Grade. An evaluation of the surface grade must be made by the Commissioner for compliance to the tolerances contained below. The finish grade will be determined by running levels at intervals of 50 feet or less longitudinally and all breaks in grade transversely (not to exceed 50 feet to determine the elevation of the completed pavement. The Contractor must pay the costs of surveying the level runs, and this work must be performed by a licensed surveyor. The documentation, stamped and signed by a licensed surveyor, must be provided by the Contractor to the Commissioner.
 - a. Lateral deviation. Lateral deviation from established alignment of the pavement edge must not exceed ± 0.10 feet in any lane.
 - b. Vertical deviation. Vertical deviation from established grade must not exceed ± 0.04 feet at any point.
5. Edge slump. When excessive edge slump cannot be corrected before the concrete has hardened, the area with excessive edge slump must be removed and replaced at the expense of the

Contractor as directed by the Commissioner in accordance with paragraph 501-4.08A.

- F. Removal and replacement of concrete. Any area or section of concrete that is removed and replaced must be removed and replaced back to planned joints. The Contractor must replace damaged dowels and the requirements for doweled longitudinal construction joints in paragraph 501-4.10 must apply to all contraction joints exposed by concrete removal. Removal and replacement must be in accordance with paragraph 501-4.20.

PART 6 CONTRACTOR QUALITY CONTROL

6.01 QUALITY CONTROL PROGRAM.

The Contractor must develop a Quality Control Program in accordance with Section 100 of the General Provisions. The program must address all elements that affect the quality of the pavement including but not limited to:

1. Mix Design
2. Aggregate Gradation
3. Quality of Materials
4. Stockpile Management
5. Proportioning
6. Mixing and Transportation
7. Placing and Consolidation
8. Joints
9. Dowel Placement and Alignment
10. Flexural or Compressive Strength
11. Finishing and Curing
12. Surface Smoothness

6.02 QUALITY CONTROL TESTING

- A. The Contractor must perform all quality control tests necessary to control the production and construction processes applicable to this specification and as set forth in the Quality Control Program. The testing program must include, but not necessarily be limited to, tests for aggregate gradation, aggregate moisture content, slump, and air content.

A Quality Control Testing Plan must be developed as part of the Quality Control Program.

B. Fine aggregate.

1. Gradation. A sieve analysis must be made at least twice daily in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.
2. Moisture content. If an electric moisture meter is used, at least two direct measurements of moisture content must be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests must be made per day. Tests must be made in accordance with ASTM C70 or ASTM C566.

C. Coarse Aggregate.

1. Gradation. A sieve analysis must be made at least twice daily for each size of aggregate. Tests must be made in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.
2. Moisture content. If an electric moisture meter is used, at least two direct measurements of moisture content must be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests must be made per day. Tests must be made in accordance with ASTM C566.

D. Slump. Four slump tests must be performed for each lot of material produced in accordance with the lot size defined in paragraph 501-5.1. One test must be made for each subplot. Slump tests must be performed in accordance with ASTM C143 from material randomly sampled from material discharged from trucks at the paving site. Material samples must be taken in accordance with ASTM C172.

E. Air content. Four air content tests, must be performed for each lot of material produced in accordance with the lot size defined in paragraph 501-5.1. One test must be made for each subplot. Air content tests must be performed in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag or other porous coarse aggregate, from material randomly sampled from trucks at the paving site. Material samples must be taken in accordance with ASTM C172.

F. Four unit weight and yield tests must be made in accordance with ASTM C138. The samples must be taken in accordance with ASTM C172 and at the same time as the air content tests.

6.03 CONTROL CHARTS

A. The Contractor must maintain linear control charts for fine and coarse aggregate gradation, slump, moisture content and air content.

Control charts must be posted in a location satisfactory to the Commissioner and must be kept up to date at all times. As a minimum, the control charts must identify the project number, the contract item number, the test number, each test parameter, the Action and suspension Limits, or Specification limits, applicable to each test parameter, and the Contractor's test results. The Contractor must use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor's projected data during production indicates a potential problem and the Contractor is not taking satisfactory corrective action, the Commissioner may halt production or acceptance of the material.

- B. Fine and coarse aggregate gradation. The Contractor must record the running average of the last five gradation tests for each control sieve on linear control charts. Specification limits contained in the Lower Specification Tolerance Limit (L) table above and the Control Chart Limits table below must be superimposed on the Control Chart for job control.
- C. Slump and air content. The Contractor must maintain linear control charts both for individual measurements and range (that is, difference between highest and lowest measurements) for slump and air content in accordance with the following Action and Suspension Limits.

Control Chart Limits

Control Parameter	Individual Measurements		Range Suspension Limit
	Action Limit	Suspension Limit	
Slip Form:			
Slump	+0 to -1 inch (0-25 mm)	+0.5 to -1.5 inch (13-38 mm)	±1.5 inch (38 mm)
Air Content	±1.2%	±1.8%	±2.5%
Side Form:			
Slump	+0.5 to -1 inch (13-25 mm)	+1 to -1.5 inch (25-38 mm)	±1.5 inch (38 mm)
Air Content	±1.2%	±1.8%	±2.5%

The individual measurement control charts must use the mix design target values as indicators of central tendency.

6.04 CORRECTIVE ACTION

- A. The Contractor Quality Control Program must indicate that appropriate action must be taken when the process is believed to be out of control. The Contractor Quality Control Program must detail what action will be taken to bring the process into control and must contain sets of rules to gauge when a process is out of control. As a minimum, a process

must be deemed out of control and corrective action taken if any one of the following conditions exists.

- B. Fine and coarse aggregate gradation. When two consecutive averages of five tests are outside of the specification limits in paragraph 501-2.1, immediate steps, including a halt to production, must be taken to correct the grading.
- C. Fine and coarse aggregate moisture content. Whenever the moisture content of the fine or coarse aggregate changes by more than 0.5%, the scale settings for the aggregate batcher and water batcher must be adjusted.
- D. Slump. The Contractor must halt production and make appropriate adjustments whenever:
 - 1. one point falls outside the Suspension Limit line for individual measurements or range
 - OR
 - 2. two points in a row fall outside the Action Limit line for individual measurements.
- E. Air content. The Contractor must halt production and adjust the amount of air-entraining admixture whenever:
 - 1. one point falls outside the Suspension Limit line for individual measurements or range
 - OR
 - 2. two points in a row fall outside the Action Limit line for individual measurements.

Whenever a point falls outside the Action Limits line, the air-entraining admixture dispenser must be calibrated to ensure that it is operating correctly and with good reproducibility.

PART 7 METHOD OF MEASUREMENT

7.01 MEASUREMENT

- A. Portland cement concrete pavement must be measured by the number of square yards of either plain or reinforced pavement as specified in-place, completed and accepted.
- B. Measurement for Thickened Edge PCC pavement will be measures as the number of square yards of either plain or reinforced pavement of the thicker pavement in place, completed and accepted.

PART 8 BASIS OF PAYMENT

8.01 PAYMENT

- A. Payment for concrete pavement meeting all acceptance criteria as specified in paragraph 5.02 Acceptance Criteria must be based on results of smoothness, strength and thickness tests. Payment for acceptable lots of concrete pavement must be adjusted in accordance with paragraph 8.01B for strength and thickness and 8.01D for smoothness, subject to the limitation that:

The total project payment for concrete pavement must not exceed 100 percent of the product of the contract unit price and the total number of square yards of concrete pavement used in the accepted work (See Note 1 under the Price Adjustment Schedule table below).

Payment must be full compensation for all labor, materials, tools, equipment, and incidentals required to complete the work as specified herein and on the drawings.

- B. Basis of adjusted payment. The pay factor for each individual lot must be calculated in accordance with the Price Adjustment Schedule table below. A pay factor must be calculated for both flexural strength and thickness. The lot pay factor must be the higher of the two values when calculations for both flexural strength and thickness are 100% or higher. The lot pay factor must be the product of the two values when only one of the calculations for either flexural strength or thickness is 100% or higher. The lot pay factor must be the lower of the two values when calculations for both flexural strength and thickness are less than 100%.

Price Adjustment Schedule¹

Percentage of Materials Within Specification Limits (PWL)	Lot Pay Factor (Percent of Contract Unit Price)
96 – 100	106
90 – 95	PWL + 10
75 – 90	0.5 PWL + 55
55 – 74	1.4 PWL – 12
Below 55	Reject ²

¹ Although it is theoretically possible to achieve a pay factor of 106% for each lot, actual payment in excess of 100% must be subject to the total project payment limitation specified in paragraph 501-8.01.

² The lot must be removed and replaced. However, the Commissioner may decide to allow the rejected lot to remain. In that case, if the Commissioner and Contractor agree in writing that the lot must not be removed, it must be paid for at 50% of the contract unit price and the total project payment limitation must be reduced by the amount withheld for the rejected lot.

For each lot accepted, the adjusted contract unit price must be the product of the lot pay factor for the lot and the contract unit price. Payment must be subject to the total project payment limitation specified in paragraph 501-8.01. Payment in excess of 100% for accepted lots of concrete pavement must be used to offset payment for accepted lots of concrete pavement that achieve a lot pay factor less than 100%.

- C. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
P-501-01	PAVING - PORTLAND CEMENT CONCRETE, 19"	SY
P-501-02	PAVING - PORTLAND CEMENT CONCRETE, TRANSITION SLAB	SY

- D. Basis of adjusted payment for smoothness. Price adjustment for pavement smoothness will apply to the total area of concrete within a section of pavement and must be applied in accordance the following equation and schedule:

(Square yard in section) × (original unit price per square yard) × PFm = reduction in payment for area within section

Average Profile Index (Inches Per Mile) Pavement Strength Rating			Contract Unit Price Adjustment (PFm)
Over 30,000 lb	30,000 lb or Less	Short Sections	
0 – 7	0 - 10	0 - 15	0.00
7.1 – 9	10.1 - 11	15.1 - 16	0.02
9.1 – 11	11.1 - 12	16.1 - 17	0.04
11.1 – 13	12.1 - 13	17.1 - 18	0.06
13.1 – 14	13.1 - 14	18.1 - 20	0.08
14.1 – 15	14.1 - 15	20.1 - 22	0.10
15.1 and up	15.1 and up	22.1 and up	Corrective work required

TESTING REQUIREMENTS

ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C70	Standard Test Method for Surface Moisture in Fine Aggregate

ASTM C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Standard Test Method for Materials Finer Than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C174	Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C227	Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C289	Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
ASTM C295	Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland Cement Concrete
ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregates by Drying
ASTM C642	Standard Test Method for Density, Absorption, and Voids in Hardened Concrete

ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM E178	Standard Practice for Dealing With Outlying Observations
ASTM E1274	Standard Test Method for Measuring Pavement Roughness Using a Profilograph
U.S. Army Corps of Commissioners (USACE) Concrete Research Division (CRD) C662	Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method)

MATERIAL REQUIREMENTS

ASTM A184	Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A704	Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
ASTM A706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A714	Standard Specification for High-Strength Low-Alloy Welded and Seamless Steel Pipe
ASTM A775	Standard Specification for Epoxy-Coated Steel Reinforcing Bars

ASTM A934	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A996	Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1078	Standard Specification for Epoxy-Coated Steel Dowels for Concrete Pavement
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving And Structural Construction
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting
ACI 309R	Guide for Consolidation of Concrete
AC 150/5320-6	Airport Pavement Design and Evaluation

PCA

Design and Control of Concrete Mixtures

END OF SECTION P-501

BITUMINOUS PRIME COAT

SECTION P-602

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item must consist of an application of bituminous material on the prepared base course in accordance with these Specifications and in reasonably close conformity to the lines shown on the Plans.

PART 2 MATERIALS

2.01 BITUMINOUS MATERIALS

- A. The bituminous material must conform to the requirements of Table 1.

TABLE 1
Bituminous Material

		Application Temperature	
		Degree Fahrenheit	Degree Celsius
Type and Grade	Specification		
Emulsified Asphalt			
SS-1, SS-1h	ASTM D977	75 – 130	25 – 55
CSS-1, CSS-1h	ASTM D2397	75 – 130	25 – 55
Cutback Asphalt			
RC-70	ASTM D2028	120 – 160	50 – 70

- B. The prime coat material shall be selected according to Section 403.02 of the IDOT SSRBC.

PART 3 CONSTRUCTION METHODS

3.01 WEATHER LIMITATIONS

- A. The prime coat must be applied only when the existing surface is dry or contains sufficient moisture to get uniform distribution of the bituminous material, when the atmospheric temperature is above 60 degrees Fahrenheit and when the weather is not foggy or rainy. The temperature requirements may be waived, but only when so directed by the Commissioner. At temperatures below 60 degrees Fahrenheit, RC-70 may be applied at an application temperature of 150-200 degrees Fahrenheit.

3.02 EQUIPMENT

- A. The equipment used by the Contractor must include a self-powered pressure bituminous material distributor and equipment for heating bituminous material.
- B. The distributor must be designed, equipped, maintained, and operated so that bituminous material at even heat may be applied uniformly on variable widths of surface at the specified rate. The allowable variation from the specified rate of application must not exceed 10 percent. The distributor must have pneumatic tires of such width and number that the load produced on the surface must not exceed 650 pounds per square inch of tire width. Distributor equipment must include a tachometer, pressure gages, volume-measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. The distributor must be self-powered and must be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically.
- C. If the distributor is not equipped with an operable quick shut off valve, the prime operations must be started and stopped on building paper. The Contractor must remove blotting sand prior to asphalt concrete lay down operations at no additional expense to the Commissioner.
- D. A power broom and/or blower must be provided for any required cleaning of the surface to be treated.

3.03 APPLICATION OF BITUMINOUS MATERIAL

- A. Immediately before applying the prime coat, the full width of the surface to be primed must be swept with a power broom to remove all loose dirt and other objectionable material.
- B. The bituminous material including solvent must be uniformly applied with a bituminous distributor at the rate of 0.15 to 0.30 gallons per square yard depending on the base course surface texture. The type of bituminous material and application rate will be approved by the Commissioner prior to application.
- C. Following the application, the primed surface must be allowed to dry without being disturbed until the prime coat has broken and all free moisture has evaporated or drained off the surface that it will not be picked up by traffic or equipment. This period will be determined by the Commissioner. The surface must then be maintained by the Contractor until the surfacing has been placed. Suitable precautions must be taken by the Contractor to protect the primed surface against

damage during this interval, including supplying and spreading any sand necessary to blot up excess bituminous material.

3.04 BITUMINOUS MATERIAL CONTRACTOR'S RESPONSIBILITY

- A. Samples of the bituminous materials that the Contractor proposes to use, together with a statement as to their source and character, must be submitted and approved before use of such material begins. The Contractor must require the manufacturer or producer of the bituminous materials to furnish material subject to this and all other pertinent requirements of the Contract. Only satisfactory materials, so demonstrated by service tests, will be acceptable.
- B. The Contractor must furnish vendor's certified test reports for each carload, or equivalent, of bituminous material shipped to the Project. The report must be delivered to the Commissioner before permission is granted for use of the material. The furnishing of the vendor's certified test report for the bituminous material must not be interpreted as basis for final acceptance. All such test reports must be subject to verification by testing samples of materials received for use on the Project.

3.05 FREIGHT AND WEIGHT BILLS

- A. Before the final estimate is allowed, the Contractor must file with the Commissioner receipted bills when railroad shipments are made, and certified weigh bills when materials are received in any other manner, or the bituminous materials actually used in the construction covered by the Contract. The Contractor must not remove bituminous material from the tank car or storage tank until the initial outage and temperature measurements have been taken by the Commissioner, nor must the car or tank be released until the final outage has been taken by the Commissioner.
- B. Copies of freight bills and weigh bills must be furnished to the Commissioner during the progress of the work.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. The bituminous material for prime coat will be measured by the gallon. Volume will be corrected to the volume at 50 degrees Fahrenheit in accordance with Table IV-3 of the Asphalt Institute's Manual MS-6 for emulsified asphalt. Water added to emulsified asphalt will not be measured for payment. Volume must be corrected to the volume at 60

degrees Fahrenheit in accordance with ASTM D 1250 for cutback asphalt.

- B. The bituminous material paid for will be the measured quantities used in the accepted work, provided that the measured quantities are not 10 percent over the specified application rate. Any amount of bituminous material more than 10 percent over the specified application rate for each application will be deducted from the measured quantities, except for irregular areas where hand spraying is necessary.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment will be made at the Contract unit price per gallon for bituminous prime coat. This price will be full compensation for furnishing all materials and for all preparation, delivering, and applying the materials, and for all labor, equipment, tools, and all work necessary to complete this item.
- B. Payment will be made under the following item:

ITEM NO.	DESCRIPTION	UOM
P-602-01	BITUMINOUS PRIME COAT	GAL

END OF SECTION P-602

BITUMINOUS TACK COAT

SECTION P-603

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item consist of preparing and treating a bituminous or concrete surface with bituminous material in accordance with these Specifications and in reasonably close conformity to the line shown on the Drawings.

PART 2 MATERIALS

2.01 BITUMINOUS MATERIALS

- A. The bituminous material must be emulsified asphalt, and must conform to the requirements of Table 1.

TABLE 1
Bituminous Material

Type and Grade	Specification	Application Temperature	
		Degree Fahrenheit	Degree Celsius
Emulsified Asphalt			
SS-1, SS-1h	ASTM D977	75 – 130	25 - 55
CSS-1, CSS-1h	ASTM D2397	75 – 130	25 - 55
Cutback Asphalt			
RC-70	ASTM D2028	120 – 160	50 - 70

PART 3 CONSTRUCTION METHODS

3.01 WEATHER LIMITATIONS

- A. When emulsified asphalt is used, the tack coat must be applied only when the existing surface is dry and the atmospheric temperature is above 60 degrees Fahrenheit (15 degrees Celsius). The temperature requirements may be waived, but only when so directed by the Commissioner. At temperatures below 60 degrees Fahrenheit, RC-70 may be applied at an application temperature of 150-200 degrees Fahrenheit.

3.02 EQUIPMENT

- A. The Contractor must provide equipment for heating and applying the bituminous material.
- B. The distributor must be designed, equipped, maintained, and operated so that bituminous material at even heat may be applied uniformly on variable widths of surface at the specified rate. The allowable variation from the specified rate must not exceed 10 percent. The distributor must have pneumatic tires of such width and number that the load produced on the surface must not exceed 65 pounds per square inch of tire width. Distributor equipment must include a tachometer, pressure gages, volume-measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. The distributor must be self-powered and must be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically.
- C. If the distributor is not equipped with an operable quick shut off valve, the prime operations must be started and stopped on building paper. The Contractor must remove blotting sand prior to asphalt concrete lay down operations at no additional expense to the Commissioner.
- D. A power broom and/or blower must be provided for any required cleaning of the surface to be treated.

3.03 APPLICATION OF BITUMINOUS MATERIAL

- A. Immediately before applying the tack coat, the full width of surface to be treated must be swept with a power broom and/or airblast to remove all loose dirt and other objectionable material.
- B. The bituminous material including vehicle or solvent must be uniformly applied with a bituminous distributor at the rate of 0.05 to 0.10 gallons per square yard depending on the condition of the existing surface. The application rate will be approved by the Commissioner prior to application.
- C. Following the application, the surface must be allowed to cure without being disturbed for such period of time as may be necessary to permit drying out and setting of the tack coat. This period will be determined by the Commissioner. The surface must then be maintained by the Contractor until the next course has been placed. Suitable precautions must be taken by the Contractor to protect the surface against damage during this interval.

3.04 BITUMINOUS MATERIAL-CONTRACTOR'S RESPONSIBILITY

- A. Samples of the bituminous material that the Contractor proposes to use, together with a statement as to its source and character, must be submitted and approved before use of such material begins. The Contractor must require the manufacturer or producer of the bituminous material to furnish material subject to this and all other pertinent requirements of the Contract. Only satisfactory materials so demonstrated by service tests will be acceptable.
- B. The Contractor must furnish the vendor's certified test reports for each carload, or equivalent, of bituminous material shipped to the Project. The report will be delivered to the Commissioner before permission is granted for use of the material. The furnishing of the vendor's certified test report for the bituminous material must not be interpreted as a basis for final acceptance. All such test reports must be subject to verification by testing samples of material received for use on the Project.

3.05 FREIGHT AND WEIGHT BILLS

- A. Before the final estimate is allowed, the Contractor must file with the Commissioner receipted bills when railroad shipments are made, and certified weight bills when materials are received in any other manner, of the bituminous materials actually used in the construction covered by the Contract. The Contractor must not remove bituminous material from the tank car or storage tank until the initial outage and temperature measurements have been taken by the Commissioner, nor must the car or tank be released until the final outage has been taken by the Commissioner. Copies of freight bills and weight bills will be furnished to the Commissioner during the progress of the work.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENTS

- A. The bituminous material for tack coat will be measured by the gallon. Volume will be corrected to the volume at 50 degrees Fahrenheit (15 degrees C) in accordance with Table IV-3 of the Asphalt Institute's Manual MS-6 for emulsified asphalt. Water added to emulsified asphalt will not be measured for payment. Volume must be corrected to the volume at 60 degrees Fahrenheit in accordance with ASTM D 1250 for cutback asphalt.
- B. The bituminous material paid for will be the measured quantities used in the accepted work, provided that the measured quantities are not 10

percent over the specified application rate. Any amount of bituminous material more than 10 percent over the specified application rate for each application will be deducted from the measured quantities, except for irregular areas where hand spraying is necessary.

PART 5 BASIS OF PAYMENT

5.01 PAYMENTS

- A. Payment will be made at the Contract unit price per gallon for bituminous material. This price will be full compensation for furnishing all materials, for all preparation, delivery, and application of these materials, and for all labor, equipment, tools, and all work necessary to complete the item.
- B. Payment will be made under the following item:

ITEM NO.	DESCRIPTION	UOM
P-603-01	BITUMINOUS TACK COAT	GAL

END OF SECTION P-603

JOINT SEALING FILLER

SECTION P-605

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item consists of providing and installing a resilient and adhesive joint sealing filler to effectively seal joints and cracks in pavements. The work under this Section is subject to the requirements of the Contract Documents.

PART 2 MATERIALS

2.01 JOINT SEALING MATERIALS

- A. The joint sealing materials must conform to one or more of the following types, as required by these Specifications and the details as shown on the Project Plans:
 - 1. Silicone Sealants: Joint sealant will be a one-part silicone material that cures to low-modulus rubber upon exposure to atmospheric moisture. The sealant must be recommended by its manufacturer for sealing Portland cement concrete, bituminous and asphaltic Airport pavements. The cured material must be capable of withstanding repeated cyclic movements of 100-percent extension and 50-percent compression without permanent damage or failure. Cyclic movement test must be similar to ASTM C 719 or as approved by the Commissioner.
 - 2. For Portland cement concrete-bituminous pavement joints, the joint sealant (Type A) must be manufactured by Dow, D.S. Brown, or Crafc. For Portland cement concrete – Portland cement concrete pavement construction and expansion joints, the joint sealant (Type B) must be manufactured by Dow, D.S. Brown, or Crafc.

TABLE 1
Silicone Sealant Requirements

Test Method	Test	Type A Sealant Requirements	Type B Sealant Requirements
<u>As Supplied</u>			
MIL-S-8802	Flow, maximum	Self Leveling	Nil
ASTM D-1475	Specific Gravity	1.1-1.4	1.15-1.52
ASTM C-1183	Extrusion Rate, Type S ml/minute, minimum	50	50
ASTM C-679	Maximum Tack Free Time, minutes	120	90
<u>Upon Complete Cure¹</u>			
ASTM D-2240	Durometer	20-65 (Shore 00)	10-25 (Shore A)
ASTM D-412, Die C	Joint Modulus at 150% elongation, maximum psi	30	45
ASTM D-412, Die C	Elongation, minimum %	800	800
CASTM D-5329	Tensile Adhesion, min. % elongation	600	500
<u>Performance²</u>			
ASTM C-719	Movement, 10 cycles at +100/-50%	No Failure	No Failure

¹Sample cured 21 days at 77 degrees F \pm 2 degrees F (25 degrees \pm 1 degrees C) and 50% \pm 5% relative humidity. Proper joint design and proper joint preparation are necessary for maximum performance.

²Specimens cured 28 days at 77 degrees F \pm 2 degrees and 50% \pm 5% relative humidity with no other conditioning prior to testing.

- B. Backer Rods: Preformed backer rod must be installed in all pavement construction, expansion and contraction joints as shown in the Plans. Rods must be approved, non-moisture absorbing, non-gassing, extruded, closed-cell polyethylene foam or reticulated closed cell extruded polyolefin foam. Rods must be of a sufficient diameter to support the sealant in the joint without leakage until it has cured. Backup materials must be compatible with the sealant, will not adhere to the sealant, must be compressible without extruding the sealant until the sealant cures, and must recover to maintain contact with the joint faces when the joint is open.
- C. Lubricant: Lubricant for installation of preformed joint seal must be one-component polycholoprene compound containing only soluble phenolic resins blended together with anti-oxidants and acid acceptors in aromatic hydrocarbon solvent mixture and must meet the following requirements:

	Requirements	ASTM
Average weight per gallons, pounds	7.8	
Solids content, percent by weight	22 – 28	D1644, Method A
Film strength, psi	2,300 min.	D412
Elongation, percent	750 min.	D412

1. Each shipment of lubricant must be delivered to the jobsite in the manufacturer's original sealed container. Each container must be marked with the manufacturer's name, batch or lot number, and the date of manufacture and must be accompanied by the manufacturer's certification stating that the lubricant meets the requirements of the Specification.
 2. This lubricant must be stored at a temperature between 50 degrees Fahrenheit and 80 degrees F and must be used within 270 days of its manufacture.
- D. Primer: Contractor must use an appropriate primer as recommended by the manufacturer. Primer must be compatible with the sealant and backer rod, and either manufactured by and/or approved by the sealant manufacturer.

2.02 PRELIMINARY MATERIAL ACCEPTANCE

- A. Samples of all materials Contractor proposes for use and copies of the manufacturer's recommendations for mixing and installation must be submitted to the Commissioner for approval at least forty (40) days before use.

2.03 ACCEPTANCE SAMPLING

- A. Each lot or batch of sealant or primer must be delivered to the job site in the manufacturer's original sealed container. Each container must be labeled to include the following:
1. Name of Material
 2. Manufacturer's Name
 3. Manufacturer's Lot Number
 4. Shelf Life
 5. Mixing Instructions
 6. Storage Instructions
- B. No sealant with expired shelf life will be installed.

PART 3 CONSTRUCTION METHODS

3.01 TIME OF APPLICATION

- A. As soon after completion of the curing period as feasible, Contractor must seal joints. Do not seal joints prior to seven (7) days of moisture free drying after concrete placement or per minimum manufacturer's recommendation. Except as the Commissioner may otherwise approve, Contractor must complete joint sealing before the pavement is opened to traffic including construction equipment, and in any event within 30 days after curing. The joints must be sealed immediately following the final cleaning period or as soon thereafter as weather conditions allow. At the time of application of the sealing filler materials, the atmospheric and pavement temperature must be above 40 degrees F, and the weather will not be rainy or foggy. The temperature requirement may be waived only when so directed by the Commissioner. Sealing must be performed only during daylight hours.
- B. A qualified representative of each sealant manufacturer must be present at the work site during start of sealing operations to insure adequate workmanship and inspection of the sealing operation.
- C. At a temperature of 75 degrees F (24 degrees C) and 50 percent relative humidity, silicone sealant must cure to a tack-free surface in about two hours. At a temperature of 40 degrees F (4 degrees C) the tack-free time must be about 4 hours.
- D. If the Contractor needs to use the sealed pavement for construction traffic before placement of the sealing filler materials, and if the Commissioner concurs in such use, the Contractor must temporarily fill the joints with a jute or nylon rope immediately after the joint is sawed. The rope must be slightly larger than the joint and must be forced into the joint so that the top of the rope is 1/8 inch below the pavement surface. The rope must be removed immediately before cleaning.

3.02 EQUIPMENT

- A. All equipment necessary for the proper construction of this work must be on the Project in first-class working condition. The equipment must be as recommended by the sealant manufacturer and will be approved by the Commissioner before construction is permitted to start. Air compressors must be equipped with suitable traps capable of removing all free water and oil from the compressed air and must be capable of furnishing air with a pressure greater than 90 psi at 150 ft³/min. Teflon-lined hoses will be required for silicone sealant application equipment.

3.03 PREPARATION OF JOINTS

- A. After final joint sawing is complete and immediately before sealing, the joints must be thoroughly cleaned of all resulting cement slurry, laitance, curing compound and other foreign material. Cleaning must be accomplished by sandblasting or by high pressure water blasting. Upon completion of cleaning, the joints must be blown out with compressed air. During all operations, Contractor must exercise care not to damage or remove the filler material in expansion joints. No airborne dust will be allowed.

3.04 INSTALLATION OF SEALANT

- A. Joints must be inspected for proper width, depth, alignment, and preparation, and will be approved by the Commissioner before sealing is allowed. Sealing filler materials must be installed according to the manufacturers' recommendations and the following requirements.
- B. Silicone Sealants: Before sealing the joints, the Contractor must demonstrate that the equipment and procedures for preparing, mixing, and placing the sealing materials must produce a satisfactory joint seal. This must include the preparation of two small batches of sealant and the application of the resulting material.
 - 1. To ensure that superior workmanship is achieved throughout the Work, the Contractor must construct tests as follows before commencing the Work. To evaluate workmanship of each of the Contractor's specific joint sealing crews, each will construct a test section at a location approved by the Commissioner. When the test sites are completed to the satisfaction of the Commissioner, the Contractor must be notified to proceed with the specifically approved crews in completing the work.
 - 2. To maintain an acceptable level of productivity and quality, the Contractor must complete the remaining work with the same crew members comprising the specifically approved crews. The Contractor must submit notice to the Commissioner if any personnel changes to the specifically approved crews are anticipated or experienced. If at any time during the construction of the work after a personnel change has been made, the Commissioner believes the workmanship has diminished and notifies the Contractor, the crew must halt construction. The Contractor must then reinstate the original specifically approved crews or must perform another test area to qualify the new crew. Upon a successful subsequent test section and approval of the new crew, the Contractor may proceed with the construction.

3. Sequence of backer rod installation and the primer application must be according to the sealant manufacturer's instructions. After the final cleaning with compressed air, the backer rod must be installed to the depth shown on the Plans by means of an approved roller device that ensures consistent, uniform placement. The backer rod must be butted tightly together at joint intersections, not allowing joint sealant to flow past the rod into the joint.
 4. The joint faces must be clean and dry when the sealant is applied. The sealant must be applied directly from the original drums as received at the site. The sealant must be applied in a continuous operation, with an approved mechanical device that will force the sealant to the bottom of the joint and completely fill the joint without spilling the material on the surface of the pavement. Any sealant spilled on the surface of the pavement must be removed immediately. The sealant must adhere to the joint surfaces and fill the joints uniformly solid without formation voids. Sealant that does not bond to the joint walls, contains voids, or fails to set to a tack-free condition will be rejected and replaced by the Contractor at no additional cost to the Owner.
- C. Preformed Elastomeric Joint Seals: Preformed joint sealer must be placed using equipment capable of installing the sealer in the upright position, without cutting, nicking, distorting, or otherwise damaging the seal. Lubricant must be applied to the concrete or preformed seal, or both, and the seal must be installed in a substantially compressed condition and at the depth below the surface of the pavement as shown in the Plans. The method of installation must be such that the joint sealer must not be stretched more than 4 percent of the minimum theoretical length, or compressed more than 2 percent. The method of installation must be checked for stretching or compression, using transverse joint sealer. The check must consist of installing sealer in five joints of at least 25 feet in length, removing the sealer immediately after installation, and checking the length. This check may be modified by premarking or precutting the sealer to length prior to installation if this is compatible with the equipment being used. If the measured length of any of these five sealers indicated that the sealer is stretched or compressed beyond these limits, the installation must be modified to correct the situation. Once satisfactory sealing operations have started, one joint length per every hundred must be removed and checked. If the limits are exceeded, the joint sealers on either side should be removed until the condition disappears. The affected joints must be resealed in a satisfactory manner at no cost to the Owner, and the method of installation must be checked again for satisfactory procedure. The seal must be installed and must be cut at the joint

intersections for continuous installation of the seal in the transverse joints.

3.05 WARRANTY

- A. The General Contractor must warrant, in writing, the entire joint sealing installation, regardless of installation conditions, for a period of five (5) years after the Project is substantially complete. The warranty must specifically state the sealant must prevent infiltration of water or other material through the joint under normal usage, will not flow, have loss of bond (adhesive failure), blister, crack, or lose its resiliency. Upon receipt of notice from the Commissioner of defects at any time within five years from the date of final acceptance, the Contractor must repair or replace any defective material or workmanship in a manner satisfactory and acceptable to the Commissioner.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. No measurement or direct payment will be made for joint sealing filler required for Section P-501 Portland Cement Concrete (PCC) Pavement. Joint sealing filler material for P-501 Portland Cement Concrete (PCC) Pavement is incidental to the pay items in the specification.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. No separate payment will be made for joint sealing filler for all P-501 Portland Cement Concrete (PCC) Pavement – Joints. All costs of furnishing materials, preparation, delivery, labor, and installation, equipment, tools, certification and all incidentals necessary to complete this item, including but not limited to all saw cutting, will be considered subsidiary to and included in the price paid for P-501 Portland Cement Concrete (PCC) Pavement.

END OF SECTION P-605

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STRUCTURAL PORTLAND CEMENT CONCRETE

SECTION P-610

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item must consist of either plain or reinforced cast-in-place structural Portland Cement concrete and precast concrete structures, prepared and constructed in accordance with these Specifications, at the locations and of the form and dimensions shown on the Drawings. The work under this Section is subject to the requirements of the Contract Documents. Work under this Section is subject to full-time Quality Control surveillance.

1.02 SUBMITTALS

- A. Mix designs
 - 1. Submit concrete mix designs prepared by an independent testing laboratory meeting the requirements of ASTM C1077 in accordance with ACI 301 "Specifications for Structural Concrete".
- B. Shop Drawings
 - 1. Structural concrete structure details including reinforcing steel. Reinforcement bar shop drawings are not required for the reinforced concrete islands.
- C. Test Reports
 - 1. Submit material test reports and certifications where referenced in this Specification.

1.03 REFERENCES

- A. ACI 301 – Structural Concrete for Buildings
- B. ASTM Standards
- C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction (SSRBC) latest edition

PART 2 MATERIALS

2.01 GENERAL

- A. Only approved materials, conforming to the requirements of these Specifications, must be used in the work. They may be subjected to inspection and tests at any time during the progress of their preparation or use. The source of supply of each of the materials must be approved by the Commissioner before delivery or use is started. Representative preliminary samples of the materials must be submitted by the Contractor, when required, for examination and testing. Materials must be stored and handled to insure the preservation of their quality and fitness for use and must be located to facilitate prompt inspection. All equipment for handling and transporting materials and concrete must be clean before any material or concrete is placed therein.
- B. In no case will the use of pit-run or naturally mixed aggregates be permitted. Naturally mixed aggregate must be screened and washed, and all fine and coarse aggregates must be stored separately and kept clean. The mixing of different kinds of aggregates from different sources in one storage pile or alternating batches of different aggregates will not be permitted.
- C. Reactivity: Aggregates (coarse and fine) must be tested for deleterious reactivity with alkalis in the cement, which may cause excessive expansion of the concrete. Tests of coarse and fine aggregate must be made in accordance with ASTM C1260 and C 1567 by an independent test laboratory that meets the requirements of ASTM C 1077. If the expansion of the coarse or fine aggregate test specimens, tested in accordance with ASTM C1260, does not exceed 0.10% at 28 days (30 days from casting), the coarse or fine aggregates shall be accepted. If the expansion at 28 days is greater than 0.10%, test specimens must be made in accordance with ASTM C1567 using all components (e.g. coarse aggregate, fine aggregate, cementitious materials, and/or specific reactivity reducing chemicals) in the proportions proposed for the mixture design. If the expansion of the proposed mixture design test specimens, tested in accordance with ASTM C1567 does not exceed 0.10% at 28 days, the aggregates will be accepted. If the expansion of the proposed mixture design test specimens is greater than 0.10% at 28 days, the aggregates will not be accepted unless adjustments to the mixture design can reduce the expansion to less than 0.10% at 28 days, or new aggregates must be evaluated and tested.

2.02 COARSE AGGREGATE

- A. The coarse aggregate for concrete must meet the requirements of IDOT S.S.R.B.C. Section 1004.
- B. Coarse aggregate must be well graded from coarse to fine and must meet one of the gradations shown in Table 1, using ASTM C 136. Independent certified test results not more than 30 days old must be submitted.

2.03 FINE AGGREGATE

- A. The fine aggregate for concrete must meet the requirements of IDOT S.S.R.B.C. Section 1003.
- B. The fine aggregate must be well graded from fine to coarse and must meet the requirements of Table 2, when tested in accordance with ASTM C 136. Independent certified test results not more than 30 days old must be submitted.

TABLE 1
Gradation for Coarse Aggregate

	Percentage by Weight Passing Sieves				
Sieve Designation (square openings)	1-1/2"	1"	3/4"	1/2"	No. 4
No. 4. to 3/4 in.	----	100	90-100	40-70	5-15
No. 4 to 1 in.	100	90-100	----	30-60	0-10

TABLE 2
Gradation for Fine Aggregate

Sieve Designation (square openings)	By Weight Passing Sieves
Sieve	Percentage
3/8 inch (9.5 mm)	100
No. 4 (4.75 mm)	95-100
No. 16 (1.18 mm)	45-80
No. 30 (0.60 mm)	25-55
No. 50 (0.30 mm)	10-30
No. 100 (0.15 mm)	2-10

- C. Blending will be permitted, if necessary, in order to meet the gradation requirements for fine aggregate. Fine aggregate deficient in the percentage of material passing the No. 50 mesh sieve may be accepted, provided that such deficiency does not exceed 5% and is remedied by the addition of pozzolanic or cementitious materials other than portland cement, as specified in P-610-2.06 on admixtures, in sufficient quantity to produce the required workability as acceptable to the Commissioner.

2.04 CEMENT

- A. Cement must conform to the requirements of ASTM C-150 Type I. See Paragraph 610-3.02 for the required amount of cement.
- B. The Contractor must furnish vendors' certified test reports for each carload, or equivalent, of cement shipped to the Project. The report must be delivered to the Commissioner before permission to use the cement is granted. All such test reports may be subject to verification by testing sample materials received for use on the Project.

2.05 WATER

- A. The water used in concrete must be free from sewage, oil, acid, strong alkalies, vegetable matter, and clay and loam. If the water is of questionable quality, it must be tested in accordance with AASHTO T 26. Water known to be of potable quality may be used without testing.

2.06 ADMIXTURES

- A. The use of any material added to the concrete mix must be acceptable to the Commissioner. Before acceptance of any material, the Contractor must be required to submit the results of complete physical and chemical analyses made by an acceptable testing laboratory. Subsequent tests may be made of samples taken by the Commissioner from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that accepted.
- B. Pozzolanic admixtures must be fly ash meeting the requirements of ASTM C 618, Class C or F, except that loss on ignition will be limited to 4%. The supplementary optional chemical and physical properties of tables 2 and 4 contained in ASTM C 618 will apply.
- C. Ground Granulated Blast Furnace (GGBF) slag cement may be permitted at the Contractor's option. GGBF slag must conform to

ASTM C 989, Grade 100 or 120. GGBF must be used only at a rate between 25 and 40 percent of the total cementitious material by mass

- D. Air-entraining admixtures must meet the requirements of ASTM C 260. Air-entraining admixtures must be added at the mixer in the amount necessary to produce the specified air content. The air-entrainment agent and any water-reducer admixture must be compatible.
- E. Water-reducing, set-controlling admixtures must meet the requirements of ASTM C 494, Type A, water-reducing or Type D, water-reducing and retarding.
- F. Water-reducing admixtures must be added at the mixer separately from air-entraining admixtures in accordance with the manufacturer's printed instructions.

2.07 PREMOLDED JOINT MATERIAL

- A. Premolded joint material for expansion joints must meet the requirements of ASTM D1751 or ASTM D1752.

2.08 JOINT FILLER

- A. Filler for joints must meet the requirements of Section P-605 Joint Sealing Filler, unless otherwise specified or shown on the Drawings

2.09 STEEL REINFORCEMENT

- A. Reinforcing must consist of deformed reinforcement bars conforming to the requirements of ASTM A 615 Grade 60.
- B. Welded steel wire fabric must conform to the requirements of ASTM A1064.

2.10 COVER MATERIALS FOR CURING

- A. Curing materials must conform to one of the following Specifications:
 - 1. Waterproof Paper for Curing Concrete - ASTM C 171.
 - 2. Polyethylene Sheeting for Curing Concrete - ASTM C 171.
 - 3. Liquid Membrane-Forming Compounds for Curing Concrete - ASTM C 309, Type 2.
 - 4. Water Absorptive Coverings – ASTM C 156.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

- A. The Contractor must furnish all labor, materials, and services necessary for, and included in the completion of all work as shown on the Drawings and specified herein. All machinery and equipment owned or controlled by the Contractor, which he or she proposes to use on the work, must be of sufficient size to meet the requirements of the work, and must be such as to produce satisfactory work; all work will be subject to inspection and acceptance by the Commissioner.

3.02 CONCRETE COMPOSITION

- A. Cast-in-place concrete must develop a minimum compressive strength of 4,000 pounds per square inch in 28 days, except as otherwise noted on the Plans or in the Specifications, as determined by test cylinders made in accordance with ASTM C 31 and tested in accordance with ASTM C 39. For junction chambers, cast-in-place concrete must develop a minimum compression strength of 4,500 pounds per square inch in 28 days. The concrete must contain not less than 535 pounds of total cementitious materials per cubic yard (318 kg per cubic meter). The concrete must contain 6 percent of entrained air, plus or minus 1 percent, as determined by ASTM C 231. The concrete must have a slump of not more than 4 inches (10 cm) as determined by ASTM C 143. For placement where workability may require a slump higher than 4 inches, the Contractor may adjust the slump upwards subject to the mix not exceeding a water cement ratio of 0.45, and that batch weights are obtained from the concrete supplier and the Contractor QC organization conducts calculations to ensure that the water/cement ratio is not exceeded, subject to the approval by the Commissioner on a case by case basis.
- B. The Contractor must employ at his expense, an independent quality control testing laboratory that meets the requirements of ASTM C1077 and approved by the Commissioner, to design the mix for each type of concrete required in accordance with the Specifications and Drawings. Mix designs prepared by concrete manufacturers must be tested and verified by the quality control testing laboratory for conformity with the Specifications and submitted to the Commissioner for review. No concrete will be placed until the mix design and 28 day strength test results are submitted and accepted by the Commissioner.

3.03 ACCEPTANCE SAMPLING AND TESTING

- A. Cast-in-place concrete for each structure will be accepted on the basis of the compressive strength specified in Paragraph 3.02, or as indicated on the plans. The concrete must be sampled in accordance

with ASTM C 172. Compressive strength specimens must be made by the Contractor in accordance with ASTM C 31. Tests for slump (ASTM C143), air content (ASTM C231), and temperature (ASTM C1064) must be made by the Contractor on the first load and last load and for every 50 cubic yards of each day's placement of concrete.

Compressive strength specimens (1 cylinder to be tested at 7 days, 1 at 14 days, 2 at 28 days) must be casted by the Contractor in accordance with ASTM C 31, for each 100 cubic yards placed with a minimum of one set per day's placement.

- B. The Contractor must make and initially cure and store the test specimens in accordance with ASTM C31. The Contractor must transport and deliver the test specimens to the Commissioner's laboratory for testing. A Chain of Custody form provided by the Commissioner must be used. The Contractor must be responsible for developing a system of recording the initial curing temperatures and this data must be sent to the Commissioner's laboratory with the test specimens. The Commissioner will make the actual tests on the specimens in accordance with ASTM C 39 at no expense to the Contractor.

3.04 PROPORTIONING AND MEASURING DEVICES

- A. When package cement is used, the quantity for each batch must be equal to one or more whole sacks of cement. The aggregates must be measured separately by weight. If aggregates are delivered to the mixer in batch trucks, the exact amount for each mixer charge must be contained in each batch compartment. Weighing boxes or hoppers must be approved by the Commissioner and must provide means of regulating the flow of aggregates into the batch box so that the required and exact weight of aggregates can be readily obtained.

3.05 CONSISTENCY

- A. The consistency of the concrete must be checked by the slump test specified in ASTM C 143.

3.06 MIXING

- A. Concrete may be mixed at the construction site, at a central point, and/or wholly or in part in truck mixers. The concrete must be mixed and delivered in accordance with the requirements of ASTM C 94.

3.07 MIXING CONDITIONS

- A. The concrete must be mixed only in quantities required for immediate use. Concrete must not be mixed while the air temperature is below 40 degrees F (4 degrees C) without permission of the Commissioner. If permission is granted for mixing under such conditions, aggregates or water, or both, must be heated and the concrete must be placed at a temperature not less than 50 degrees F (10 degrees C) nor more than 90 degrees F (32 degrees C). The Contractor must be held responsible for any defective work, resulting from freezing or injury in any manner during placing and curing, and must replace such work at his or her expense.
- B. No retempering of concrete by adding water or any other material is permitted.
- C. The delivery of concrete to the job must be in such a manner that batches of concrete will be deposited at uninterrupted intervals.

3.08 FORMS

- A. Concrete must not be placed until all the forms and reinforcements have been inspected and acceptable to the Commissioner. Forms must be of suitable material and must be of the type, size, shape, quality, and strength to build the structure as designed on the Plans. The forms must be true to line and grade and must be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports. The Contractor must bear responsibility for their adequacy. The surfaces of forms must be smooth and free from irregularities, dents, sags, and holes.
- B. The internal ties must be arranged so that, when the forms are removed, no metal will show in the concrete surface or discolor the surface when exposed to weathering. All forms must be wetted with water or with a nonstaining mineral oil which must be applied shortly before the concrete is placed. Forms must be constructed so that they can be removed without injuring the concrete or concrete surface. The forms must not be removed from vertical faces, walls, slender columns, and similar structures before the expiration of at least 30 hours; forms supported by falsework under slabs, beams, girders, arches, and similar construction must not be removed until tests indicate that at least 60% of the design strength of the concrete has developed.

3.09 PLACING REINFORCEMENT

- A. All reinforcement must be accurately placed, as shown on the Plans, and must be firmly held in position during concreting. Bars must be tied at all intersections except where the center to center dimension is less than 1 foot in each direction, in which case alternate intersections may be tied. The reinforcement must be supported by approved metal chairs. Shop Drawings, lists, and bending details must be supplied by the Contractor when required.

3.10 EMBEDDED ITEMS

- A. Before placing concrete, any items that are to be embedded must be firmly and securely fastened in place as indicated. All such items must be clean and free from coating, rust, scale, oil, or any foreign matter. The embedding of wood must be avoided. The concrete must be spaded and consolidated around and against embedded items.

3.11 PLACING CONCRETE

- A. All concrete must be placed during daylight, unless otherwise approved. The concrete must not be placed until the depth and character of foundation, the adequacy of forms and falsework, and the placing of the steel reinforcing have been approved by the Commissioner. Concrete must be placed as soon as practical after mixing and in no case later than 60 minutes after water has been added to the mix. The method and manner of placing must be such to avoid segregation and displacement of the reinforcement. Troughs, pipes, and chutes must be used as an aid in placing concrete when necessary. Dropping the concrete a distance of more than 5 feet, or depositing a large quantity at one point, will not be permitted. Concrete must be placed upon clean, damp surfaces, free from running water, or upon properly consolidated soil.
- B. The concrete must be compacted with suitable mechanical vibrators operating within the concrete. When necessary, vibrating must be supplemented by hand spading with suitable tools to assure proper and adequate compaction. Furnish a spare, working vibrator on the job site whenever concrete is placed. Consolidate concrete slabs greater than 4 inches in depth with highly frequency mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs 4 inches or less in depth by wood tampers, spading and settling with a heavy leveling straightedge. Operate internal vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 6000 cycles per minute. Do not use vibrators to transport the concrete in the forms. Penetrate the

previously placed lift with the vibrator when more than one lift is required. Use external vibrators on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of the concrete.

- C. Vibrators must be manipulated so as to work the concrete thoroughly around the reinforcement and embedded fixtures and into corners and angles of the forms. The vibration at any joint must be of sufficient duration to accomplish compaction but must not be prolonged to the point where segregation occurs. Concrete deposited under water must be carefully placed in a compact mass in its final position by means of a tremie, a closed bottom dump bucket, or other approved method and must not be disturbed after being deposited.

3.12 CONSTRUCTION JOINTS

- A. When the placing of concrete is suspended, necessary provisions must be made for joining future work before the placed concrete takes its initial set. For the proper bonding of old and new concrete, such provisions must be made for grooves, steps, keys, dovetails, reinforcing bars or other devices as may be prescribed. The work must be arranged so that a section begun on any day must be finished during daylight of the same day. Before depositing new concrete on or against concrete which has hardened, the surface of the hardened concrete must be cleaned by a heavy steel broom, roughened slightly, wetted, and covered with a neat coating of cement paste or grout.

3.13 EXPANSION JOINTS

- A. Expansion joints must be constructed at such points and dimensions as indicated on the Drawings. The premolded fillers must be cut to the same shape as the surfaces being joined. The filler must be fixed firmly against the surface of the concrete already in place so that it will not be displaced when concrete is deposited against it.

3.14 DEFECTIVE WORK

- A. Any defective work disclosed after the forms have been removed must be immediately removed and replaced. If any dimensions are deficient, or if the surface of the concrete is bulged, uneven, or shows honeycomb, which in the opinion of the Commissioner cannot be repaired satisfactorily, the entire section must be removed and replaced at the expense of the Contractor.

3.15 SURFACE FINISH

- A. All exposed concrete surfaces must be true, smooth and free from open or rough spaces, depressions, or projections greater than ¼-inch of the proposed finish. The concrete in horizontal plane surfaces must be brought flush with the finished top surface at the proper elevation and must be struck-off with a straightedge and floated. Mortar finishing will not be permitted, nor must dry cement or sand-cement mortar be spread over the concrete during the finishing of horizontal plane surfaces.
- B. When directed, the surface finish of exposed concrete must be a rubbed finish. If forms can be removed while the concrete is still green, the surface must be pointed and wetted and then rubbed with a wooden float until all irregularities are removed. If the concrete has hardened before being rubbed, a carborundum stone must be used to finish the surface. When approved, the finishing can be done with a rubbing machine. Surfaces subject to foot traffic must have a broom finish.

3.16 CURING AND PROTECTION

- A. All concrete must be properly cured and protected by the Contractor. The work must be protected from the elements, flowing water, and from defacement of any nature during the building operations. The concrete must be cured as soon as it has sufficiently hardened by covering with an approved material. Membrane-forming curing compound must be applied in accordance with the manufacturer's recommendations. Water-absorptive coverings must be thoroughly saturated when placed and kept saturated for a period of at least 3 days. All curing mats or blankets must be sufficiently weighted or tied down to keep the concrete surface covered and to prevent the surface from being exposed to currents of air or blown about due to the blast of jet engines. Where wooden forms are used, they must be kept wet at all times until removed to prevent the opening of joints and drying out of the concrete. Traffic or loading must not be allowed on concrete surfaces for 7 days after the concrete has been placed. If the Contractor seeks permission from the Commissioner to place traffic or load before 7 days, the Contractor QC and his laboratory must make and break additional cylinders for this purpose, subject to verification by the Commissioner.

3.17 DRAINS OR DUCTS

- A. Drainage pipes, conduits, and ducts that are to be encased in concrete must be installed by the Contractor before the concrete is placed. The

pipe must be held rigidly so that it will not be displaced or moved during the placing of the concrete.

3.18 HOT AND COLD WEATHER PROTECTION

- A. The Contractor will not be entitled to additional compensation for satisfying the hot weather or cold weather placement requirements below.
- B. The Contractor must place concrete in accordance with ACI 305R Hot Weather Concreting and ACI 306.1 Standard Specification for Cold Weather Concreting.
- C. If concrete is placed where the weather is such that the temperature of the concrete could exceed 90 degrees Fahrenheit, the Contractor must employ effective means such as pre-cooling of aggregates or using ice as necessary to maintain the temperature of concrete below 90 degrees Fahrenheit as it is placed.
- D. When concrete is placed at temperatures below 40 degrees F (4 degrees C), the Contractor must provide satisfactory methods and means to protect the mix from injury by freezing. The aggregates, or water, or both, must be heated in order to place the concrete at temperatures between 50 degrees and 90 degrees F. Snow, ice, and frost must be removed from the surfaces, including reinforcement against which concrete is to be placed. Before beginning concrete placement, the subgrade must be thawed.
- E. Calcium chloride must not be used in the concrete mix. After the concrete has been placed, the Contractor must provide sufficient protection such as cover, canvas, framework, heating apparatus, etc., to enclose and protect the structure and maintain the temperature of the mix at not less than 50 degrees F (10 degrees C) until at least 60% of the designed strength has been attained.
- F. The Contractor must submit detailed procedures for production, transportation, placement, protection curing, testing and temperature monitoring of concrete during hot or cold weather. The Hot or Cold Weather Concreting Plan must include procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

3.19 FILLING JOINTS

- A. All joints which require filling must be thoroughly cleaned, and any excess mortar or concrete must be cut out with proper tools. Joint filling must not be started until after final curing and must be done only

when the concrete is completely dry. The cleaning and filling must be carefully done with proper equipment and in a manner to obtain a neat looking joint free from excess filler.

3.20 PRECAST CONCRETE

- A. At the option of the Contractor and subject to the approval by the Commissioner, some cast-in-place structures such as manholes, handholes, and drainage structures may be substituted with precast concrete. If precast concrete is adopted, it will be subject to the requirements of the applicable portions of Sections 504, 1020, and 1042 or other Sections or articles cited elsewhere in this Specifications of the following:
 - 1. “Standard Specifications for Road and Bridge Construction: (SSRBC) prepared by the Illinois Department of Transportation, latest edition and the supplemental specifications adopted January 1, 2010. The SSRBC is referred to in the following Articles as the “Standard Specifications” and as except as may be otherwise stated, the work to be done under Precast Concrete must conform to the requirements of said “Standard Specifications”.
 - 2. Where the “Standard Specifications” refer to “Engineer”, it will be understood to mean “Commissioner”.
 - 3. Where the “Standard Specification refer to “Engineer” for required tests and inspections, it will be understood to mean “Contractor”.
 - 4. Standard Specifications articles referring to “Method of Measurement” and “Basis of Payment” are not applicable.
- B. Precast concrete materials must meet the requirements of Article 504.02 as applicable and equipment must meet the requirements of Article 504.03.
- C. The precast unit manufacturer must have a minimum of 5 years’ experience in producing precast/precast prestressed units and must have a current Prestressed Concrete Institute quality program certification which demonstrates its registration to the ISO 9002 standard or approved equal. A copy of the certification must be submitted to the Commissioner for review.
- D. Concrete materials must be combined so as to produce a concrete meeting all the requirements specified in Articles 1020.04, 1020.05,

and 1042.03 for Class PC Concrete (Mix design compressive strength of 4,500 psi minimum at 28 days) for precast structures. Other concrete mix designs proposed by the Contractor must be submitted for review and approval by the Commissioner. Aggregates must conform to the requirements of Articles 1003.02 and 1004.02 with the exception of gradation. It will be the Contractor's responsibility to determine the proportions of the materials for the concrete, and to exercise quality control with respect to the mixture, so that each batch of concrete entering into the members will meet the requirements specified. Batches of concrete not meeting the requirements as to slump and entrained air content will be rejected.

- E. Before the work begins, the Contractor must furnish the Commissioner a listing of the name, source, brand or type and/or supplier for each of the materials, and must secure the Commissioner's approval of the proportions of cement, fine aggregate, coarse aggregate, admixtures and water the Contractor proposes to use.
- F. Precast construction requirements must be in accordance with the applicable provisions of Articles 504.05 and 504.06.
- G. Slump, air content, and strength tests for precast concrete must be in accordance with the applicable provisions of Articles 1020.07, 1020.08, and 1020.09, respectively. Certified concrete test results must be submitted in a timely manner by the Contractor for review by the Commissioner. Handling, measuring, batching, and mixing of precast concrete must be in accordance with Articles 1020.10 and 1020.11. The Commissioner reserves the right to inspect and witness the manufacture of the precast units and the testing of concrete samples.
- H. Precast sections must be installed in horizontal courses. The units must be laid in mortar, sealed with external sealing bands, or sealed using mortar joint sealer. When mastic joint sealer is used, the material shall completely fill the joint after the units have been brought together. All precast units shall be installed on a 6" thick sand cushion of FA-6 compacted to 95% Modified Proctor in accordance with ASTM D1557, or as shown on the Drawings.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Special Requirements for ComEd Precast Manholes and Accessories – ComEd prefers the use of precast manholes (ComEd Standard C4381) wherever possible. ComEd precast manholes can only be

ordered and furnished from an approved ComEd vendor. Installation of precast ComEd manholes must comply with ComEd Standard C4381. Refer to CE-100, Commentary on ComEd Standards for Utility Manholes, Ductbanks, and Equipment Foundations at the CDA/OMP.METHOD OF MEASUREMENT

- B. Cast-in-place and precast Portland Cement concrete, either plain or reinforced, and the reinforcing steel will not be measured separately for payment but will be included in the unit of measurement for manholes, handholes, catch basins, junction chambers, ducts, marker light bases, sign bases, fencing and jet blast protection fence, drainage and electrical structures, electrical duct bank, light bases, and all other items which require cast-in-place and precast Portland cement concrete as specified herein.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment for Cast-in-Place and Portland cement concrete, either plain or reinforced, is incidental to the Contract unit price for designated item and unit of measurement, including but not limited to: manholes, handholes, catch basins, junction chambers, drainage and electrical structures, ductbanks, marker light bases, light bases, sign bases, fencing and jet blast protection fence and all other items which require cast-in-place and precast Portland cement concrete as specified herein. Reinforcing steel and welded wire fabric will not be paid for separately but will be included in the unit price bid for the designated item.

END OF SECTION P-610

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PAVEMENT MARKING

SECTION P-620

PART 1 DESCRIPTION

1.01 GENERAL

- A. This work consists of the painting of markings and stripes on the surface of taxiways in accordance with these Specifications, the latest version of FAA Advisory Circular 150/5340-1, Latest Revision, and at the locations shown on the Plans, or as directed by the Commissioner. The work under this Section is subject to the requirements of the Contract Documents.

PART 2 MATERIALS

2.01 MATERIALS ACCEPTANCE

- A. The Contractor must furnish manufacturer's certified test reports for the materials shipped to the Project. The certified test reports must include a statement that the materials meet the Specification requirements. The reports can be used for material acceptance or the Commissioner may perform verification testing. The reports will not be interpreted as a basis for payment. The Contractor must notify the Commissioner upon arrival of a shipment of materials to the site.

2.02 PAINT

- A. Paint must be Waterborne base in accordance with the requirements of paragraph 2.02.A.1. Paint shall be furnished in accordance with Federal Standard No. 595 *Colors used in Government Procurement*. Paint must be furnished in White – 37925, Yellow – 33538 or 33655, Red – 31136, and Black – 37038 in accordance with Federal Standard No. 595. Paint must be furnished in Type I – Standard drying time for no-pick-up or Type II – Fast drying time for no-pick-up when tested in accordance with ASTM D 711. Any pavement to be utilized immediately must be marked with waterborne paint meeting the requirements of Federal Specification TT-P-1952E. Waterborne base black paint must be used to outline a border at least 6 inches (150 mm) wide around markings on the pavements.
 - 1. WATERBORNE. Paint must meet the requirements of Federal Specification TT-P-1952E Type I or Type II.

2.03 REFLECTIVE MEDIA

- A. Glass spheres to be applied on water borne based paints must meet the requirements of Federal Specification TT-P-1325D, Type III. Glass beads must be treated with all compatible coupling agents and adhesion promoting and/or flotation coatings as specified by the manufacturers of the paint and reflective media.

Paint Color	Glass Beads, Type I, Gradation A	Glass Beads, Type III	Glass Beads, Type IV
White	See Table 1.	See Table 1.	See Table 1.
Yellow	See Table 1.	See Table 1.	See Table 1.
Red	See Table 1 and Note.	Not Used.	See Table 1 and Note.
Pink	See Table 1 and Note.	Not Used.	See Table 1 and Note.
Black	Not Used.	Not Used.	See Table 1 and Note.

PART 3 CONSTRUCTION METHODS

3.01 WEATHER LIMITATIONS

- A. The painting must be performed only when the surface is dry, when the atmospheric temperature is above 45 degrees F (7 degrees C) and rising and the pavement surface temperature is at least 5 degrees F above the dew point and when the weather is not foggy or windy. The Commissioner may specify a lower temperature in the field based on the conditions and the paint manufacturer's recommendations. Painting operations must be discontinued when the surface temperature exceeds 120 degrees F or the maximum surface temperature recommended by the paint manufacturer.

3.02 EQUIPMENT

- A. Equipment Commissioner will include the apparatus necessary to properly clean the existing surface, a mechanical marking machine, a bead and/or silica sand dispensing machine and such auxiliary hand-painting equipment as may be necessary to satisfactorily complete the job.
- B. The mechanical marker must be an atomizing spray-type marking machine suitable for application of traffic paint. It must produce an even and uniform film thickness at the required coverage and must apply markings of uniform cross sections and clear-cut edges without running or spattering and without overspray.
- C. The heater used to apply performed thermoplastic pavement markings

must be in accordance with Paragraph 3.08.

3.03 PREPARATION OF SURFACE

- A. Immediately before application of the paint, the surface must be dry and free from dirt, grease, oil, laitance, or other foreign material which would reduce the bond between the paint and the pavement. The area to be painted must be cleaned by sweeping and blowing or by other methods as required to remove all dirt, laitance, and loose materials without damage to the pavement surface.
- B. Paint must not be applied to Portland cement concrete pavement until the areas to be painted are clean of curing material. Shot blasting or water blasting will be used to remove curing materials.

3.04 LAYOUT OF MARKINGS

- A. The proposed markings must be laid out in advance of the paint application. All permanent markings must receive glass beads.
- B. Locations to receive glass beads include all taxiway centerline markings and taxiway edge markings.

3.05 TEST SECTION

- A. Prior to the application of the paint materials, the Contractor must provide a 300 linear foot test strip at a location directed by the Commissioner to include both centerline and edge striping (including edge strips around a radius fillet) for acceptance by the Commissioner. The cost of this section must be included in the work.

3.06 APPLICATION – WATERBORNE BASE PAINT

- A. Markings must be applied at the locations and to the dimensions and spacing shown on the Plans or as outlined in FAA Advisory Circular 150/5340- 1, Latest Revision. Paint must not be applied until the layout and condition of the surface have been accepted by the Commissioner.

Prior to the initial application of markings, the Contractor must certify in writing that the surface has been prepared in accordance with the paint manufacturer's requirements, that the application equipment is appropriate for marking paint and that environmental conditions are appropriate for the material being applied. Their certification along with a copy of the paint manufacturer's application and surface preparation requirements must be submitted to the Commissioner prior to the initial

application of markings.

- B. The edges of the markings must not vary from a straight line more than ½ inch in 50 feet and marking dimensions and spacings must be within the following tolerances:

Dimensions and Spacing	Tolerance
36 inches or less	+/- ½ inch
Greater than 36 inches to 6 feet	+/- 1 inch
Greater than 6 feet to 60 feet	+/- 2 inches
Greater than 60 feet	+/- 3 inches

- C. The paint must be mixed in accordance with the manufacturer's instructions and applied to the pavement with a marking machine at the rate(s) shown in Table 1. The addition of thinner will not be permitted. A period of 24 hours must elapse between placement of a bituminous surface course (4 days for a bituminous seal coat) and application of waterborne paint for temporary pavement markings. A period of 30 days must elapse between placement of a bituminous surface course and application of waterborne paint for final pavement markings.
- D. Temporary marking must be applied at 50 percent of the specified coverage rate. Glass beads will not be applied to temporary marking. However, the final marking application must be at full strength in order to adequately set the glass bead.

Table 1
Application Rates for Paint and Glass Beads

Paint Type	Paint, Square Feet per Gallon, ft ² /gal	Glass Beads, Type I, Gradation A Pounds per Gallon of Paint lb./gal.	Glass Beads, Type III, Pounds per Gallon of Paint lb./gal.	Glass Beads, Type IV, Pounds per Gallon of Paint lb./gal.
Waterborne	115 ft ² /gal. maximum	7 lb. /gal. minimum	10 lb. /gal. minimum	--
Solvent Base	115 ft ² /gal. maximum	7 lb. /gal. minimum	10 lb. /gal. minimum	--
Waterborne	90 ft ² /gal. maximum	--	--	8 lb. /gal. minimum
Solvent Base	90 ft ² /gal. maximum	--	--	8 lb. /gal. minimum

Note: The glass bead application rate for Red and Pink shall be reduced by 2 lb. / gal. for Type I and Type IV beads. Type III beads shall not be applied to Red or Pink paint.

- E. Glass beads must be distributed upon the markings immediately after application of the paint. A dispenser must be furnished that is properly designed for attachment to the marking machine and suitable for dispensing glass beads. Glass beads must be applied at the rate(s) shown in Table 1. Glass beads will not be applied to black paint. Glass beads must adhere to the cured paint or all marking operations must cease until all corrections are made.
- F. All emptied containers must be returned to the paint storage area for checking by the Commissioner. The containers will not be removed from the Airport or destroyed until authorized by the Commissioner.

3.07 PROTECTION AND CLEANUP

- A. After application of the paint, all markings must be protected from damage until the paint is dry. All surfaces must be protected from excess moisture and/or rain and from disfiguration by splatter, splashes, spillage, or drippings of paint.
- B. The Contractor must remove from the work area all debris, waste, loose or un-adhered reflective media and by-products generated by the surface preparation and application operations to the satisfaction of the Commissioner. The Contractor shall dispose of these wastes in strict compliance with all applicable state, local and Federal environmental statutes and regulations.

3.08 CONTRACTOR'S QUALIFICATIONS

- A. The Contractor must show proof that he is familiar with Airport pavement marking and that said Contractor has performed and completed such work in the past.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. The quantity of taxiway markings to be paid for will be the number of square feet of painting, excluding black paint, performed in accordance with the Specifications and accepted by the Commissioner.
- B. The quantity of black taxiway markings will not be measured separately but will be considered incidental.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment will be made at the respective Contract price per square foot for taxiway painting and for reflective media. This price will be full compensation for furnishing all materials and for all labor, equipment, tools, and all work necessary to complete the item.
- B. Black pavement marking will be considered incidental and will not be paid for separately.
- C. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
P-620-01	PAVEMENT MARKING - YELLOW	SF
P-620-02	PAVEMENT MARKING - REMOVAL	SF

END OF SECTION P-620

GEOTEXTILE FABRIC

SECTION P-629

PART 1 DESCRIPTION

1.01 GENERAL

- A. This work consists of furnishing and placing geotextile fabrics for use as shown on the Typical Sections of the Plans and Drawings, or as directed by the Commissioner or as required for use with stabilization stone. The work under this Section is subject to the requirements of the Contract Documents.

1.02 SUBMITTALS

- A. Certificate of Compliance and Factory Test Results
 - 1. Before starting the work, the Contractor must submit: A Certification of Compliance from the geotextile manufacturer that the product(s) delivered to the Project will have property values equal to or greater than those specified, and
 - 2. Factory test results of materials certified by the manufacturer as being similar, showing conformance with the requirements of these Specifications. Certified property values must be equal to the average value less two standard deviations. A swatch of the geotextile to be used must be submitted with the certification letter.
- B. For quantities over 10,000 square yards, the Contractor must furnish to the Commissioner, at least 10 working days prior to use in the work, a sample of five square yards of the geotextile from the shipment of materials to be used on the Project of verification testing. The lot number of the roll and the location of the sample obtained must be documented.
- C. After Contract award, upon request, the geotextile manufacturer must make available quality control test results for the materials delivered to the Project. Quality control sampling must be done in accordance with ASTM D4354, and the samples must be tested according to ASTM standards to grab tensile strength, trapezoidal tear strength, and puncture resistance. At least one AOS and one permeability test must be performed per lot number.

PART 2 MATERIALS

2.01 GEOTEXTILES

- A. Fibers, used in the manufacture of geotextiles, and thread, used in joining geotextiles by sewing, must consist of long chain synthetic polymers, composed of at least 95%, by weight, polypropylene or polyester. The material must be free of defects and tears and must meet or exceed the material requirements as listed below.
- B. The geotextile must meet or exceed the minimum property values in Table 1.

TABLE 1
Physical Property Requirements

Test	Woven ¹	Nonwoven ¹
Grab Tensile Strength (ASTM D-4632)	270 lbs	180 lbs
Puncture Resistance (ASTM D-4833)	100 lbs	75 lbs
Trapezoid Tear Strength (ASTM D-4533)	100 lbs	75 lbs
Apparent Opening Size (ASTM D-4751)	< 0.3 mm	
Permittivity (ASTM D-4991)	>1.5 sec ⁻¹	
Flow Rate (ASTM D-4991)	> 70 gpm/ft ²	
Ultraviolet Degradation (ASTM D-4355)	> 70% strength 500 hrs exposure	

¹Values shown are minimum average roll values with strength values based on the weaker principle direction. Specification conformance of the geotextile must be based on the ASTM D-4759 procedure.

- C. In addition to the above requirements, the following limitations will also apply:
1. If the fabric is in contact with asphalt, it must be capable of withstanding temperatures of 338 degrees F without any negative effect on material's properties.
- D. Geotextile Fabric for Temporary Erosion Control
1. Geotextile fabric materials for silt fence and temporary erosion control devices are specified separately under Section P-156 Temporary Air and Water Pollution, Soil Erosion, and Sediment Control of these specifications.

PART 3 CONSTRUCTION METHODS

3.01 PACKAGING AND STORAGE

- A. Geotextile materials delivered to the site must be furnished with an outer plastic wrapping, suitable for protection against moisture and extended ultraviolet exposure prior to placement. An opaque tarp must be placed over all rolls where the outer wrap is removed or damaged, such that the geotextile is exposed.
- B. Each roll of geotextile must be externally labeled or tagged to provide product identification sufficient for field identification, as well as inventory and quality control purposes. As a minimum, external tagging must include:
 - 1. Name of Manufacturer
 - 2. Product Type and Style
 - 3. Product Grade
 - 4. Lot Number
 - 5. Physical Dimensions (Length and width)
- C. The product grade, manufacturer's name, and lot number must be clearly marked directly on the geotextile at the beginning and end of each roll of product.
- D. Rolls must be stored in a manner which protects them from the elements. If stored outdoors, they must be elevated and protected with a waterproof cover.

3.02 INSTALLATION

- A. The installation site must be prepared by clearing and grading the areas, as indicated on the Plans. Remove all sharp objects, large stones, stumps, and other items that may tear or damage the geotextile fabric.
- B. The geotextile must be unrolled as smoothly as possible with no wrinkles or folds (except in curved sections and corners) on the prepared subgrade in the direction of construction traffic. Adjacent rolls must be overlapped 12 inches or greater, as shown on the Plans. Adjacent rolls may be connected by sewn or sealed seams, provided the seam meets or exceeds the grab strength requirement listed in 2.01.B Table 1 of this specification.

- C. For curves, the geotextile must be folded or cut and overlapped in the direction of the turn. Overlaps must be 12 inches or greater. Folds in geotextile must be stapled or pinned five feet on center.
- D. The frost protection material must be placed onto the geotextile from the edge of the fabric or over previously placed aggregate. The first lift of aggregate must be spread and graded down to a minimum depth of 12 inches or to the design thickness, if less than 12 inches. A minimum lift of six inches compacted thickness must be maintained in all cases. Compaction of the first lift must be performed by "tracking" with a dozer, followed by compaction with a smooth-drum roller to the specified density. Construction vehicles that create ruts in the apron surface of greater than three inches will not be allowed. All ruts occurring during construction must be filled with additional aggregate and compacted to the specified density. Sudden stops and starts must be avoided where possible.
- E. Holes, tears, or otherwise damaged geotextiles, as determined by the Commissioner, must be repaired immediately at the Contractor's expense. The damaged area must be cleared of all fill material, a suitable distance from the damaged area, to allow placement of a geotextile patch which extends 3 feet beyond perimeter of the damaged area. Aggregate removed must be replaced to the specified lift thickness and density.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Geotextile fabric will not be measured separately for payment, but will be considered as incidental to the associated pay item: frost protection, stabilization stone, rip rap placement, 8 inch perforated PVC pipe, and in any other areas where it is required as shown on the Drawings.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. No separate payment will be made for Geotextile Fabric. This work, including materials, labor and equipment, will be incidental to Section P-154 – Frost Protection Course or other work associated pay items.

END OF SECTION P-629

QUALITY CONTROL PROGRAM

SECTION Q-100

PART 1 GENERAL

1.01 DESCRIPTION

- A. The Contractor must establish, provide, and maintain an effective Quality Control Program that details the methods and procedures that will be taken to assure that all materials and completed construction for all work items included under this project, as described in the Contract Documents, conform to the contract requirements, whether manufactured by the Contractor or procured from subcontractors or vendors. Although guidelines are established and certain minimum requirements are specified herein and elsewhere in the contract technical specifications, the Contractor must assume full responsibility for accomplishing the stated purpose. This purpose will be included in a mission statement for the program.
- B. The intent of this section is to enable the Contractor to establish a necessary level of control prior to performing work that will:
 - 1. Adequately provide for the production of acceptable quality materials.
 - 2. Provide sufficient information to assure both the Contractor and the Commissioner that the specification requirements must be met.
 - 3. Allow the Contractor as much latitude as possible to develop its own standard of quality control.
- C. The Contractor is to discuss and present, in an oral presentation at the preconstruction conference, its understanding of the quality control requirements. The Quality Control Program will be submitted to the Commissioner at the preconstruction conference. The Contractor must not begin any construction or production of materials to be incorporated into the completed work until the Quality Control Program has been reviewed and accepted by the Commissioner. No partial payment will be made for materials subject to specific quality control requirements until the Quality Control Program has been accepted by the Commissioner.
- D. The requirements for the Contractor's Quality Control Program contained in this section are in addition to and separate from the acceptance testing requirements stated in the technical specifications.

Acceptance testing requirements will be as specified in the individual technical specifications.

- E. Paving projects over \$250,000 will have a Quality Control (QC)/Quality Assurance (QA) workshop with the Designer, Contractor, subcontractors, testing laboratories, and Commissioner's representative and the FAA prior to or at start of construction. The workshop must address QC and QA requirements of the project specifications. The Contractor will coordinate with the Commissioner and the Designer on time and location of the QC/QA workshop.

1.02 DESCRIPTION OF PROGRAM

- A. General Description. This Quality Control Program will ensure conformance to applicable specifications and plans with respect to materials, workmanship, construction, finish, and functional performance. The Quality Control Program will be effective for control of all construction work performed under this Contract and will specifically include full-time surveillance and tests required by the technical specifications, in addition to other requirements of this section and any other activities deemed necessary by the Contractor to establish an effective level of quality control.
- B. Quality Control Program. The Contractor must describe the Quality Control Program in a written document which will be reviewed by the Commissioner prior to the start of any production, construction, or off-site fabrication. The written Quality Control Program will be submitted to the Commissioner for review at the preconstruction conference.

The Quality Control Program will be organized to address, as a minimum, the following items:

1. Quality control organization;
 2. Project progress schedule;
 3. Submittals schedule;
 4. Inspection requirements;
 5. Quality control testing plan;
 6. Documentation of quality control activities; and
 7. Requirements for corrective action when quality control and/or acceptance criteria are not met.
- C. The Contractor is encouraged to add any additional elements to the Quality Control Program that it deems necessary to adequately control all production and/or construction processes required by this contract.

1.03 QUALITY CONTROL ORGANIZATION

- A. The Contractor's Quality Control Program must be implemented by the establishment of a separate quality control organization. An organizational chart must be developed to show all quality control personnel and how these personnel integrate with other management/production and construction functions and personnel. In addition, a letter from the President of the company certifying the authority given to the Program Administrator and the QC organization, in accordance with the requirements of the Contract Documents, must be included as part of the plan.
- B. The organizational chart must identify all quality control staff by name and function, and must indicate the total staff required to implement all elements of the Quality Control Program, including full-time inspection, testing and full time surveillance for each item of work. Different technicians must be utilized for specific inspection and testing functions for different items of work. If an outside organization or independent testing laboratory is used for implementation of all or part of the Quality Control Program, the personnel assigned must be subject to the qualification requirements of Paragraphs 1.03.D.1 and 1.03.D.2. The organizational chart must indicate which personnel are Contractor employees and which are provided by an outside organization. The Program Administrator will be required to conduct a documented training session, detailing the aspects of the Quality Control Program. All project foremen, superintendents, project managers and QC technicians, whether employed by the Contractor, subcontractor or outside testing organization must attend. The Commissioner will have the opportunity to have his designees attend this training. In addition, the Program Administrator will conduct a pre-activity meeting at least 2 workdays in advance of any activity of work. This meeting must be attended by the Superintendent and Foreman responsible for the work, with notification to the CM Quality Assurance Manager and Resident Engineer. QC and QA Technicians are encouraged to attend.
- C. Payment will not be made for any materials installed without Quality Control inspection by the Contractor. In addition, the Commissioner may withhold, or deny payment for an inspected item, if in the Commissioner's opinion; the Contractor's Quality Control Program is not functioning as required by the project specifications.
- D. The quality control organization will consist of the following minimum personnel:

1. Program Administrator. The Program Administrator will be a full-time employee of the Contractor, or a consultant engaged by the Contractor. The Program Administrator will be acceptable to the Commissioner and will have had prior quality control experience on a project of comparable size and scope as this contract.
 - a. Additional qualifications for the Program Administrator will include at least one (1) of the following requirements:
 - (1) Professional engineer with 1 year of airport paving experience acceptable to the Commissioner.
 - (2) Engineer-in-training with 2 years of airport paving experience acceptable to the Commissioner.
 - (3) An individual with 3 years of highway and/or airport paving experience acceptable to the Commissioner, with a Bachelor of Science Degree in Civil Engineering, Civil Engineering Technology or Construction.
 - (4) Construction materials technician certified at Level III by the National Institute for Certification in Engineering Technologies (NICET).
 - (5) Highway materials technician certified at Level III by NICET.
 - (6) Highway construction technician certified at Level III by NICET.
 - (7) A NICET certified engineering technician in Civil Engineering Technology with 5 years of highway and/or airport paving experience acceptable to the Commissioner.
 - (8) Certification of technicians at an equivalent level, by a state or nationally recognized organization will be acceptable in lieu of NICET certification.
 - b. The Program Administrator will have full authority to institute any and all actions necessary for the successful implementation of the Quality Control Program to ensure compliance with the contract plans and technical specifications. The Program Administrator will report directly to a responsible officer of the construction firm and will be independent from the field operation.
2. Quality Control Technicians. A sufficient number of quality control technicians necessary to adequately implement the Quality Control Program will be provided. These personnel will be engineers, engineering technicians, or experienced craftsman with qualifications in the appropriate field equivalent

to NICET Level II or higher construction materials technician or highway construction technician and will have a minimum of 2 years of experience in their area of expertise, and have the necessary certifications appropriate for the testing and inspection performed.

- a. The quality control technicians will report directly to the Program Administrator and will perform the following functions:
 - (1) Inspection of all materials, construction, plant, and equipment for conformance to the technical specifications, and as required by Paragraph 1.06.
 - (2) Performance of all quality control tests as required by the technical specifications and Paragraph 1.07.
 - (3) Performance of density tests for the Commissioner where required by the technical specifications.
 - b. Certification of technicians at an equivalent level, by a state or nationally recognized organization will be acceptable in lieu of NICET certification.
3. **Staffing Levels.** The Contractor must provide qualified quality control staff to monitor each work activity on a full time basis. The Commissioner will make the final determination as to the adequacy of quality control staffing levels and personnel. Where material is being produced in a plant for incorporation into the work, separate plant and field technicians will be provided at each plant and field placement location. The scheduling and coordinating of all inspection and testing must match the type and pace of work activity. The Quality Control Program will state where different technicians will be required for different work elements.

1.04 PROJECT PROGRESS SCHEDULE

- A. The Contractor must submit a coordinated construction schedule for all work activities. The schedule must be prepared as a network diagram in Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), or other format, or as otherwise specified in Part Two of the Specifications, Article VIII, Paragraph D.
- B. The Contractor must maintain a work schedule and provide an update and analysis of the progress schedule on a twice monthly basis, or as otherwise specified in the contract. Submission of the work schedule will not relieve the Contractor of overall responsibility for scheduling,

sequencing, and coordinating all work to comply with the requirements of the contract.

1.05 SUBMITTALS SCHEDULE

- A. The Contractor must submit a detailed listing of all submittals (e.g., mix designs, material certifications) and Shop Drawings prior to the start of work required by the technical specifications. The listing can be developed in a spreadsheet format and must include:
 - 1. Specification item number;
 - 2. Item description;
 - 3. Description of submittal;
 - 4. Specification paragraph requiring submittal;
 - 5. Scheduled date of submittal;
 - 6. Submittal approval level; and
 - 7. Contractor/subcontractor responsible.
- B. This spreadsheet must be produced and maintained by the Contractor's Project Manager on a bi-weekly basis and will be reviewed by the Program Administrator prior to submission to the Commissioner.

1.06 INSPECTION REQUIREMENTS

- A. Quality control inspection functions included in the Contractor's Quality Control Program will be organized to provide full-time inspections by the Contractor's personnel or by an outside organization provided by the Contractor, as detailed below. All such inspections must be documented by the Contractor as specified in Paragraph 1.08.
- B. Inspections will be performed daily to ensure continuing compliance with contract requirements until completion of the particular feature of work. These will include the following minimum requirements:
 - 1. During plant operation for material production, quality control test results and full time inspections will be utilized to ensure the quality of aggregates and other mix components, and to adjust and control mix proportioning to meet the approved mix design and other requirements of the technical specifications. All equipment utilized in proportioning and mixing will be inspected to ensure its proper operating condition. The Quality Control Program will detail how these and other quality control functions will be accomplished and utilized.

2. During field operations, quality control test results and full time inspections will be utilized to ensure the quality of all materials and workmanship. All equipment utilized in placing, finishing, and compacting will be inspected and calibrated as necessary to ensure its proper operating condition and to ensure that all such operations are in conformance to the technical specifications and are within the plan dimensions, lines, grades, and tolerances specified. The Program will document how these and other quality control functions will be accomplished and utilized.

1.07 QUALITY CONTROL TESTING PLAN

- A. As a part of the overall Quality Control Program, the Contractor must implement a quality control testing plan, as required by the technical specifications. The testing plan will include the minimum tests and test frequencies required by each technical specification Item, as well as any additional quality control tests that the Contractor deems necessary to adequately control production and/or construction processes.
- B. The testing plan can be developed in a spreadsheet fashion and will, as a minimum, include the following:
 1. Specification item number (e.g., P-401);
 2. Item description (e.g., Plant Mix Bituminous Pavements);
 3. Test type (e.g., gradation, grade, asphalt content);
 4. Test standard (e.g., ASTM or AASHTO test number, as applicable);
 5. Test frequency (e.g., as required by technical specifications or minimum frequency when requirements are not stated; where no minimum test frequency is specified for aggregate gradations, one gradation test must be run per 5000 tons per aggregate type delivered or a minimum of one test per week, and one modified proctor ASTM D 1557 test must be run at a minimum of double the frequency above, or when materials substantially change as determined by the Commissioner);
 6. Responsibility (e.g., plant technician); and
 7. Control requirements (e.g., target, permissible deviations).
- C. The testing plan will contain a statistically-based procedure of random sampling for acquiring test samples in accordance with ASTM D 3665. The Commissioner will be given access to witness all quality control sampling and testing.

- D. All quality control test results must be documented by the Contractor as specified in Paragraph 1.08.

1.08 DOCUMENTATION

- A. The Contractor must maintain current quality control records of all inspections and tests performed under the Quality Control Program. These records must include factual evidence that the required inspections or tests have been performed, including type and number of inspections or tests involved; results of inspections or tests; nature of defects, deviations, causes for rejection, etc.; proposed remedial action; and corrective actions taken.
- B. These records must cover both conforming and defective or deficient features, and must include a statement that all supplies and materials incorporated in the work are in full compliance with the Contract Documents. Legible copies of these records must be furnished to the Commissioner daily, at a time established by the Commissioner at the pre-construction conference. The records must cover all work placed subsequent to the previously furnished records and must be verified and signed by the Contractor's Program Administrator and the inspector.
- C. Specific Contractor quality control records required for the contract must include, but are not necessarily limited to, the following records:
 - 1. Daily Inspection Reports. Each Contractor quality control technician must maintain a daily log of all inspections performed for both Contractor and subcontractor operations on a form acceptable to the Commissioner. These technician's daily reports must provide factual evidence that continuous quality control inspections have been performed and will, as a minimum, include the following:
 - a. Technical specification item number and description;
 - b. Compliance with approved submittals;
 - c. Proper storage of materials and equipment;
 - d. Proper operation of all equipment;
 - e. Adherence to plans and technical specifications;
 - f. Review of quality control tests; and
 - g. Safety inspection.
- D. The daily inspection reports must identify inspections conducted, results of inspections, location and nature of defects found, causes for rejection, and remedial or corrective actions taken or proposed.

- E. The daily inspection reports will be signed by the responsible quality control technician and the Program Administrator. The Commissioner will be provided at least one legible original copy of each daily inspection reports, by 10:00 am on the work day following the day of record.
1. Daily Test Reports. The Contractor must be responsible for establishing a system which will record all quality control test results. Daily test reports must document the following information:
 - a. Technical specification item number and description;
 - b. Test designation;
 - c. Location;
 - d. Date and time of test;
 - e. Control requirements;
 - f. Test results;
 - g. Causes for rejection;
 - h. Recommended remedial actions; and
 - i. Retests.
 2. Checklists. The Quality Control Program Administrator must develop Checklists for each specification section in the Contract Documents. The Checklist must summarize the major items contained in the technical specifications and include a check box signifying compliance designated "Yes", "No" or "N/A". Each Quality Control Technician must fill out a Checklist for each specification section worked on that day. The form must also include:
 - a. Date
 - b. Shift
 - c. Specification Section
 - d. QC Conformance – Yes/No
 - e. Non-Conformance Report (NCR) Number
 - f. Contractor
 - g. Pay Item Number and Description
 - h. Location
 - i. Comments
 - j. Signatures of Technicians and Program Administrator
- F. Test results from each day's work period must be submitted to the Commissioner prior to the start of the next day's work period. When required by the technical specifications, the Contractor must maintain statistical quality control charts. The daily test reports will be signed by the responsible quality control technician and the Program Administrator.

1.09 CORRECTIVE ACTION REQUIREMENTS

- A. The Quality Control Program will indicate the appropriate action to be taken when a process is deemed, or believed, to be out of control (out of tolerance) and detail what action will be taken to bring the process into control. The requirements for corrective action will include both general requirements for operation of the Quality Control Program as a whole, and for individual items of work contained in the technical specifications.
- B. The Quality Control Program will detail how the results of quality control inspections and tests will be used for determining the need for corrective action and will contain clear sets of rules to gauge when a process is out of control and the type of correction to be taken to regain process control.
- C. When applicable or required by the technical specifications, the Contractor must establish and utilize statistical quality control charts for individual quality control tests. The requirements for corrective action will be linked to the control charts.

1.10 SURVEILLANCE BY THE COMMISSIONER

- A. All items of material and equipment will be subject to surveillance by the Commissioner at the point of production, manufacture or shipment to determine if the Contractor, producer, manufacturer or shipper maintains an adequate quality control system in conformance with the requirements detailed herein and the applicable technical specifications and plans. In addition, all items of materials, equipment and work in place will be subject to surveillance by the Commissioner at the site for the same purpose.
- B. Surveillance by the Commissioner does not relieve the Contractor of performing quality control inspections of either on-site or off-site Contractor's or subcontractor's work.
- C. Any testing performed by the Commissioner and deemed by the Contractor to be improperly performed will be noted on the Daily Inspection Report. In addition, a written document by the Program Administrator will be submitted indicating the deviation noted. Testing procedures will be considered accurate and correct unless this procedure is followed. The Contractor must not seek additional compensation for any testing irregularities not reported.
- D. Any testing performed by the Contractor and deemed by the Contractor to be improperly performed or not meeting the requirements

of the project specifications must be noted by the Contractor on their daily inspection reports.

- E. No videotaping or recording of QA or QC personnel will be permitted unless written permission is given by both parties.

1.11 NONCOMPLIANCE

- A. The Commissioner will notify the Contractor of any noncompliance with any of the foregoing requirements. The Contractor must, after receipt of such notice, immediately take corrective action. Any notice, when delivered by the Commissioner or its authorized representative to the Contractor or its authorized representative at the site of the work, must be considered sufficient notice.
- B. In cases where quality control activities do not comply with either the Contractor's Quality Control Program or the contract provisions, or where the Contractor fails to properly operate and maintain an effective Quality Control Program, as determined by the Commissioner, the Commissioner may:
 - 1. Order the Contractor in writing to replace ineffective or unqualified quality control personnel or subcontractors within 24 hours after receipt of such order.
 - 2. Order the Contractor to stop operations until appropriate corrective actions are taken.
 - 3. Withhold progress payments in the event of Contractor failure to take corrective actions within the specified time.

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION [NOT USED]

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Contractor quality control program will not be measured for payment and will be considered included in the total contract price.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. The preparation of a Quality Control Program and its implementation, including any corrective measures that may be required to be carried out by the Contractor to bring items of work into compliance with the requirements of the Quality Control Program and the technical specifications will not be paid for separately but will be included in the total Contract price.

END OF SECTION Q-100

**METHOD OF ESTIMATING PERCENTAGE OF MATERIAL
WITHIN SPECIFICATION LIMITS (PWL)
SECTION Q-110**

PART 1 DESCRIPTION

1.01 GENERAL

- A. When the specifications provide for acceptance of material based on the method of estimating percentage of material within specification limits (PWL), the PWL will be determined in accordance with this section. All test results for a lot will be analyzed statistically to determine the total estimated percent of the lot that is within specification limits. The PWL is computed using the sample average (\bar{X}) and sample standard deviation (S_n) of the specified number (n) of subplot for the lot and the specification tolerance limits, L for lower and U for upper, for the particular acceptance parameter. From these values, the respective Quality index(s) (Q_L for Lower Quality Index and/or Q_U for Upper Quality Index) is computed and the PWL for the lot for the specified n is determined from Table 1.
- B. There is some degree of uncertainty (risk) in the measurement for acceptance because only a small fraction of production material (the population) is sampled and tested. This uncertainty exists because all portions of the production have the same probability to be randomly sampled. The Contractor's risk is the probability that material produced at the acceptable quality level is rejected or subjected to a pay adjustment. The Owner's risk is the probability that material produced at the rejectable quality level is accepted.
- C. *IT IS THE INTENT OF THIS SECTION TO INFORM THE CONTRACTOR THAT, IN ORDER TO CONSISTENTLY OFFSET THE CONTRACTOR'S RISK FOR MATERIAL EVALUATED, PRODUCTION QUALITY (USING POPULATION AVERAGE AND POPULATION STANDARD DEVIATION) MUST BE MAINTAINED AT THE ACCEPTABLE QUALITY SPECIFIED OR HIGHER. IN ALL CASES, IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO PRODUCE AT QUALITY LEVELS THAT WILL MEET THE SPECIFIED ACCEPTANCE CRITERIA WHEN SAMPLED AND TESTED AT THE FREQUENCIES SPECIFIED.*

1.02 METHOD FOR COMPUTING PWL

Note: Spreadsheets for PWL calculations are available at the following website: <http://www.faa.gov/airports/engineering/design software/>.

- A. The computational sequence for computing the PWL is as follows:
1. Divide the lot into n sublots in accordance with the acceptance requirements of the specification.
 2. Locate the random sampling position within the subplot in accordance with the requirements of the specification.
 3. Make a measurement at each location, or take a test portion and make the measurement on the test portion in accordance with the testing requirements of the specification.
 4. Find the sample average of all subplot values within the lot by using the following formula:

$$\bar{X} = (x_1 + x_2 + x_3 + \dots + x_n) / n$$

Where:

\bar{X} = Average of all subplot values within a lot

x_1, x_2 = Individual subplot values

n = Number of sublots

- B. Find the sample standard deviation S_n by use of the following formula:

$$S_n = [(d_1^2 + d_2^2 + d_3^2 + \dots + d_n^2) / (n-1)]^{1/2}$$

Where:

S_n = standard deviation of the number of subplot values in the set

d_1, d_2 = deviations of the individual subplot values $X_1, X_2 \dots$ from the average value \bar{X}

that is: $d_1 = (x_1 - \bar{X}), d_2 = (x_2 - \bar{X}) \dots d_n = (x_n - \bar{X})$

n = number of sublots

- C. For single sided specification limits (i.e., L only), compute the Lower Quality Index Q_L by use of the following formula:

$$Q_L = (\bar{X} - L) / S_n$$

Where:

L = specification lower tolerance limit

Estimate the percentage of material within limits (PWL) by entering Table 1 with Q_L , using the column appropriate to the total number (n) of measurements. If the value of Q_L falls between values shown on the table, use the next higher value of PWL.

- D. For double sided specification limits (i.e. L and U), compute the Quality Indexes Q_L and Q_U by use of the following formulas:

$$Q_L = (X - L) / S_n \text{ and } Q_U = (U - X) / S_n$$

Where:

L and U = specification lower and upper tolerance limits

Estimate the percentage of material between the lower (L) and upper (U) tolerance limits (PWL) by entering Table 1 separately with Q_L and Q_U , using the column appropriate to the total number (n) of measurements, and determining the percent of material above P_L and percent of material below P_U for each tolerance limit. If the values of Q_L fall between values shown on the table, use the next higher value of P_L or P_U . Determine the PWL by use of the following formula:

$$PWL = (P_U + P_L) - 100$$

Where:

P_L = percent within lower specification limit

P_U = percent within upper specification limit

1.03 EXAMPLE OF PWL CALCULATION

Project: Example Project
Test Item: Item P-401, Lot A.

A. PWL Determination for Mat Density.

1. Density of four random cores taken from Lot A.

A-1	96.60	
A-2	97.55	
A-3	99.30	
A-4	98.35	n=4

2. Calculate average density for the lot.

$$X = (x_1 + x_2 + x_3 + \dots + x_n) / n$$

$$X = (96.60 + 97.55 + 99.30 + 98.35) / 4$$

$$X = 97.95 \text{ percent density}$$

3. Calculate the standard deviation for the lot.

$$S_n = [(96.60 - 97.95)^2 + (97.55 - 97.95)^2 + (99.30 - 97.95)^2 + (98.35 - 97.95)^2 / (4 - 1)]^{1/2}$$

$$S_n = [(1.82 + 0.16 + 1.82 + 0.16) / 3]^{1/2}$$

$$S_n = 1.15$$

4. Calculate the Lower Quality Index Q_L for the lot. ($L=96.3$)

$$Q_L = (X - L) / S_n$$

$$Q_L = (97.95 - 96.30) / 1.15$$

$$Q_L = 1.4348$$

5. Determine PWL by entering Table 1 with $Q_L = 1.43$ and $n = 4$.

$$PWL = 98$$

B. PWL Determination for Air Voids.

1. Air Voids of four random samples taken from Lot A.

A-1	5.00
A-2	3.74
A-3	2.30
A-4	3.25

2. Calculate the average air voids for the lot.

$$X = (x_1 + x_2 + x_3 + \dots + x_n) / n$$

$$X = (5.00 + 3.74 + 2.30 + 3.25) / 4$$

$$X = 3.57 \text{ percent}$$

3. Calculate the standard deviation S_n for the lot.

$$S_n = [((3.57 - 5.00)^2 + (3.57 - 3.74)^2 + (3.57 - 2.30)^2 + (3.57 - 3.25)^2) / (4 - 1)]^{1/2}$$

$$S_n = [(2.04 + 0.03 + 1.62 + 0.10) / 3]^{1/2}$$

$$S_n = 1.12$$

4. Calculate the Lower Quality Index Q_L for the lot. ($L = 2.0$)

$$Q_L = (X - L) / S_n$$

$$Q_L = (3.57 - 2.00) / 1.12$$

$$Q_L = 1.4018$$

5. Determine P_L by entering Table 1 with $Q_L = 1.40$ and $n = 4$.

$$P_L = 97$$

6. Calculate the Upper Quality Index Q_U for the lot. ($U = 5.0$)

$$Q_U = (U - X) / S_n$$

$$Q_U = (5.00 - 3.57) / 1.12$$

$$Q_U = 1.2768$$

7. Determine P_U by entering Table 1 with $Q_U = 1.28$ and $n = 4$.

$$P_U = 93$$

8. Calculate Air Voids PWL

$$PWL = (P_L + P_U) - 100$$

$$PWL = (97 + 93) - 100 = 90$$

1.04 EXAMPLE OF OUTLIER CALCULATION (Reference ASTM E178)

Project: Example Project

Test Item: Item P-401, Lot A

A. Outlier Determination for Mat Density

1. Density of four random cores taken from Lot A arranged in descending order

A-3 99.30

A-4 98.35

A-2 97.55

A-1 96.60

2. Use $n = 4$ and upper 5% significance level to find the critical value for test criterion = 1.463.
3. Use average density, standard deviation, and test criterion value to evaluate density measurements.

- a. For measurement greater than the average:

If (measurement - average) / (standard deviation) is less than test criterion, then the measurement is not considered an outlier.

For A-3, check if $(99.30 - 97.95) / 1.15$ is greater than 1.463.

Since 1.174 is less than 1.463, the value is not an outlier.

b. For measurements less than the average:

If $(\text{average} - \text{measurement}) / (\text{standard deviation})$ is less than test criterion, then the measurement is not considered an outlier.

For A-1, check if $(97.95 - 96.60) / 1.15$ is greater than 1.463.
Since 1.435 is less than 1.463, the value is not an outlier.

Note: In this example, a measurement would be considered an outlier if the density were:

Greater than $(97.95 + 1.463 \times 1.15) = 99.63\%$, or
Less than $(97.95 - 1.463 \times 1.15) = 96.27\%$.

TABLE 1								
Table for Estimating Percent of Lot Within Limits (PWL)								
Percent Within Limits (P_L and P_U)	Positive Values of Q (Q_L and Q_U)							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
99	1.1541	1.4700	1.6714	1.8008	1.8888	1.9520	1.9994	2.0362
98	1.1524	1.4400	1.6016	1.6982	1.7612	1.8053	1.8379	1.8630
97	1.1496	1.4100	1.5427	1.6181	1.6661	1.6993	1.7235	1.7420
96	1.1456	1.3800	1.4897	1.5497	1.5871	1.6127	1.6313	1.6454
95	1.1405	1.3500	1.4407	1.4887	1.5181	1.5381	1.5525	1.5635
94	1.1342	1.3200	1.3946	1.4329	1.4561	1.4716	1.4829	1.4914
93	1.1269	1.2900	1.3508	1.3810	1.3991	1.4112	1.4199	1.4265
92	1.1184	1.2600	1.3088	1.3323	1.3461	1.3554	1.3620	1.3670
91	1.1089	1.2300	1.2683	1.2860	1.2964	1.3032	1.3081	1.3118
90	1.0982	1.2000	1.2290	1.2419	1.2492	1.2541	1.2576	1.2602
89	1.0864	1.1700	1.1909	1.1995	1.2043	1.2075	1.2098	1.2115
88	1.0736	1.1400	1.1537	1.1587	1.1613	1.1630	1.1643	1.1653
87	1.0597	1.1100	1.1173	1.1191	1.1199	1.1204	1.1208	1.1212
86	1.0448	1.0800	1.0817	1.0808	1.0800	1.0794	1.0791	1.0789
85	1.0288	1.0500	1.0467	1.0435	1.0413	1.0399	1.0389	1.0382
84	1.0119	1.0200	1.0124	1.0071	1.0037	1.0015	1.0000	0.9990
83	0.9939	0.9900	0.9785	0.9715	0.9672	0.9643	0.9624	0.9610
82	0.9749	0.9600	0.9452	0.9367	0.9325	0.9281	0.9258	0.9241

TABLE 1								
Table for Estimating Percent of Lot Within Limits (PWL)								
Percent Within Limits (P _L and P _U)	Positive Values of Q (Q _L and Q _U)							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
81	0.9550	0.9300	0.9123	0.9025	0.8966	0.8928	0.8901	0.8882
80	0.9342	0.9000	0.8799	0.8690	0.8625	0.8583	0.8554	0.8533
79	0.9124	0.8700	0.8478	0.8360	0.8291	0.8245	0.8214	0.8192
78	0.8897	0.8400	0.8160	0.8036	0.7962	0.7915	0.7882	0.7858
77	0.8662	0.8100	0.7846	0.7716	0.7640	0.7590	0.7556	0.7531
76	0.8417	0.7800	0.7535	0.7401	0.7322	0.7271	0.7236	0.7211
75	0.8165	0.7500	0.7226	0.7089	0.7009	0.6958	0.6922	0.6896
74	0.7904	0.7200	0.6921	0.6781	0.6701	0.6649	0.6613	0.6587
73	0.7636	0.6900	0.6617	0.6477	0.6396	0.6344	0.6308	0.6282
72	0.7360	0.6600	0.6316	0.6176	0.6095	0.6044	0.6008	0.5982
71	0.7077	0.6300	0.6016	0.5878	0.5798	0.5747	0.5712	0.5686
70	0.6787	0.6000	0.5719	0.5583	0.5504	0.5454	0.5419	0.5394
69	0.6490	0.5700	0.5423	0.5290	0.5213	0.5164	0.5130	0.5105
68	0.6187	0.5400	0.5129	0.4999	0.4924	0.4877	0.4844	0.4820
67	0.5878	0.5100	0.4836	0.4710	0.4638	0.4592	0.4560	0.4537
66	0.5563	0.4800	0.4545	0.4424	0.4354	0.4310	0.4280	0.4257
65	0.5242	0.4500	0.4255	0.4139	0.4073	0.4031	0.4001	0.3980
64	0.4916	0.4200	0.3967	0.3856	0.3793	0.3753	0.3725	0.3705
63	0.4586	0.3900	0.3679	0.3575	0.3515	0.3477	0.3451	0.3432
62	0.4251	0.3600	0.3392	0.3295	0.3239	0.3203	0.3179	0.3161
61	0.3911	0.3300	0.3107	0.3016	0.2964	0.2931	0.2908	0.2892
60	0.3568	0.3000	0.2822	0.2738	0.2691	0.2660	0.2639	0.2624
59	0.3222	0.2700	0.2537	0.2461	0.2418	0.2391	0.2372	0.2358
58	0.2872	0.2400	0.2254	0.2186	0.2147	0.2122	0.2105	0.2093
57	0.2519	0.2100	0.1971	0.1911	0.1877	0.1855	0.1840	0.1829
56	0.2164	0.1800	0.1688	0.1636	0.1607	0.1588	0.1575	0.1566
55	0.1806	0.1500	0.1408	0.1363	0.1338	0.1322	0.1312	0.1304
54	0.1447	0.1200	0.1125	0.1090	0.1070	0.1057	0.1049	0.1042
53	0.1087	0.0900	0.0843	0.0817	0.0802	0.0792	0.0786	0.0781
52	0.0725	0.0600	0.0562	0.0544	0.0534	0.0528	0.0524	0.0521

TABLE 1								
Table for Estimating Percent of Lot Within Limits (PWL)								
Percent Within Limits (P_L and P_U)	Positive Values of Q (Q_L and Q_U)							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
51	0.0363	0.0300	0.0281	0.0272	0.0267	0.0264	0.0262	0.0260
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 2

Table for Estimating Percent of Lot Within Limits (PWL)

Percent Within Limits (P_L and P_U)	Negative Values of Q (Q_L and Q_U)							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
49	-0.0363	-0.0300	-0.0281	-0.0272	-0.0267	-0.0264	-0.0262	-0.0260
48	-0.0725	-0.0600	-0.0562	-0.0544	-0.0534	-0.0528	-0.0524	-0.0521
47	-0.1087	-0.0900	-0.0843	-0.0817	-0.0802	-0.0793	-0.0786	-0.0781
46	-0.1447	-0.1200	-0.1125	-0.1090	-0.1070	-0.1057	-0.1049	-0.1042
45	-0.1806	-0.1500	-0.1408	-0.1363	-0.1338	-0.1322	-0.1312	-0.1304
44	-0.2164	-0.1800	-0.1688	-0.1636	-0.1607	-0.1588	-0.1575	-0.1566
43	-0.2519	-0.2100	-0.1971	-0.1911	-0.1877	-0.1855	-0.1840	-0.1829
42	-0.2872	-0.2400	-0.2254	-0.2186	-0.2147	-0.2122	-0.2105	-0.2093
41	-0.3222	-0.2700	-0.2537	-0.2461	-0.2418	-0.2391	-0.2372	-0.2358
40	-0.3568	-0.3000	-0.2822	-0.2738	-0.2691	-0.2660	-0.2639	-0.2624
39	-0.3911	-0.3300	-0.3107	-0.3016	-0.2964	-0.2931	-0.2908	-0.2892
38	-0.4251	-0.3600	-0.3392	-0.3295	-0.3239	-0.3203	-0.3179	-0.3161
37	-0.4586	-0.3900	-0.3679	-0.3575	-0.3515	-0.3477	-0.3451	-0.3432
36	-0.4916	-0.4200	-0.3967	-0.3856	-0.3793	-0.3753	-0.3725	-0.3705
35	-0.5242	-0.4500	-0.4255	-0.4139	-0.4073	-0.4031	-0.4001	-0.3980
34	-0.5563	-0.4800	-0.4545	-0.4424	-0.4354	-0.4310	-0.4280	-0.4257
33	-0.5878	-0.5100	-0.4836	-0.4710	-0.4638	-0.4592	-0.4560	-0.4537
32	-0.6187	-0.5400	-0.5129	-0.4999	-0.4924	-0.4877	-0.4844	-0.4820
31	-0.6490	-0.5700	-0.5423	-0.5290	-0.5213	-0.5164	-0.5130	-0.5105
30	-0.6787	-0.6000	-0.5719	-0.5583	-0.5504	-0.5454	-0.5419	-0.5394
29	-0.7077	-0.6300	-0.6016	-0.5878	-0.5798	-0.5747	-0.5712	-0.5686
28	-0.7360	-0.6600	-0.6316	-0.6176	-0.6095	-0.6044	-0.6008	-0.5982
27	-0.7636	-0.6900	-0.6617	-0.6477	-0.6396	-0.6344	-0.6308	-0.6282
26	-0.7904	-0.7200	-0.6921	-0.6781	-0.6701	-0.6649	-0.6613	-0.6587
25	-0.8165	-0.7500	-0.7226	-0.7089	-0.7009	-0.6958	-0.6922	-0.6896
24	-0.8417	-0.7800	-0.7535	-0.7401	-0.7322	-0.7271	-0.7236	-0.7211
23	-0.8662	-0.8100	-0.7846	-0.7716	-0.7640	-0.7590	-0.7556	-0.7531
22	-0.8897	-0.8400	-0.8160	-0.8036	-0.7962	-0.7915	-0.7882	-0.7858
21	-0.9124	-0.8700	-0.8478	-0.8360	-0.8291	-0.8245	-0.8214	-0.8192

TABLE 2

Table for Estimating Percent of Lot Within Limits (PWL)

Percent Within Limits (P_L and P_U)	Negative Values of Q (Q_L and Q_U)							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
20	-0.9342	-0.9000	-0.8799	-0.8690	-0.8625	-0.8583	-0.8554	-0.8533
19	-0.9550	-0.9300	-0.9123	-0.9025	-0.8966	-0.8928	-0.8901	-0.8882
18	-0.9749	-0.9600	-0.9452	-0.9367	-0.9325	-0.9281	-0.9258	-0.9241
17	-0.9939	-0.9900	-0.9785	-0.9715	-0.9672	-0.9643	-0.9624	-0.9610
16	-1.0119	-1.0200	-1.0124	-1.0071	-1.0037	-1.0015	-1.0000	-0.9990
15	-1.0288	-1.0500	-1.0467	-1.0435	-1.0413	-1.0399	-1.0389	-1.0382
14	-1.0448	-1.0800	-1.0817	-1.0808	-1.0800	-1.0794	-1.0791	-1.0789
13	-1.0597	-1.1100	-1.1173	-1.1191	-1.1199	-1.1204	-1.1208	-1.1212
12	-1.0736	-1.1400	-1.1537	-1.1587	-1.1613	-1.1630	-1.1643	-1.1653
11	-1.0864	-1.1700	-1.1909	-1.1995	-1.2043	-1.2075	-1.2098	-1.2115
10	-1.0982	-1.2000	-1.2290	-1.2419	-1.2492	-1.2541	-1.2576	-1.2602
9	-1.1089	-1.2300	-1.2683	-1.2860	-1.2964	-1.3032	-1.3081	-1.3118
8	-1.1184	-1.2600	-1.3088	-1.3323	-1.3461	-1.3554	-1.3620	-1.3670
7	-1.1269	-1.2900	-1.3508	-1.3810	-1.3991	-1.4112	-1.4199	-1.4265
6	-1.1342	-1.3200	-1.3946	-1.4329	-1.4561	-1.4717	-1.4829	-1.4914
5	-1.1405	-1.3500	-1.4407	-1.4887	-1.5181	-1.5381	-1.5525	-1.5635
4	-1.1456	-1.3800	-1.4897	-1.5497	-1.5871	-1.6127	-1.6313	-1.6454
3	-1.1496	-1.4100	-1.5427	-1.6181	-1.6661	-1.6993	-1.7235	-1.7420
2	-1.1524	-1.4400	-1.6016	-1.6982	-1.7612	-1.8053	-1.8379	-1.8630
1	-1.1541	-1.4700	-1.6714	-1.8008	-1.8888	-1.9520	-1.9994	-2.0362

END OF SECTION Q-110

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SEEDING

SECTION T-901

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item consists of seeding in the areas shown on the Plans to be regraded or as directed by the Commissioner in accordance with these Specifications.

PART 2 MATERIALS

2.01 SEED

- A. The kinds of grass, legume, and cover-crop seed furnished must be those stipulated herein. Seed must conform to the requirements of the Illinois Department of Transportation (IDOT) Standard Specification for Road and Bridge Construction (SSRBC), latest edition, Article 1081.04 unless otherwise specified in this Specification. For Tall Fescue varieties shown in 2.01C, use parameters specified for "Fescue Inferno Tall" in Table II of Article 1081.04.
- B. Seed must be furnished separately or in mixtures in standard containers with the seed name, lot number, net weight, percentages of purity and of germination and hard seed, and percentage of maximum weed seed content clearly marked for each kind of seed. The Contractor must furnish the Commissioner duplicate signed copies of a statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within 6 months of date of delivery. This statement must include: name and address of laboratory, date of test, lot number for each kind of seed, and the results of tests as to name, percentages of purity and of germination, and percentage of weed content for each kind of seed furnished, and, in case of a mixture, the proportions of each kind of seed.
- C. Seeds must be spread uniformly at the rate and mixture specified below in pounds per acre of pure live seed (PLS):

<u>Grass Seed Blend</u>	<u>lb/acre PLS</u>
<u>Type 1 – CDA/OMP Permanent Seed Mix</u>	
Tall Fescue (<i>Festuca arundinacea</i>)	325

Use a minimum of 3 varieties of tall fescue. Each variety should contain a minimum of 70% viable endophytes. Varieties should come from the following list: 2nd Millennium, Bonsai, Cayenne, Cochise III, Constitution, Covenant, Coyote II, Crossfire II, Dakota, Dynasty II, Escalade, Falcon IV, Mustang 3, Rendition, SR 8600, Scorpion II, Shenandoah II, Taos, Titan Ltd., Titanium or Tombstone or as approved by the Commissioner.

Type 2 – Late Fall Seed Mix

Tall Fescue (<i>Festuca arundinacea</i>)	250
Perennial Ryegrass (<i>Lolium perenne</i>)	75

Use Tall Fescue blend of varieties listed in Schedule 1 and a blend of up to two cultivars of endophyte – containing Perennial Ryegrass.

Type 3 – Dormant Seed Mix

Tall Fescue (<i>Festuca arundinacea</i>)	300
Perennial Ryegrass (<i>Lolium perenne</i>)	75

Use Tall Fescue blend of varieties listed in Schedule 1 and a blend of up to two cultivars of endophyte – containing Perennial Ryegrass.

Type 4 – Swale/Ditch Seed Mix (See CDA/OMP Standard Detail 7-03-01)

<u>Type 1</u>	325
Or	
<u>Type 2</u>	325
Or	
<u>Type 3</u>	375
And	
Red Top (<i>Agrostis alba</i>)	10
Rough Bluegrass (<i>Poa trivialis</i>)	20

Use swale mix in areas where irregular inundation is expected. The area to be seeded shall include the swale/ditch banks up to an elevation that is two feet above the normal water elevation for the channel. For normally dry channels, this shall be measured from the channel invert. The Red Top and Rough Bluegrass should be

over seeded at the specified rates over the Type 1 or Type 2 seed application depending on application date.

- D. The Contractor must store the Tall Fescue seed varieties in a cool dry place until planted to protect endophyte levels from high heat. The seed must not be stored in direct sunlight and must not be kept in a hot shed during summer.

2.02 LIME

- A. Lime, if required to adjust the soil pH, must be ground limestone containing not less than 85% of total carbonates, and must be ground to such fineness that 90% will pass through a No. 20 mesh sieve and 50% will pass through a No. 100 mesh sieve. Coarser material will be acceptable, providing the rates of application are increased to provide not less than the minimum quantities and depth specified in the special provision on the basis of the two sieve requirements above. Dolomitic lime or a high magnesium lime must contain at least 10% magnesium oxide.
- B. To determine if lime is required, the Contractor must perform 4 pH tests, located at least 50 feet apart, on the soil for each acre to be seeded. The average value of the test results must be the pH value for that acre tested. If the pH value is less than 5.5, the soil must be amended to raise the pH to the acceptable range. Lime requirement must be determined by soil test of the buffering capacity of the soil. Sufficient lime must be applied to raise soil pH to 6.5. Copies of the test results must be transmitted to the Commissioner upon receipt by the Contractor.

2.03 FERTILIZER

- A. Fertilizer must be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphorus, and water-soluble potash. They must be applied at the rate and to the depth specified in this Specification, and must meet the specified requirements of the applicable state and federal laws. They must be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime will be permitted in mixed fertilizers.
- B. The fertilizers may be supplied as a finely-ground fertilizer soluble in water, suitable for application by power sprayers or for dry application as granules.

2.04 SOILS FOR REPAIRS

- A. The soil for fill and topsoiling of areas to be repaired must be at least of equal quality to the topsoil as outlined in Section T-905 Topsoiling.

2.05 MULCH WITH TACKIFIER

- A. Mulch must be a hydraulic mulch that meets the requirements of Article 1081.06 (a) (2) for a Light Duty Hydraulic Mulch of the Illinois Department of Transportation, Standard Specifications for Road and Bridge Construction (S.S.R.B.C.), latest edition, except that the minimum application rate must be 2,500 lbs/acre instead of 2,000 lbs/acre and as further modified herein.
- B. Mulch fiber must be colored green to contrast the area on which the mulch is being applied and must not stain concrete or other surfaces with which it comes in contact.
- C. Prior to use of the mulch, the Contractor must submit the following to the Commissioner for review and approval:
 - 1. A notarized certification by the manufacturer that the mulch meets the requirements of these specifications.
 - 2. Property test results for the mulch including the C factor analytical results performed and certified by an approved accredited independent laboratory.

PART 3 CONSTRUCTION METHODS

3.01 ADVANCE PREPARATION AND CLEANUP

- A. After grading of areas has been completed and before applying fertilizer and ground limestone, areas to be seeded must be raked or otherwise cleared of stones, sticks, stumps, and other debris which might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after the completion of grading and before beginning the application of fertilizer and ground limestone, the Contractor must repair such damage. This may include filling gullies, smoothing irregularities, and repairing other work related damages.
- B. An area to be seeded must be considered a satisfactory seedbed without additional treatment if it has recently been thoroughly loosened and worked to a depth of not less than 5 inches as a result of grading operations and, if immediately prior to seeding, the top 3 inches of soil

is loose, friable, reasonably free from large clods, rocks, large roots, or other undesirable matter, and if shaped to the required grade.

- C. However, when the area to be seeded is sparsely sodded, weedy, barren and unworked, or packed and hard, any grass and weeds must first be cut or otherwise satisfactorily disposed of, and the soil then scarified or otherwise loosened to a depth not less than 5 inches. Clods must be broken and the top 3 inches of soil must be worked into a satisfactory seedbed by disking, or appropriate means.
- D. Lime if required must be sprayed only upon previously prepared seedbeds. After the applied lime mixture has dried, the lime must be worked into the top 3 inches after which the seedbed must again be properly graded and dressed to a smooth finish.
- E. Apply a starter fertilizer, derived from quick release or mineral sources of nutrients, containing a minimum of 45 pounds of nitrogen per acre, 45 pounds of phosphorus (P_2O_5) per acre, and 45 pounds of potassium (K_2O) per acre immediately prior to the seed application described in paragraph 3.02. Additionally, apply a minimum of 70/lbs N/acre containing at least 75% SCU, XCU or nitroform type slow release nitrogen immediately prior to the application described in paragraph 3.02. These products can be applied separately or may be combined into a single application, providing a fertilizer formulator does the mixing. No on-site mixing will be allowed

3.02 APPLICATION METHODS

- A. Seed Application: The Contractor must apply seed uniformly to the prepared seedbed in two directions perpendicular to each other, using one or more of the following methods as required:
 - 1. Class 1 – Apply seed uniformly, using a slit seeder, cultipacker or Brillion-type seeder. Roll with corrugated roller after seeding.
 - 2. Class 2 - Broadcast seed and cover with a light disk harrow or cultipacker or other suitable equipment. Class 2 seed application to be done only with the approval of the Commissioner.
 - 3. Class 3 - Apply seed uniformly with a hydroseeder in a mixture not exceeding 220 pounds solids per 100 gallons of water. Class 3 seed application to be done only with the approval of the Commissioner.
- B. Mulch Application: After application of the seed using the approved methods above, mulch and mulch supertackifier must be applied

immediately over the freshly seeded areas in opposing directions using the following rates:

1. Mulch 2500 lbs/acre (1250 lbs/acre per direction)
2. Mulch supertackifier per manufacturer recommendations.

Mulch must be applied in accordance with Article 251.03 (c), Method 3 of SSRBC, except that mulch supertackifier must be applied concurrently with mulch.

- C. **Spraying Equipment:** The spraying equipment must have a container or water tank equipped with a liquid level gauge calibrated to read in increments not larger than 50 gallons over the entire range of the tank capacity, mounted so as to be visible to the nozzle operator. The container or tank must also be equipped with a mechanical power-driven agitator capable of keeping all the solids in the mixture in complete suspension at all times until used.
1. The unit must also be equipped with a pressure pump capable of delivering 100 gallons per minute at a pressure of 100 pounds per square inch. The pump must be mounted in a line which will recirculate the mixture through the tank whenever it is not being sprayed from the nozzle. All pump passages and pipe lines must be capable of providing clearance for 5/8 inch solids. The power unit for the pump and agitator must have controls mounted so as to be accessible to the nozzle operator. There must be an indicating pressure gauge connected and mounted immediately at the back of the nozzle.
 2. The nozzle pipe must be mounted on an elevated supporting stand in such a manner that it can be rotated through 360 degrees horizontally and inclined vertically from at least 20 degrees below to at least 60 degrees above the horizontal. There must be a quick-acting, three-way control valve connecting the recirculating line to the nozzle pipe and mounted so that the nozzle operator can control and regulate the amount of flow of mixture delivered to the nozzle. At least three different types of nozzles must be supplied so that mixtures may be properly sprayed over distance varying from 20 feet to 100 feet. One must be a close-range ribbon nozzle, one a medium-range ribbon nozzle, and one a long-range jet nozzle. For ease of removal and cleaning, all nozzles must be connected to the nozzle pipe by means of quick-release couplings.
 3. In order to reach areas inaccessible to the regular equipment, an extension hose at least 50 feet in length must be provided to which the nozzles may be connected.

4. Seed mixtures to be sprayed must include a green colorant to help identify areas of coverage.
- D. Mixtures: Lime, if required, must be applied separately, in the quantity specified, prior to the fertilizing and seeding operations. Not more than 220 pounds of lime must be added to and mixed with each 100 gallons of water. Mulch and mulch supertackifier must be mixed together and applied after seed application at the specified rates above but not more than 220 pounds combined solids per 100 gallons of water.
 - E. All water used must be obtained from fresh water sources and must be free from injurious chemicals and other toxic substances harmful to plant life. Brackish water must not be used at any time. The Contractor must identify to the Commissioner all sources of water at least 2 weeks prior to use. The Commissioner may take samples of the water at the source or from the tank at any time and have a laboratory test the samples for chemical and saline content. The Contractor must not use any water from any source which is disapproved by the Commissioner following such tests.
 - F. All mixtures must be constantly agitated from the time they are mixed until they are finally applied to the seedbed. All such mixtures must be used within 2 hours from the time they were mixed or they must be wasted and disposed of at locations acceptable to the Commissioner.
 - G. The mixtures must be applied by means of a high-pressure spray which will always be directed upward into the air so that the mixtures will fall to the ground like rain in a uniform spray. Nozzles or sprays will never be directed toward the ground in such a manner as might produce erosion or runoff.
 - H. Particular care must be exercised to insure that the application is made uniformly and at the prescribed rate and to guard against misses and overlapped areas. Proper predetermined quantities of the mixture in accordance with Specifications must be used to cover specified sections of known area. Checks on the rate and uniformity of application may be made by observing the degree of wetting of the ground or by distributing test sheets or paper or pans over the area at intervals and observing the quantity of material deposited thereon.

3.03 MAINTENANCE OF SEEDED AREAS

- A. The Contractor must protect seeded areas against traffic or other use by warning signs or barricades, as approved by the Commissioner. Surfaces gullied or otherwise damaged following seeding must be repaired by regrading and reseeding as directed. The Contractor must

mow, water as directed, and otherwise maintain seeded areas in a satisfactory condition until final inspection and acceptance of the work. Areas with excessive weed growth must be regraded and/or treated with an application of a select herbicide, at the approval of the Commissioner, and reseeded to establish a satisfactory stand of grass. Watering will only be accomplished at night or as directed by the Commissioner.

- B. When the seed application method outlined above is used for work done out of season, it will be required that the Contractor establish a good stand of grass of uniform color and density to the satisfaction of the Commissioner. If at the time when the Contract has been otherwise completed it is not possible to make an adequate determination of the color, density, and uniformity of such stand of grass, payment for the unaccepted portions of the areas seeded out of season will be withheld until such time as these requirements have been met.

3.04 TIME OF SEEDING

- A. The seeding and related operations must be performed during the following periods:
 - 1. Standard seeding must occur between March 15 and September 15. Apply at specified rate and mix according to 2.01C (Type 1).
 - 2. Late fall seeding must occur between September 16 and October 15 according to 2.01C (Type 2).
 - 3. Late Fall seeding can be done between October 16 and November 14 at the direction of the Commissioner (Type 2).
 - 4. Dormant seeding must occur between June 15 and August 15 at the discretion of the Commissioner and between November 15 and December 31 or until the ground becomes frozen according to 2.01C (Type 3).
 - 5. Seeding must be done immediately upon completion of work in a given area. The outlet channel, peripheral drain and other areas of work completed during the course of the Contract must be permanently seeded during the next seeding period after completion. If it is more than 45 days until the period, the Contractor must use temporary protection measures to prevent soil erosion, and they will be acceptable to the Commissioner.

6. No seeding may occur between October 16 and November 14 (except as directed by the Commissioner in Section 3.04.A.3) and between January 1 and March 14.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Completed and accepted quantities ordered by the Commissioner will be measured as follows:
 1. Seeding, Permanent. Permanent seeding must include seed bed preparation, including fertilization, and hydroseeding (seed, fertilizer, mulch and mulch supertackifier) which will be measured by the acre covered.
 2. Lime, pH Adjustment. During seed bed preparation, if lime is needed for pH adjustment, then it must be measured as a separate item in tons.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Accepted quantities ordered by the Commissioner and measured as described herein will be paid for under the items below. Such payment shall be full compensation for supply and distribution of all materials including water, nutrients, lime, mulch, and for all labor, tools, and incidentals necessary to complete this work.
- B. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
T-901-01	SEEDING, PERMANENT	ACRE
T-901-02	LIME, PH ADJUSTMENT	TON

END OF SECTION T-901

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TOPSOILING

SECTION T-905

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item must consist of preparing the ground surface for topsoil application, placing machine pulverized topsoil obtained from on site unclassified excavation or from approved sources off the site at the Contractor's option, and spreading the topsoil on prepared areas in accordance with this Specification at the locations shown on the Drawings or as determined by the Commissioner. The work under this Section is subject to the requirements of the Contract Documents.

PART 2 MATERIALS

2.01 TOPSOIL

- A. Topsoil must be the surface layer of soil with no admixture of refuse or any material toxic to plant growth, and it must be reasonably free from subsoil and stumps, roots, brush, stones, clay lumps, sticks, debris, or similar objects of one inch dimension and larger. The topsoil must be thoroughly pulverized through a topsoil pulverizer / screen machine before placement. Brush and other vegetation which will not be incorporated with the soil during handling operations must be cut and removed. Ordinary sods and herbaceous growth such as grass and weeds are not to be removed but must be thoroughly broken up and intermixed with the soil during handling and pulverizing operations. The topsoil or soil mixture, unless otherwise specified or approved, must have a pH range of approximately 5.5 pH to 7.6 pH, when tested in accordance with the methods of testing of the Association of Official Agricultural Chemists in effect on the date of invitation of bids. The organic content must be not less than 3% nor more than 20% as determined by the wet-combustion method (chromic acid reduction) AASHTO T194. There must be not less than 20% nor more than 80% of the material passing the 200 mesh sieve as determined by the wash test in accordance with AASHTO T 11.
- B. Natural topsoil may be amended by the Contractor with approved materials and methods to meet the above Specifications. Topsoil must be pulverized prior to application.

2.02 INSPECTION AND TESTS

- A. At least 21 days prior to placement, the Contractor must notify the Commissioner of the source of topsoil he proposes to furnish whether from strippings or grading on site, supplemented from sources off site of the Project area, or totally from an off site source. When directed by the Commissioner, the topsoil must be inspected to determine if the selected soil meets the requirements specified and to determine the depth to which stripping will be permitted. The Contractor must take a minimum of one representative soil sample from three (3) locations within the area under consideration and to the proposed stripping depths, for testing purposes as specified in Paragraph 2.01.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

- A. Areas to be topsoiled must be as shown on the Drawings or designated by the Commissioner. Suitable equipment necessary for proper preparation and treatment of the ground surface, stripping of topsoil and for the handling and placing of all required materials must be on hand, in good condition, and approved by the Commissioner before the various operations are started.

3.02 PREPARING THE GROUND SURFACE

- A. Immediately prior to dumping and spreading the topsoil on any area, the surface must be loosened by discs or spike-tooth harrows, or by other means acceptable to the Commissioner, to a minimum depth of one (1) inch to facilitate bonding of the topsoil to the covered subgrade soil. The surface of the area to be topsoiled must be cleared of all stones larger than 1 inch in any diameter and all litter or other material which may be detrimental to proper bonding, the rise of capillary moisture, or the proper growth of the desired planting. Limited areas, as shown on the Plans, which are too compact to respond to these operations, must receive special scarification.
- B. Grades on the area to be topsoiled, which have been established by others as shown on the Plans, must be maintained in a true and even condition. Where grades have not been established, the areas must be smooth-graded and the surface left at the prescribed grades in an even and properly compacted condition to prevent, insofar as practical, the formation of low places or pockets where water will stand.

3.03 OBTAINING TOPSOIL

- A. Topsoil, whether obtained on-site or off-site, must be pulverized prior to installation in the Project.
- B. Prior to the stripping of topsoil from designated areas, any vegetation, briars, stumps and large roots, sticks, rubbish or stones found on such areas, which may interfere with subsequent operations, must be removed using methods acceptable to the Commissioner. Heavy sod or other cover, which cannot be incorporated into the topsoil by pulverizing must be removed.
- C. The topsoil must be spread on areas already tilled and smooth-graded, or stockpiled in areas approved by the Commissioner. Any topsoil stockpiled by the Contractor must be rehandled and placed without additional compensation. The sites of all stockpiles and areas adjacent thereto which have been disturbed by the Contractor must be graded if required and put into a condition acceptable for seeding.
- D. When suitable topsoil is secured off the Airport site, the Contractor must locate and obtain the supply, subject to the approval of the Commissioner. The Contractor must notify the Commissioner sufficiently in advance of operations in order that necessary measurements and tests can be made. The Contractor must remove the topsoil from approved areas and to the depth as directed. The topsoil must be hauled to the site of the work and pulverized per Paragraph 2.01.A and placed for spreading, or spread as required. Any topsoil hauled to the site of the work and stockpiled must be rehandled and placed without additional compensation.

3.04 PLACING TOPSOIL

- A. The topsoil must be evenly spread on the prepared areas to a uniform depth of 4 inches after compaction, unless otherwise shown on the Plans. Spreading must not be done when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work. Spreading must be carried on so that turving operations can proceed with a minimum of soil preparation or tilling.
- B. After spreading, any large, stiff clods and hard lumps must be broken with a pulverizer or by other effective means, and all stones or rocks (1 inch or more in diameter), roots, sticks, litter, or any foreign matter must be raked up and disposed of by the Contractor. After spreading is completed, the topsoil must be satisfactorily compacted by rolling with a cultipacker or by other means acceptable to the Commissioner. The compacted topsoil surface must conform to the required lines,

grades, and cross sections. Any topsoil or other dirt falling upon pavements as a result of hauling or handling of topsoil must be promptly removed.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENTS

- A. Topsoil shall be measured for payment as Square Yards of 4" topsoil in place (thickness may vary as dictated in plans, but all topsoil placement will be paid within this item)

PART 5 BASIS OF PAYMENT

5.01 PAYMENTS

- A. Topsoil will be paid for per Square Yard of 4" topsoil in place (or as otherwise dictated in plans and method of measurement). Which price shall be payment in full for all material, equipment and labor required to complete the work.
- B. Payment will be made under the following item:

ITEM NO.	DESCRIPTION	UOM
T-905-01	TOPSOILING – PULVERIZING AND PLACEMENT, 4" MINIMUM THICKNESS	SY

END OF SECTION T-905

RIPRAP

SECTION T-906

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item must consist of furnishing, transporting and placing a protective course of stone, broken concrete or precast concrete blocks laid as riprap for erosion protection, sediment control or rockfill on slopes or in channels.
- B. Riprap for temporary erosion control devices is specified separately under Section P-156 Temporary Air and Water Pollution, Soil Erosion, and Sediment Control.

PART 2 MATERIALS

2.01 GENERAL

- A. Materials must meet the requirements of the following Articles of Section 281 contained in the Illinois Department of Transportation (IDOT) Standard Specifications for Road and Bridge Construction (S.S.R.B.C.), latest edition.
 - 1. Stone for erosion protection, sediment control and rockfill – 1005.01.
 - 2. Concrete Block, Broken Concrete, Concrete mats for Riprap - 1005.02
 - 3. Individual pieces of broken concrete must be free from reinforcing bars and debris.
- B. Non-woven geotextile fabric must be in accordance with P-629.

PART 3 CONSTRUCTION METHODS

3.01 FOUNDATION PREPARATION

- A. Before any riprap is placed, the underlying subgrade must be prepared and conditioned as specified. The subgrade must be checked by the Contractor and verified and accepted by the Commissioner before placing and spreading operations are started. The subgrade must either be compacted in accordance with the requirements of P-152 Excavation and Embankment or be a cut subgrade of minimal strength according to the Contract documents.

- B. The bed for the riprap must be trimmed and shaped to allow the finished surface to conform to the lines specified. At the toe of the slope, the riprap must commence on a continuation of the slope after excavation to accommodate the full depth of geotextile fabric, bedding layer, and riprap specified.

3.02 PLACING

- A. After the Commissioner has approved the foundation preparation, a layer of geotextile fabric must be installed. Installation of the geotextile fabric must be required under stone riprap gradations No. RR 4, No. RR 5, No. RR 6 and No. RR 7 for all uses, and under concrete block riprap, and stone or broken concrete dumped riprap when used for erosion protection. The geotextile fabric must be installed in accordance with the Drawings and Section P-629 Geotextile Fabric. A bedding layer must be required for stone riprap. No bedding is required for concrete block riprap, broken concrete riprap or for stone or broken concrete dumped riprap, unless specified.
1. **Stone Riprap.** Gradation No. 1 must be used as the bedding material for gradation No. RR 4 and RR 5. Gradation No. 2 must be used as the bedding material for gradation No. RR 6 and No. RR 7. Bedding material must be spread uniformly on the filter fabric in a satisfactory manner, to the neat lines specified. Placing of material by methods which must tend to segregate particle sizes within the bedding will not be permitted. Any damage to the surface of the bedding base or the filter geotextile fabric during placing of the bedding must be repaired before proceeding with the work. Compaction of the bedding layers will not be required but it must be finished to present a reasonably even surface free from mounds, windrows, or depressions.
 2. Thickness of the stone riprap layer must be according to the following table:

Gradation No.	Min. Thickness	Bedding Thickness
RR 1 & 2	6 inches	-
RR 3	8 inches	-
RR 4	16 inches	6 inches
RR 5	22 inches	8 inches
RR 6	26 inches	10 inches
RR 7	30 inches	12 inches

- B. Stone must be placed on the bedding layer in such manner in order to produce a reasonably well-graded mass of rock with the minimum practicable percentage of voids providing maximum interlocking of stones and must be constructed to the lines and grades shown.
- C. The riprap must not be placed or dropped from a height of more than one foot. The stone riprap must be placed to its full course thickness in one operation and in such a manner as to avoid displacing the bedding material and geotextile filter fabric. Placing of material must begin at the lower elevations, progressing up the slope, and from the center outward, unless otherwise determined by the Commissioner. In order to prevent damage to the bedding and geotextile filter fabric, the riprap must be back-dumped on the bedding or fabric by constructing a ramp of material to establish an initial working platform and then progressively spreading material out from the ramp. The larger stones must be well distributed and the entire mass of stones in their final position must be roughly graded to conform to the gradation specified. There must be no abrupt changes in the riprap surface. All tapers between minimum thickness and any high points must be at a uniform rate. The finished riprap must be free from objectionable pockets of small stones and clusters of larger stones. Placing riprap in layers will not be permitted. Placing riprap by dumping into chutes or by similar methods likely to cause segregation of the various sizes will not be permitted. The desired distribution of the various sizes of stones throughout the mass must be obtained by selective loading of the material at the quarry or other source; by controlled dumping of successive loads during final placing or by other methods of placement which will produce the specified results. Rearranging of individual stones by mechanical equipment or by hand will be required to the extent necessary to obtain a reasonably well graded distribution of stone sizes as specified above.
1. **Concrete Block Riprap.** Concrete blocks must be laid with the joints approximately perpendicular to the slope. The individual blocks in each horizontal course must be placed by hand so that they will break joints with the blocks in the course below. Each tenth course must be embedded into the slope with the long dimension of the blocks perpendicular to the slope.
 2. **Broken Concrete Riprap.** The individual pieces of broken concrete must be placed by hand, flat upon the slope. The pieces must be laid with close joints, the larger pieces being placed in the lower courses. Any open joints must be filled with spalls thoroughly rammed into place. The finished surface of the riprap must present an even, close surface, true to the lines, grades and sections given.

3. **Stone or Broken Concrete Dumped Riprap.** The dumped riprap must be a minimum of 12 inches thick, unless otherwise specified. Placement must begin at the lower elevations and progress up the slope. Dumped riprap of stone or broken concrete, as specified, must be placed on slopes or in channels by mechanical means. End dumping of material using mechanical equipment will be permitted, provided the larger stone or pieces of broken concrete are well distributed, and the entire mass, in final position, is roughly graded to conform to the gradation specified. Placement by dumping into chutes or other methods likely to cause segregation will not be permitted.
- D. The finished riprap must be reasonably free from objectionable pockets of small pieces and clumps of large pieces, and the surface will be shaped to follow the grade of the slope or channel. Rearranging of the dumped stone or broken concrete by mechanical equipment or by hand will be required only to the extent necessary to remove objectionable pockets or clumps of small or large material, and to obtain a surface reasonably true to line and grade.

3.03 DISPOSAL OF SURPLUS MATERIAL

- A. Surplus or waste material resulting from the riprap operations must be disposed of by the Contractor at his own expense.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENTS

- A. Riprap will be measured in place, and the area computed in square yards. The area for measurement will include the upper sloped surface of the riprap and upper horizontal surface of the toe anchor.

PART 5 BASIS OF PAYMENT

5.01 PAYMENTS

- A. This work will be paid for at the Contract unit price per square yard for Riprap Placement.
- B. Excavation and aggregate bedding will not be paid for as a separate item, but the cost will be considered included in the cost of the riprap.
- C. Payment will be made under the following item:

ITEM NO.	DESCRIPTION	UOM
T-906-01	EROSION AND SILTATION CONTROL – RIPRAP PLACEMENT, RR4	SY

END OF SECTION T-906

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SITE DEMOLITION

SECTION X-100

PART 1 DESCRIPTION

1.01 GENERAL

- A. This Section includes all the work required to demolish and remove existing surface and underground structures/utilities indicated on the Plans. Structures include but are not limited to fire hydrants, trees, guardrail, fence, existing manholes, inlets, catch basins, pipes, water valves, culverts, storm sewer, underdrains, sanitary sewer, water lines, gas lines, utility tunnels, concrete foundations, and signs. Electrical utility removal includes but not limited to CECO/ComEd (Overhead and underground), electrical cables, telephone ductbanks, FAA ductbanks, , manholes, handholes, ducts, light poles, light bases with and without lights, conduits, LAAS/GPS equipment, utility poles, as shown in the Plans.
- B. Contractor must conform to the Building Code of the City of Chicago for Demolition of Structures, safety of adjacent structures and dust control and all OSHA requirements related to building demolition and safety.
- C. Contractor must notify affected utility companies before starting work and comply with their requirements for protection and or termination of facilities. Disconnection of electric service to LAAS/GPS equipment must be coordinated with the ComEd.
- D. All equipment to be used on the Project must comply with the height restrictions of the FAA 7460 permit and FAR Part 77 requirements.
- E. Blasting will not be permitted.
- F. Contractor must protect all existing utilities to remain and existing utilities to be demolished until they are demolished.
- G. Underdrains, inspection holes, duct, cables, and any other miscellaneous items within the limits of pavement demolition shall be removed. For pavement removal occurring in plan sheets, all in-pavement lighting base cans, fixtures, transformers, conduit, and cable within the limits of removal of existing pavement are considered incidental to pavement removal. The Contractor shall provide connection between limits of removal on these items to existing underdrain and electrical items that are to remain in service. Disruption

of service shall be minimal and coordinated with the Commissioner.

1.02 RELATED WORK

- A. As specified in the following divisions:
1. Section 01524 – Construction Waste Management
 2. Section 01525 – Disposal of Clean Construction or Demolition Debris (CCDD) and Uncontaminated Soils
 3. Section 02710 - Dust Control
 4. Section P-150 – Pavement Removal
 5. Section P-151 – Clearing and Grubbing
 6. Section P-152 – Excavation and Embankment
 7. Section P-156 – Temporary Air and Water Pollution, Soil Erosion, and Sediment Control
 8. Section P-157 – Trench Backfilling

1.03 QUALITY CONTROL

- A. Contractor Qualifications: Site Demolition must be performed only by a qualified demolitionist. The term qualified means experienced in performing the Work required by this Section. The qualified demolitionist must have a minimum of five (5) years documented experience on Projects similar in size and scope to this Project. The demolitionist must submit evidence of such qualifications upon request by the Commissioner.
- B. Perform Work in accordance with the latest edition, of the appropriate divisions, of the following:
1. EPA - Environmental Protection Agency (Federal). Comply with governing EPA notification regulations before starting demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
 2. Section 02710 – Dust Control

PART 2 MATERIALS

2.01 GRANULAR BACKFILL

- A. Granular backfill must conform to IDOT Standard Specification, Section 209 or 311, Type CA-6 and Section P-157 Trench Backfill. Recycled or virgin material is allowed.

PART 3 CONSTRUCTION METHODS

3.01 DEMOLITION REQUIREMENTS

- A. Contractor must:
 - 1. Contractor must submit a demolition plan prior to starting work in the field.
 - 2. Conduct demolition operations to minimize interference with adjacent structures, utilities or appurtenances.
 - 3. Cease operations immediately if adjacent structures appear in danger. Notify the Commissioner. Do not resume operations until directed.
 - 4. Sprinkle work with water to minimize dust. Provide hoses and water connections for this purpose. If water is to be supplied from a fire hydrant, then backflow preventers must be used. Water trucks may also be needed.
 - 5. See Section 02710 Dust Control, for dust control requirements, and Section 01524 Construction Waste Management, for disposal requirements of non-hazardous construction debris and demolition waste.
 - 6. Obtain the Commissioner's acceptance of any new AOA perimeter fencing before removing existing AOA fence.
- B. Existing Concrete Structures and Bituminous Pavement Removal:
 - 1. Method of removal. Equipment and methods used for removing existing concrete structures must be such as to prevent cracking, shattering or spalling of the concrete remaining in place. Breaking concrete by means of a ball breaker or a gravity drop hammer will not be permitted.
 - 2. Partial removal of structures or pavement. Where portions of existing structures or pavements are to remain in service, portions to be removed must be removed in such a manner as to leave the structure or pavement undamaged and in proper condition for the use contemplated. Any damage to the portions

remaining in service must be repaired by the Contractor at its own expense. Old concrete or bituminous must be carefully removed to the lines designated unless otherwise directed by the Commissioner. Prior to removal, a saw cut of approximately $\frac{3}{4}$ -inch deep must be made along all boundaries of full-depth removal areas adjacent to areas to remain in place.

The concrete must then be removed with jackhammers not heavier than the nominal 45-pound class and suitable hand tools. Final removal at the designated lines of full-depth removal must be accomplished by 15-pound chipping hammers or hand tools, with particular care being exercised at the top of the wall to avoid breakage beyond the designated removal line.

The surfaces presented as a result of this removal must be reasonably true and even, with sharp straight corners that will permit a neat and workmanlike joint with the new construction or be satisfactory for the purpose intended. Where existing bars are to extend from the remaining portions of existing structures into new construction, the concrete must be removed so as to leave the projecting bars clean and undamaged. All newly exposed concrete and exposed reinforcement bars to be incorporated into new concrete must be blast cleaned.

Upon removal of the falsework, the bottom surfaces of the new concrete, adjacent to remaining portions of existing concrete, must be inspected with hammer sounding to detect loose and delaminated areas. Those areas must be removed as directed by the Commissioner. All removed areas 1-inch or deeper must be repaired with an approved method. This removal and repair must be completed to the satisfaction of the Commissioner.

3. Where airfield lights, transformers, signs or other structures are indicated on the plans to be salvaged, care must be taken to protect the structures from damage during salvage operations. Salvaged structures are to be delivered to the CDA or FAA at a location approved by the Commissioner.

3.02 EXISTING UTILITIES

- A. The Contractor must demolish and completely remove existing utilities where indicated. The limits of demolition must be approved by the Commissioner and the respective utility company prior to removal. The limits of demolition shown on the plans are approximate and exact limits will be coordinated with the respective utility company. The Contractor must cap and abandon utilities in place where indicated. Utilities must include, but not be limited to, hydrants, underground

piping, ductbanks, concrete encased ductbanks, conduit and cables, and mechanical and electrical systems, regardless of depth, indicated to be removed. The Contractor must coordinate with the Commissioner and the existing utility owners for shut-off of services if lines are active and for cut-off and sealing or capping (Commonwealth Edison Co., AT&T, FAA, ComEd, Peoples Gas, etc.).

3.03 CLOSING ABANDONED UNDERGROUND UTILITIES

- A. The Contractor must permanently close open ends of abandoned underground utilities indicated to remain with the following materials to withstand backfill pressures which may result after closing.
- B. Close open ends of conduit and pipe with caps, plugs or other suitable method for the type and size of material as acceptable to the Commissioner. Wooden caps or plugs are not acceptable.
- C. Close open ends of concrete and masonry utilities 2'-0" diameter or smaller with not less than 8 inches thick concrete bulkheads, constructed to completely close the openings.
- D. Submit details for closure of concrete or masonry utilities larger than 2'-0" diameter to the Commissioner for review.

3.04 REMOVAL OF PREVIOUSLY ABANDONED UNDERGROUND UTILITIES

- A. Contractor must remove underground utility lines and structures indicated to be removed in their entirety. Backfill must meet the material requirements of Section P-157 Trench Backfilling and must be placed in layers not to exceed 6" inches and compacted to 95% of the maximum density determined by ASTM D 1557.

3.05 REMOVAL OF EXISTING MANHOLE(S) AND HANDHOLE(S)

- A. Coordinate the removal of manholes and handholes with the removal of ductbank, as specified herein.
- B. Remove manholes and handholes as indicated in the Drawings.

3.06 FILL

- A. All areas excavated below the elevation indicated on the Drawings such as former basements, foundations, manholes and like areas must be filled with granular backfill to the indicated elevation in six (6) inch lifts and compacted to 95% of the maximum density determined by ASTM D 1557. This work must be done in accordance with the material

requirements of Specification P-157 Trench Backfilling.

- B. After the backfill is completed, the Contractor must dispose of all surplus material and rubbish off site. Excess dirt and excavated material must be embanked within the project embankment limits in accordance with section P-152 Excavation and Embankment, and will be considered incidental to the work. The Contractor must restore all disturbed areas to their original condition. Where the original condition is grass, topsoil and sod or permanent seeding must be used for restoration as shown on the drawings. All cost for restoration will be included in the Contract unit price. Any future settlement of trenches must be restored at the Contractor's expense.

3.07 UNFORESEEN DEBRIS REMOVAL AND CONDITIONS

- A. An allowance amount has been established for unforeseen debris removal. The directed removal or demolition of unforeseen debris, including, but not limited to, foundations, former basements, existing debris piles, large underground boulders, recycled materials, and non-native underground materials, which require demolition. Unforeseen debris will be removed/demolished to at least two (2) feet below the proposed excavation grades.
- B. An allowance amount has been established for unforeseen conditions. The removal or demolition of an existing item indicate for removal on the drawings that requires additional unforeseen work to be performed such as relocating connected services, bracing material to remain, unanticipated adjustment, modification or tie-in connections resulting from the removal of the item.
- C. The Allowances are to cover the labor, material, equipment, expendable costs associated with the demolition, removal, relocation, adjustment, or tie-in connection, for the utility or obstruction encountered. The disposition of the encountered unforeseen debris or condition will be determined at the sole discretion of the Commissioner.
Such unforeseen removals are not indicated in the Plans. Items identified on the plans for removal will be paid in accordance with the applicable pay item. The Contractor will not proceed to perform any such Work without written permission from the Commissioner and Chief Procurement Officer.
- D. The Contractor will be responsible to notify the Commissioner when unforeseen debris or condition is encountered and to receive written permission from the Commissioner and Chief Procurement Officer to proceed with the Work. The Work will be paid for as shown in Article X, "Changes in the Work," of Part 2, General Conditions.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. The work for Site Demolition will be not be measured for payment but will instead be included in a lump sum pay item. The work includes but is not limited to the removal of all existing inspection holes, manholes, catch basins, valve vaults, light poles, handholes, sectionalizers, transformers, gas mains, fire hydrants, tunnels, ductbanks, conduit, sign bases, sanitary sewers, storm sewers, drainage structures, water mains, underdrains, fences, concrete pavement striping, temporary utility connections, and any other such items as shown on the Plans to be removed. Excess dirt spoils and excavated material must be embanked within the project limits, or as directed by the Commissioner, in accordance with Section P-152 Excavation and Embankment, and will be considered incidental to the work.
- B. No separate payment will be made for granular backfill material used to fill removed utility lines and structures as it will be considered incidental to the lump sum pay item.
- C. Allowance for Unforeseen Debris Removal: When unforeseen debris removal is encountered which is not shown in the Drawings, and for which no pay item exists, notification to the Commissioner is required. Work will not commence until written permission is received. The Contractor will perform the required Work for the disposition of the encountered unforeseen debris as "Unforeseen Debris Removal", per allowance, and measurement of this Work will be as described in Article X, "Changes in the Work", of the Part 2, General Conditions of the Contract.
- D. Allowance for Unforeseen Conditions: When an unforeseen condition is encountered which is not shown in the Drawings, and for which no pay item exists, notification to the Commissioner is required. Work will not commence until written permission is received. The Contractor will perform the required Work for the associated with the encountered unforeseen condition as "Unforeseen Conditions", per allowance, and measurement of this Work will be as described in Article X, "Changes in the Work", of the Part 2, General Conditions of the Contract.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment for removal of storm sewers, underdrains, water main, utility infrastructure, drainage structures, signs, sign foundations, cable and ductbank will be included in the lump sum pay item for SITE DEMOLITION. Payment will be payment in full for all labor, including compensation for excavation, removal and disposal of the item, cut and capping pipe where indicated on the plans, restoration, backfill, compaction, labor, materials, equipment, granular backfilling, tools, and all work and necessary to remove the underground utility.

The Commissioner reserves the right to salvage any items from demolition. The Contractor must salvage manhole frame and covers. The Contractor must deliver salvaged material to a site within the limits of O'Hare airport property as instructed by the Commissioner. All items not to be salvaged shall be removed off airport property at the contractor's expense.

- B. Allowance for UNFORESEEN DEBRIS REMOVAL which is not shown on the Contract Plans. The Contractor must receive written permission from the Commissioner to proceed with the work. The work will be paid for as shown in General Conditions, Article X, Changes in Work, 3. Time and Materials Basis. Unused portions of these allowances will not be paid to the Contractor.
- C. Allowance for UNFORESEEN CONDITIONS: The Contractor must receive written permission from the Commissioner to proceed with the work. The work will be paid for as shown in General Conditions, Article X, Changes in Work, 3. Time and Materials Basis. Unused portions of these allowances will not be paid to the Contractor.
- D. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
X-100-01	SITE DEMOLITION	LS
X-100-02	ALLOWANCE FOR UNFORESEEN DEBRIS REMOVAL	AL
X-100-03	ALLOWANCE FOR UNFORESEEN CONDITIONS	AL

END OF SECTION X-100

AIRFIELD ARTIFICIAL TURF

SECTION X-200

PART 1 DESCRIPTION

1.01 GENERAL

- A. This item shall consist of the installation of new airfield artificial turf in accordance with these specifications and the details shown on the plans and in conformity with the lines and grades shown on the plans.
- B. The artificial turf contractor shall provide certification of a minimum number of turf installations on airfields which have been in service for a minimum number of years. Certification of such experience must be provided to the Commissioner. Such certification must include the following information in order to be approved as an acceptable manufacturer:
 - 1. Airfield where turf was installed
 - 2. Date of installation
 - 3. Method of installation
 - 4. Quantity of turf installed
 - 5. Record of any repairs to the turf since accepted by the client

PART 2 MATERIALS

2.01 TURF CARPET

- A. The turf material shall be AvTurf, Air Field Turf or approved equal. The turf shall meet the requirements of FAA Circular 150/5370-15, Latest Edition. The carpet shall be made of polyethylene fibers tufted into a fibrous, non- perforated, porous or non-porous backing. The carpet shall consist of fibers tufted into a primary backing with a secondary backing. The carpet shall be furnished in 15-foot wide rolls. The carpet's primary backing shall be a double-layered polypropylene fabric. The secondary backing shall consist of an application of a full width water resistant, heat activated urethane coating to permanently lock the fiber tufts in place. The fiber shall be 8,000 denier (nominal), UV resistance fiber. Samples of the carpet shall be submitted to the Commissioner for inspection and approval.

2.02 EDGE TREATMENT

- A. The contractor shall provide an edge treatment as shown on the Contract Drawings and approved by the manufacturer.

2.03 ADHESIVE

- A. Adhesive shall be as recommended by the artificial turf manufacturer. The adhesive shall be one that has performed satisfactorily in the airport environment.

2.04 EQUIPMENT

- A. Equipment used in the installation of the artificial turf shall be as provided by the manufacturer subject to the approval of the Commissioner and maintained in first-class working conditions at all times.

2.05 GROOMING

- A. The contractor shall provide a grooming schedule along with the maintenance manual post installation.

2.06 TRAINING

- A. The contractor shall provide a minimum of four (4) hours of training to airport personnel. Training shall include, at a minimum, use of the grooming machine, maintenance and repair of the airfield artificial turf, cutting and sewing of airfield artificial turf in the event that additional utilities would need to be installed under the turf, use of chemicals (i.e. herbicides, pesticides, etc.) on the airfield artificial turf and snow removal.

2.07 WARRANTY AND INSPECTIONS

- A. The airfield artificial turf shall be, at a minimum, guaranteed for a period of eight (8) years for the product and five (5) years for the installation. One (1) maintenance manual and warranty shall be submitted to the CDA upon installation sign-off. The Contractor shall provide semi-annual inspections for the first year and annual inspections thereafter.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

- A. Areas to have artificial turf installation are shown on the plans. Installation procedures shall follow manufacturer's recommendations.

3.02 BASE PREPARATION

- A. Asphalt base preparation shall be in accordance with the details on the drawings. Contractor shall install to the lines, grades and thickness shown on the plan.

3.03 ATTACHMENT SYSTEM

- A. The attachment system installation shall be as recommended by the artificial turf manufacturer and as shown in the Contract Drawings.

3.04 ATTACHMENT SYSTEM FOR LIGHT CANS AND SIGN STRUCTURES

- A. The attachment system installation for light cans, sign structures, and inlets/manholes shall be as recommended by the artificial turf manufacturer.

3.05 INSTALLATION OF AIRFIELD ARTIFICIAL TURF

- A. For installation, carpet shall be positioned, unrolled, sewn, flipped, cut and glued following the manufacturer's recommendations. After carpet has set to adhesive, fibers shall be lifted sufficiently to allow placement of infill material. Actual installation of artificial turf shall be performed by the manufacturer's installation crew.
- B. The contractor shall follow the manufacturer's recommendations for the adhesive and allow sufficient time for the adhesive to set before exposing the turf to jet blast.

3.06 DISTRIBUTION OF INFILL MATERIAL

- A. Infill shall be applied to a minimum of 7 lbs per square foot or as directed by the manufacturer.

3.07 TEST STRIP

- A. The contractor must provide a test section of turf that will be installed on the airfield. The test section will be of a size specified by the Commissioner no smaller than 2500 square feet. The Commissioner will specify the location of test strip installation prior to installation. The test strip must include adhesive and infill material and will be tested for resistance to jet blast. Acceptance of the test strip is required before placement of turf can commence. The Contractor will be responsible for removing the test strip once testing is complete.

3.08 END OF SHIFT TREATMENT

- A. The contractor will be responsible for leaving unfinished edges of turf installation in a condition that is resistant to jet blast at the end of each work shift. The Contractor is responsible for the means and methods to achieve this state and must submit a work plan to the Commissioner which will indicate anticipated production rate and means and methods for securing turf edges at the end of each work shift.

PART 4 METHOD OF MEASUREMENT

4.01 MEASUREMENT

- A. Installation of airfield turf will be measured for payment by the square foot and shall include the required training, warranty and inspections.
- B. No measurement will occur for test strip installation, removal or items required for test strip approval.
- C. No measurement will occur for additional adhesives that are required to secure turf edges at the end of a work shift.

PART 5 BASIS OF PAYMENT

5.01 PAYMENT

- A. Payment for installation of airfield artificial turf will be made at the contract unit price per square yard. These prices shall be full compensation for furnishing all materials and for all preparation, erection, and installation of these materials, infill material, training, warranty and inspection, and for all labor equipment, tools, and incidentals necessary to complete the item. Edge treatment shall not be paid for separately and shall be included in the contract unit price for artificial turf.
- B. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
X-200-01	ARTIFICIAL TURF OVER PAVEMENT	SY

END OF SECTION X-200

ATTACHMENT A

FAA-GL-918D

**SPECIFICATION FOR CONSTRUCTION OF
TERMINAL NAVIGATIONAL
AID FACILITIES**

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
GREAT LAKES REGION
CHICAGO, ILLINOIS

FAA-GL-918D
April 25, 2013

SPECIFICATION FOR CONSTRUCTION OF
TERMINAL NAVIGATIONAL
AID FACILITIES

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DIVISION 1 - GENERAL REQUIREMENTS
SECTION 1A
SPECIAL CONDITIONS

1A.1 SCOPE.

- a. This Specification covers general requirements for construction of an Instrument Landing System (ILS) and Visual Guidance Lighting Systems. The complete ILS consists of several component facilities. The term, visual guidance lighting systems, covers lighting facilities. Refer to the solicitation package for types of facilities to be constructed. This Specification includes requirements common to all facilities and requirements specific to individual facility types. In general, all parts of this Specification covering construction required on project drawings and in other Contract documents, are applicable to this Contract.
- b. The Contractor shall furnish all plant, labor, materials (except Government-furnished property), equipment, energy, transportation, and other services necessary to construct all elements of the systems required in the Specifications, Drawings, and other Contract documents. Construction shall include all miscellaneous and incidental work necessary for a complete and operational system, whether or not such work is specifically shown or specified.

1A.2 GOVERNMENT-FURNISHED PROPERTY. Government-furnished property (GFP) is also known as Government-furnished material (GFM). Government-furnished property for this Contract is shown on the Government-Furnished Property List. The Government-Furnished Property List is the sole Contract document which validly identifies Government-furnished property under this Contract. The Contract Drawings give little or no indication of which items are Government-furnished. To determine whether an item of equipment or other material is Government-furnished, see the Government-Furnished Property List. For Government-furnished property, the Contractor shall provide for and pay for loading of this property at the storage location (location indicated on the Government-Furnished Property List) and transportation to, and unloading at, the job site.

1A.3 CONTRACTOR-FURNISHED MATERIAL. The Contractor shall furnish all material under this contract per Paragraph 1A.1b, except the Government-furnished property identified on the Government-Furnished Property List. The instruction "provide" on the drawings means furnish and install unless the item(s) to which the instruction applies is Government-furnished property included in the Government-Furnished Property List. The Contractor shall be aware that certain materials to be furnished by the Contractor, may be long-lead-time items. Therefore, the successful bidder should determine the availability of all material immediately after Contract award, and initiate procurement action on long-lead-time items at the earliest possible date. Where the Specifications mention material or equipment by brand, it is regarded as a known acceptable source, as it meets Specifications.

1A.4 SUBMITTALS AND BRAND NAME USAGE.

- a. Introduction. Each product required for use in the Contract Drawings and Specifications must meet the actual minimum needs of the Government as demonstrated in the salient characteristics for that product. If a brand name product is used in the Drawings or Specifications, it should be regarded as a "known acceptable source" (i.e., a product that meets the actual minimum needs, and demonstrates the appropriate salient characteristics). The product used can be identical or equal to the brand name product or known acceptable source in meeting the salient characteristics, but it need not exceed the actual minimum requirements. Any brand name product or known acceptable source mentioned will, however, not be required for use in order to comply with the Specification or Drawing unless those documents make it clear that the brand name product is required, and substitution is prohibited. The following submittal procedure shall be followed in order to:
 - (1) Insure adherence to functional and quality standards in substitute Contractor-furnished material.
 - (2) Inform the FAA of the Contractor's plans to use certain material and equipment, e.g., splicing materials and tools, even if they are a known acceptable source.
- b. Definition. A submittal is a collection of information required by Specifications, or by the Contracting Officer, presenting detailed information on:
 - (1) Material or equipment items the Contractor proposes to use.
 - (2) Methods or plans of action which the Contractor intends to employ in specific situations.
- c. Requirements. Each product that a Contractor wishes to use that is not a known acceptable source, must be approved before use, by the Contracting Officer or the Contracting Officer's designee. To gain approval, the Contractor must submit documents and/or samples that demonstrates the product clearly meets the Government's minimum needs, and demonstrates appropriate salient characteristics. All submittals must be in writing. The Contracting Officer shall have the right to require submittals from the Contractor where the Contractor makes an unsolicited change proposal. The information presented in a submittal shall be sufficient to demonstrate that all Specification requirements for the subject material, equipment, methods, or plans, are met by the Contractor's proposal. The informational materials may include documents such as shop drawings, sketches, calculations, data sheets, written plans of action, manufacturers' catalog cuts, brochures, and/or specification sheets. If the Specifications or Contracting Officer requires actual samples of material or equipment, the Contractor shall provide them. For any documentary submittal, the Contractor shall submit three identical sets of documents.

- d. Submittal Review. When submitting before the Notice to Proceed date, the Contractor shall send the submittal package(s) directly to the Contracting Officer. When submitting after Contract work has begun, the Contractor shall give submittal packages to the Contracting Officer's Representative (COR), who will forward them promptly to the Contracting Officer. The Contracting Officer may personally evaluate the submittal, or request FAA engineers to evaluate it. In either case, the submittal will return directly from the Contracting Officer to the Contractor, with the Contracting Officer's approval, approval with comments, or disapproval.
- e. Submittal Time Frame. To provide adequate time for document transmission and submittal review, the FAA reserves the right to take two weeks to complete a review, transmission date to transmission date. Terminal navigational aid contracts are brief contracts. The review process can therefore span a substantial portion of the contract period. For this reason:
 - (1) The Contractor is urged to initiate submittals as soon as feasible after contract award, and to expedite document transmission.
 - (2) The Contracting Officer and other reviewers (if any) will expedite reviews and document transmission insofar as feasible.

Maximum use of fast document transmission modes (e.g. email, fax, etc.) is encouraged.

- f. Procurement Before Approval. The Contractor is advised not to procure any item for which submittal approval is required but not yet granted. If approval is denied, the Contractor will be prevented from installing the disapproved item(s). The Contractor must transmit a new submittal package for the new items replacing the disapproved items, and must procure only approved items. The Contractor shall take responsibility for the delivery and installation of any items installed before submittal approval is granted. The FAA reserves the right to discontinue field work on any item furnished without submittal approval. Procuring and/or installing material which is later disapproved could result in substantial losses of money and time for the Contractor.
- 1A.5 PRE-CONSTRUCTION CONFERENCE. The Contractor shall attend a pre-construction conference when required by the Contracting Officer or airport management. The Contractor shall abide by all agreements reached at the conference regarding safety practices, ingress and egress routes to the site, maintenance of airport security (locking gates, etc.), deference to air traffic, and other operational procedures.
- 1A.6 COORDINATION. All coordination between the Contractor and the airport management and local FAA personnel, shall be accomplished through the COR.

1A.7 PROJECT DRAWINGS.

- a. Conflict Between Site Drawings and Standard Drawings. If any conflict should exist between site Drawings (location-specific Drawings) and standard Drawings (Drawings not referring to a particular location), the site Drawings shall govern.
- b. Drawings Referenced But Not Provided. Unless otherwise specified, Drawings which are referenced on Contract Drawings, but which are not listed in the list of Specifications and Drawings, do not apply to the Contract.

1A.8 TEMPORARY ELECTRICAL POWER. Unless otherwise specified, the Contractor shall make all arrangements and pay all costs for temporary electrical power needed for construction of the facility.

1A.9 COMPLIANCE WITH LOCAL AND OTHER CODES. The Contractor shall comply with standards (e.g., National Electrical Code) adopted by the Contract documents, and with local and other codes. Where the requirements of the Specifications and Drawings exceed those of the adopted and local codes, the Contractor shall comply with the requirements of the Specifications and Drawings.

1A.10 SANITARY FACILITIES. Sanitary facilities are not available at the work sites. The Contractor shall provide temporary toilet facilities as required for his employees. The locations of the toilet facilities shall be where directed by the COR.

DIVISION 1 - GENERAL REQUIREMENTS
SECTION 1B
SAFETY ON AIRPORTS

1B.1 DEFINITIONS.

- a. Classified Area. A classified area is a graded and compacted safety area consisting of all land within 200 feet of runway centerline, for the full length of the runway and to 1,000 feet outbound of each end of the runway, or within 125 feet of taxiway centerline, or within 75 feet of edges of ramps.
- b. Unclassified Area. An unclassified area is an area not located within a classified area.

1B.2 GENERAL PRECAUTIONS. The Contractor shall abide by all requirements as specified herein, in the Contract clauses, on the construction safety plan, and as established by airport authorities in the pre-construction conference. The Contractor shall be responsible for thoroughly explaining all safety and security precautions required on the airport to all workmen, both under his direct employment and under his subcontractors.

1B.3 CONSTRUCTION WITHIN CLASSIFIED AREAS.

- a. Restrictions.
 - (1) Construction within or access through classified areas will not be permitted whenever runways or taxiways defining the classified areas are being used for aircraft operations.
 - (2) If runways and taxiways within classified areas are required to remain open, construction within the classified areas will be interrupted as necessary to permit normal aircraft operations.
 - (3) The portions of VASI, REIL, and PAPI construction in classified areas, involving the use of hand tools only, will generally not require runway or taxiway closure, unless otherwise specified or directed. Such work may include the assembly, installation, wiring and adjustments of equipment units, but will preclude the use or parking of construction equipment, or vehicles, in the applicable classified area.
- b. Time Frame. All construction within classified areas shall be completed within the shortest possible time. Construction shall be performed continuously during normal working hours, except as otherwise specified, until all work within the classified areas is completed.

1B.4 CONSTRUCTION WITHIN UNCLASSIFIED AREAS. Construction will be permitted within unclassified areas while aircraft are using adjacent runways and taxiways, excepting as specified elsewhere or established during the pre-construction conference.

- 1B.5 MAINTENANCE OF AIRCRAFT OPERATING SURFACES. Soil, debris, or loose materials dropped or tracked onto airport roads, runways, taxiways, and ramps shall be immediately swept up and removed. Likewise, all loose material at the job site or dropped enroute to the job site which can be blown onto the above aircraft surfaces, shall be immediately placed in closed containers to prevent damage to aircraft.
- 1B.6 EQUIPMENT PARKING. All equipment not in use at the close of each day shall be parked as directed by the COR or removed to a pre-designated area.
- 1B.7 RADIO COMMUNICATIONS. At airports served by airport traffic control towers or airport owner/operator radio communications facilities, (if so directed by the airport management), the Contractor shall furnish and operate two-way radio communications with these facilities when personnel, vehicles, and equipment are required to enter the aircraft operations area, to obtain proper clearance for construction hazards to aircraft, and at all other times established during the pre-construction conference.
- 1B.8 TEMPORARY AIRCRAFT PAVEMENT TEMPORARY MARKING AND LIGHTING.
- a. Installation. If runway and/or taxiway closure or runway threshold relocation or displacement is required, the Contractor shall install temporary marking or temporary marking and lighting, as shown on the construction safety plan Drawing(s), if any. All temporary marking shall be constructed of plywood, durable fabric, or other approved material, placed and secured so as to pose no threat of damage to aircraft, and which can be easily removed after construction completion.
 - b. Maintenance. It will be the Contractor's responsibility to maintain the temporary marking and lighting in a condition acceptable to the COR. If marking or lighting is damaged or becomes inoperative, the Contractor shall immediately repair the affected items.
 - c. Removal. Upon acceptable completion of the work that necessitated runway threshold displacement or runway and/or taxiway closure, the Contractor shall remove all temporary marking and lighting, and shall return the runway and taxiway and lighting configuration to the original condition.

DIVISION 2 - SITE WORK
SECTION 2A
EARTHWORK AND SITE IMPROVEMENTS

2A.1 DESCRIPTION OF WORK. The extent of earthwork is indicated on the drawings and by the provisions of this section. Requirements for access road and site surfacing and paving are covered in Sections 2B and 2C.

2A.2 QUALITY ASSURANCE.

- a. Codes and Standards. Perform all earthwork in compliance with applicable requirements of governing authorities having jurisdiction.
- b. Testing and Inspection.
 - (1) Soil materials and degree of compaction shall conform to ASTM specifications referenced herein. Professional soil testing methods associated with this specification will generally not be required, but the FAA reserves the right to engage a state-licensed soil testing service to resolve disputes regarding adequacy of all earthwork performed.
 - (2) Visual inspection and qualitative testing shall be performed by the contractor in the presence of, and wherever directed by, the Resident Engineer.

2A.3 SAFETY REQUIREMENTS.

- a. Refer to Division 1 for construction within classified and unclassified areas.
- b. To protect life, property, and work, all earthwork operations shall be performed in compliance with local and OSHA (Occupational Safety and Health Administration) requirements. The Contractor shall provide all sheeting, shoring, and other bracing as necessary.
- c. All trenches in classified areas, excavated in one day, shall be backfilled during the same day. An effort shall be made to backfill other excavations in classified areas, during the same day.

2A.4 JOB CONDITIONS.

a. Existing Utilities.

- (1) Locate all underground cables, utility lines, and other underground construction before beginning excavation work. Any damage to such lines or construction belonging to the FAA, utility companies, or others, shall be promptly repaired, at contractor's expense, to the complete satisfaction of the owner.
- (2) Project drawings generally indicate locations of cables maintained by the Federal Aviation Administration only. The FAA will field establish approximate locations of its own cables.

b. Weather Conditions.

- (1) Excavating and backfilling for foundations, trenches, and jacking or boring pits, shall not proceed when excessively wet or freezing weather conditions could adversely affect the load-bearing characteristics of the soil, or prevent proper compaction.
- (2) When freezing weather is expected, excavations shall not be made to full depth unless concrete or conduits can be placed immediately. If an excavation is already at full depth, the excavation shall be protected from frost.

c. Drainage.

- (1) All excavations shall be continually drained by natural means or pumping to prevent any decrease in soil bearing capacity or damage to poured foundations or to trenches.
- (2) Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
- (3) Establish and maintain temporary drainage ditches and other diversions outside excavations limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

2A.5 MATERIALS.

- a. Structure and Foundation Materials. In-place undisturbed inorganic soils will be adequate to support all project structures, unless otherwise indicated. Highly organic soils (topsoil, peat, and swamp location soils) shall be removed entirely from areas to be occupied by structures.

- b. Backfill and Fill. Material shall be inorganic soil excavated from site, or borrow comprised of inorganic soil approved by the COR. All such soils shall be free of rock, gravel, and cohesive lumps greater than two inches in any direction, and debris, waste, vegetation, frozen material, and other deleterious materials.
- c. Base Course for Concrete Slabs. Material shall be a graded mixture of washed crushed stone or crushed or uncrushed gravel with 100% passing a 1 1/2 inch sieve, and not more than 5% passing a number 4 sieve.

2A.6 SITE PREPARATION.

- a. Clearing and Grubbing. The Contractor shall scalp areas where excavation or embankment will be made. Scalping shall include the removal of materials such as trees, brush, roots, sod, grass, residue of agriculture crops, sawdust, and decayed vegetable matter, from the surface of the ground. These materials shall be removed from the site and disposed of off airport property.
- b. Topsoil Removal.
 - (1) Topsoil shall be considered soil containing visible vegetable matter and black loam that will not compact with the usual compacting methods.
 - (2) Unless otherwise specified, topsoil shall be removed from all areas to receive fill, granular surfacing, pavement, and structures, and from all areas where subsoil excavating is required, such as for roadway cuts and ditches. Dispose of excess topsoil on or off airport property, as directed by the COR, at no additional cost to the Government.

2A.7 EXCAVATION.

- a. Excavation Classification. Excavation is unclassified and includes excavation to subgrade elevation indicated, regardless of character of materials and obstructions encountered excepting as qualified herein.
- b. Rock Excavation. If rock is encountered above the design footing elevations of any facility structure, such foundation shall bear entirely on clean solid rock or on soil, but not on both. If the soil-and-rock bearing condition is encountered, the COR will determine which material shall support the structure. If rock surface is used, it shall be reasonably level or shall be stepped to make level segments.

- c. Unauthorized Excavation. Removal of materials beyond design subgrade elevations or dimensions without specific direction from the COR constitutes unauthorized excavation. Remedial work for such excess excavation shall be as directed by the COR at the Contractor's expense.
- d. Additional Excavation. When any excavation has reached required subgrade elevation, notify the COR, who will inspect soil conditions. If the COR determines that the soil possesses inadequate bearing capacity, carry such excavation deeper as directed by the COR.
- e. Excavation for Structures.
 - (1) Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services and other construction, and for inspection.
 - (2) In excavating for footings and foundations, take care not to disturb the bottom of the excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave a solid base.
- f. Excavation for Cable and Conduit Trenches.
 - (1) Excavate in compliance with lines and depths shown on drawings. Minimum trench depth shall allow for cables to be installed at the depths specified in Paragraph 16F.3b(2), unless otherwise specified. Slope trenches to same elevations as conduits where cables will be routed to a building interior. Minimum trench width shall be that required to accept power-operated mechanical tampers.
 - (2) Grade bottom surfaces of trenches to provide uniform bearing and continuous support for cable and conduit.
 - (3) Material excavated in excess by error, or due to unsuitable bearing, shall be replaced with mechanically compacted inorganic soil.
 - (4) If solid rock is encountered, the COR will decide if such rock need be removed or if an alternate trench route or lesser depth conduit installation will be acceptable.
 - (5) If a trench must cross a concrete or asphalt paved surface, all cuts shall be saw cuts, unless otherwise specified.

2A.8 COMPACTION.

a. General.

- (1) All compaction shall be accomplished by using power-operated mechanical equipment except for limited use of manual tampers in constricted areas. Operate all power equipment as herein specified to achieve the minimum degree of compaction subject to acceptance by testing.
- (2) Cohesive soils are defined herein as those containing less than 60 percent sand, gravel, or stone. Percentages greater than 60 percent are herein termed non-cohesive soils.

b. Cohesive Soil Compaction.

- (1) Use sheepsfoot roller of such minimum weight that at least 200 psi will be transmitted to surface area of studs or feet. Operate at speeds not exceeding 4 mph on each layer of fill until roller walks itself to top of grade.
- (2) Use motor-operated soil tamper (stomper) in confined areas, including trenches, on each layer of fill until no further visible consolidation is evident.
- (3) Use a heavy blunt tamping rod on each layer of fill in the most constricted locations where power equipment cannot be used.

c. Non-Cohesive Soil Compaction.

- (1) Use pneumatic tire roller fully loaded and weighing not less than 275 pounds per inch of tire tread width. Operate at speeds not exceeding 4 mph. A minimum of ten passes of the roller is required on each layer of fill.
- (2) Use motor-operated vibratory tamper in confined areas, including trenches, on each layer of fill until no further visible consolidation is evident.
- (3) Use heavy blunt tamping rods on each fill layer in constricted locations where power equipment cannot be used.

d. Moisture Control.

- (1) Where soil material must be moisture-conditioned before compaction, uniformly apply water to a layer of soil material in such quantity that free water will not appear on the surface during or subsequent to compaction operations.
- (2) Scarify and air-dry soil material that is too wet to permit compaction to specified density.

e. Percentage of Maximum Density Requirements.

- (1) General Requirements. The required densities for cohesive and non-cohesive soils are determined by quantitative testing procedures defined by ASTM Standards D 1557 and D 4253/4254, respectively. To assure compliance, the Contractor may arrange for such professional soil testing services, at no additional cost to the Government. The FAA, at its expense, may also make such arrangements if qualitative testing procedures appear inadequate.
- (2) Structures, Slabs, and Access Roads/Parking Areas. Compact top surfaces of subgrade and each layer of backfill or fill material to 90% of maximum density for cohesive soils, or to 95% relative density for non-cohesive material.
- (3) Turf and Non-Vehicular Surfaced Areas. Compact top surfaces of subgrade and each layer of backfill or fill material to 90 percent of maximum density for cohesive soils, or to 90 percent relative density for non-cohesive material.

f. Qualitative Testing and Inspection Procedures.

- (1) General. The Contractor shall perform qualitative soil compaction testing and inspection procedures for each type of backfill or fill material used wherever directed by, and in the presence of, the **COR**. Special attention shall be given to the backfilling of structures and trenches.
- (2) Qualitative Testing.
 - (a) Qualitative soil testing will consist of comparing the resistance to penetration of undisturbed soil to that of compacted backfill of the same composition. For borrow material the penetration comparison shall be made between maximum test sample density and in-place fill density.
 - (b) A soil penetration device (penetrometer) indicating depth and force exerted shall be utilized. Compaction will be adequate if backfill or fill possesses at least 95% of the resistance to penetration of undisturbed soil or test sample, respectively.
 - (c) Borrow test sample shall be a four inch deep (compacted measurement) layer of soil, aerated or moistened as directed by the COR, and compacted by power equipment until no further consolidation occurs, as approved by the COR.
- (3) Concrete Slab Base Course. Compact with vibratory tamper until no further visible consolidation is evident.

2A.9 BACKFILL AND FILL.

- a. Structure Foundations. Backfill or fill as promptly as work permits, but not until completion of the following:
 - (1) Acceptance of construction below grade.
 - (2) Recording locations of underground conduit.
 - (3) Removal of concrete formwork, bracing, trash, and debris.
- b. Ground Surface Preparation. Remove vegetation, debris, topsoil, and unsatisfactory subsoil from ground surface, and compact the subgrade, prior to placement of fill layers.
- c. Placement and Compaction.
 - (1) Place acceptable backfill and fill materials in layers not more than eight inches in loose depth for material to be compacted by heavy equipment, and not more than four inches in loose depth for material to be compacted by hand-operated tampers.
 - (2) Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Do not place backfill or fill on water, ice, snow, frozen soil, or excessively wet soil.
- d. Cable Trench Backfill.
 - (1) Before laying cables, inspect the bottom of the cable trench. If it is not smooth, or if any rock or stone that would be retained on a 1/4-inch sieve is present, place a two-inch layer of bedding material, according to Paragraph (2) below, in the trench. Do not compact this layer. Lay cables on top of this layer.
 - (2) The first layer of backfill material over cables shall be three inches deep, loose measurement, and shall be sand or other homogeneous inorganic soil containing no mineral aggregate particles that would be retained on a 1/4-inch sieve. This layer shall not be mechanically compacted.
 - (3) The second layer, in turf and crushed rock surface areas, shall be four inches deep, loose measurement, and shall contain no mineral aggregate particles that would be retained on a one-inch sieve. Subsequent layers shall be clean soil containing no rock particles larger than two inches in their largest dimension.
 - (4) Except for surfacing material, all layers of trench backfill, for areas to be paved or surfaced with crushed rock, shall be sand, placed and compacted as required for access roads.
 - (a) If a trench crosses an area surfaced with crushed rock, the top 12 inches of trench backfill shall be crushed rock, placed and compacted as required for access roads. The finished grade elevation of the crushed rock backfill shall equal the grade elevation of existing adjacent crushed rock.

- (b) If a trench crosses an area surfaced with concrete or asphalt pavement, the pavement shall be replaced with materials of the same composition, thickness, and degree of compaction as the adjacent pavement structure, except that the crushed rock base shall be a minimum of 12 inches deep. Replacement concrete shall have a 28-day compressive strength of 3,000 psi. Finished grade of the pavement patch shall be flush with the adjacent pavement surfaces.
- e. Backfill and Fill Surface Elevations. Finished grade, shown on the drawings, is the top surface of turf and crushed rock or crushed stone surfaced areas. Therefore, make allowances for six inches of topsoil and depths as detailed or specified for surfaced areas when establishing top surface of fill or backfill.

2A.10 GRADING.

- a. General. Uniformly grade areas within limits of grading, including adjacent transition area. Smooth the finished surfaces within specified tolerances, and compact with uniform slopes between points where elevations are indicated, or between such points and existing grades.
- b. Grading Outside Building Lines. Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish areas to receive topsoil and surfacing within 0.10 feet above or below required subgrade elevations.
- c. Grading Surface of Fill Under Building Slabs. Grade smooth and level and to proper elevation to within a tolerance of 1/2 inch when tested with a 10-foot straightedge.

2A.11 MAINTENANCE.

- a. Protection of Graded Areas. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- b. Reconditioning. Where compacted areas are disturbed by construction operations, adverse weather, or where any settlement has occurred, scarify surface, add acceptable fill, reshape, grade, and compact as necessary.

2A.12 DISPOSAL OF EXCESS AND WASTE MATERIALS. Remove and dispose of all excess soil and waste material from the project site and adjacent lands. All costs associated with disposal shall be at Contractor's expense.

DIVISION 2 - SITEWORK
SECTION 2B
CRUSHED AGGREGATE ROAD AND SITE SURFACING

- 2B.1 DESCRIPTION OF WORK. The extent of work is indicated on the drawings and by the provisions of this section.
- 2B.2 STATE SPECIFICATIONS. State highway construction specifications, latest edition, form a part of this Specification and are applicable for all work unless otherwise specified. This referenced specification will be hereinafter referred to as "State Specifications." Disregard all references in the State Specifications to layout of work by others, and to measurements and payments. All layout work will be accomplished by the Contractor, and payment for all work under this section will be a part of the lump-sum contract.
- 2B.3 MATERIALS.
- a. Geotextile.
- (1) Application. The most common application of geotextiles in FAA navigational construction is as a separator. In this application, the geotextile is placed over prepared roadway subgrade soil, and crushed aggregate is placed and compacted on top of the geotextile. The geotextile permits water to permeate into the subgrade, while preventing the aggregate from mixing with the subgrade soil. The geotextile specified below is for application as a separator.
- (2) Separator Geotextile Selection Criteria. The geotextile fibers, and the threads used in joining the geotextile by sewing, shall consist of long chain polymeric fibers composed of polypropylene, polyester, polyolefins, or polyamide. Both the geotextile and threads shall be resistant to chemical attack, mildew, and rot. The geotextile shall conform to the physical property requirements listed in the following table. All values shall represent certifiable minimum values in the weakest principle direction of the fabric.

<u>Property</u>	<u>Test Method</u>	<u>Requirement</u>
Tensile Strength	ASTM D-4595	2460 lbs/ft
Tensile Strength (at 2% strain)	ASTM D-4595	480 lbs/ft
Tensile Strength (5%)	ASTM D-4595	1212 lbs/ft
Tensile Strength (10%)	ASTM D-4595	2340 lbs/ft
Factory Seam Strength	ASTM D-4632	1250 lbs/ft
Flow Rate	ASTM D-4491	50 gpm/ ft ²
Permeability	ASTM D-4491	.04 cm/sec
Permittivity	ASTM D-4491	.70 sec ⁻¹
Apparent Opening Size	ASTM D-4751	U.S. Sieve #30, max
UV Resistance	ASTM D-4355	80% str. retained

Mirafi HP270 manufactured by Royal Ten Cate Corporation is one of the products which meets these Specifications. For any substitution, provide the Contracting Officer with complete product literature, including values of the properties tabulated above, and a sample of fabric. Do not procure any substitute before receiving the Contracting Officer's approval. See Paragraph 1A.4 above.

- (3) Geotextile Fabric Width. Fabric width shall be at least 15 feet for the normal 13-foot-wide access road. Fabric in other vehicular areas shall be cut to fit, and overlapped per Paragraph 2B.4c(2)(b), below, to fully cover such areas.

b. Landscape Fabric.

- (1) Application. Landscape fabric shall be applied under all non-roadway crushed rock surfacing, such as walkways around navaid shelters, at RVR sites, and between light bars of a MALSR. In these applications, landscape fabric is placed over prepared walkway subgrade soil, and crushed aggregate is placed and compacted on top of the landscape fabric. The landscape fabric acts as a separator, as does geotextile, and blocks weed growth. The Contractor shall have the option of substituting geotextile per Paragraph 2B.3a, for landscape fabric.
- (2) Landscape Fabric Selection Criteria. The landscape fabric fibers shall be a needlepunched nonwoven geotextile composed of polypropylene, polyester, polyolefin, or polyamide fibers. The fabric shall be resistant to chemical attack, mildew, and rot. The fabric shall conform to the physical property requirements listed in the following table. All values shall represent certifiable minimum values in the weakest principle direction of the fabric.

<u>Property</u>	<u>Test Method</u>	<u>Requirement</u>
Grab Tensile Strength	ASTM D-4632	120 lbs
Grab Elongation	ASTM D-4632	50%
Trapezoidal Tear	ASTM D-4533	50lbs
CBR Puncture Strength	ASTM D-6241	310 lbs
Apparent Opening Size	ASTM D-4751	U.S. Sieve #70, max
Permittivity	ASTM D-4491	1.7 sec ⁻¹
Flow Rate	ASTM D-4491	135 gpm/ft ²

Mirafi 140N manufactured by Royal Ten Cate Corporation is one of the products which meets these Specifications. For any substitution, provide the Contracting Officer with complete product literature, including values of the properties tabulated above, and a sample of fabric.

Do not procure any substitute before receiving the Contracting Officer's approval. See Paragraph 1A.4 above.

- (3) Landscape Fabric Width. Fabric width shall be 3 feet wide for a 3-foot-wide crushed rock walkway. Fabric in other walkway areas shall be cut to fit, and overlapped per Paragraph 2B.4c(2)(a), below, to fully cover such areas.

c. Crushed Aggregate Surfacing.

- (1) Crushed rock or crushed stone aggregate shall comply with State Specification quality requirements for crushed rock or crushed stone used for road surface course, and shall be of the State gradation most closely conforming with the following gradation:

<u>Sieve Size</u>	<u>Total Passing, Percent</u>
1-inch	100
3/4-inch	80-100
3/8"-inch	30-60
No. 4	48-65
No. 8	35-50
No. 30	19-30
No. 50	13-23
No. 100	7-15
No. 200	0-8

- (2) A certified sieve analysis, referenced to State Specification gradation, shall be submitted to the COR for approval.

2B.4 CONSTRUCTION.

- a. General Requirements. All earthwork requirements in Section 2A for areas to receive surfacing are applicable, excepting as qualified herein. Where the additional work or more stringent requirements in this section conflict with Section 2A, requirements herein shall prevail.
- b. Foundation Preparation.
 - (1) Foundation Material. All topsoil shall be removed from areas to receive paving and surfacing or fill under such surfaces. Only inorganic soil shall exist under surfaced or paved areas.
 - (2) Compaction. Compact as required in Section 2A.

- (3) Grading. Shape with motor grader to achieve such surface trueness that when tested with a 10-foot straightedge, no deviation greater than 1/2-inch shall exist.
- (4) Corrective Work. Any ruts or soft-yielding spots that may appear in the subgrade, any areas having inadequate compaction, and deviations of the surface from the requirements specified shall be corrected by loosening, removing, and adding approved material and reshaping and recompacting the affected areas to line and grade, and to the specified density.

c. Geotextile or Landscape Fabric.

- (1) General. Geotextile or landscape fabric, if required on the drawings, shall be installed on prepared subgrade for all areas that will experience vehicular traffic or pedestrian traffic, respectively.
- (2) Construction Requirements.
 - (a) Prepared subgrade and foundations shall be compacted smooth and level as specified elsewhere and as shown on the drawings.
 - (b) The fabric shall be rolled out directly upon the prepared surface, and shall not be dragged over any surface. Fabric in place shall have a smooth surface and shall be free of folds, wrinkles, cuts, or other imperfections. Individual panels of fabric shall be overlapped at least 24 inches, with the preceding layer overlapping the following layer in the direction that surfacing material will be spread. No vehicular traffic will be permitted directly upon the fabric.

d. Crushed Aggregate Surfaced Areas and Crushed Aggregate Base Course for Bituminous Pavement.

- (1) Spreading. Crushed aggregate surfaced areas and base course shall be constructed in one or more layers of maximum 6-inch compacted thickness each. Crushed aggregate shall be deposited directly and uniformly on the prepared subgrade, if no geotextile or landscape fabric is used. If geotextile fabric is required, the aggregate shall be back-dumped on the fabric, and machine spread in the direction of overlap. Dumping in windrows, which requires excessive rehandling, will not be permitted. When deposited, the aggregate shall be free from segregation, and shall require minimum blading or manipulation.

(2) Compaction and Grading.

- (a) Each layer of aggregate shall be compacted using equipment required in the State Specifications. For compacting aggregate on a geotextile or landscape fabric, use a smooth-drum roller. Compaction shall closely follow the spreading operation to prevent loss of contained moisture or displacement of materials.
- (b) When the surface stability of the crushed aggregate cannot be obtained due to lack of fines, additional fines shall be added to the upper portion of the course in an amount sufficient to secure stability, at no additional cost to the Government. In no case, however, shall the quantity of fines added increase the percent passing the Number 200 sieve by more than 15 percent in the upper portion.
- (c) Any irregularities or depressions that develop in the layers under rolling operations shall be corrected by loosening the material and removing or adding aggregate and rerolling. The rolling shall be continued until the surface is shown to be smooth and uniform, and to such trueness that when tested with a 10-foot straightedge it shall not show any deviation in excess of 1/4-inch. At all places not accessible to the roller, the aggregate of each layer shall be tamped separately and compacted to grade and line with mechanical tampers.
- (d) If any subgrade material is worked into the aggregate material during the compacting or finishing operations, all granular material within the affected areas shall be removed and replaced with new aggregate. The COR may restrict hauling or traffic over the completed or partially completed base after inclement weather or at any time when the subgrade is soft, and there is a tendency for the subgrade material to work into the base material.
- (e) If considered necessary by the COR, water shall be applied to each layer to aid in compaction and prevent segregation of the material. Disc or harrow surfacing material during moistening operations to secure uniform moisture distribution. Add water in a manner that will not soften the subgrade. All work associated with the additional water shall be accomplished at no additional cost to the Government.

- (f) The aggregate shall be compacted to 95 percent maximum density as determined by AASHTO-T99. Compaction shall continue until no further discernible compaction is evidenced under action of the compaction equipment. If in the opinion of the COR, the required degree of compaction has not been achieved, testing in accordance with the standard will be conducted and paid for by the Government. If testing confirms unacceptable compaction, reconstruction or other remedial work may be required by the Contractor at no additional cost to the Government.

DIVISION 2 - SITEWORK
SECTION 2C
ASPHALT CONCRETE PAVEMENT

- 2C.1 DESCRIPTION OF WORK. The extent of asphalt concrete pavement construction is indicated on the drawings and by the provisions of this section. Pavement construction will include placing prime and tack coats and asphalt concrete base and surface courses on prepared subgrade and aggregate base course.
- 2C.2 CERTIFICATION. Provide certification signed by material producer and Contractor that all materials and mix compositions comply with the specified requirements.
- 2C.3 APPLICABLE SPECIFICATIONS.
- a. American Association of State Highway and Transportation Officials (AASHTO) material referenced herein.
 - b. State Highway Construction Specifications.
 - (1) State highway construction specifications, latest edition, form a part of this specification and are applicable for all work, unless otherwise specified. This referenced specification will hereinafter be referred to as "State Specifications."
 - (2) Disregard all references in the State Specifications to layout of work by others, and to measurements and payments. All layout work will be accomplished by the contractor, and payment for all work under this section will be a part of the lump-sum contract.
 - (3) Prime and tack coats, as specified herein, are a requirement under this contract even if such coats are not required under the State Specifications.
- 2C.4 WEATHER LIMITATIONS.
- a. Surface Conditions. Apply all coats and asphalt layers to dry surfaces only. Do not commence work when wet weather threatens.
 - b. Temperatures.
 - (1) Apply prime and tack coats when air temperature is above 50°F and when temperature has not been below 35°F for 12 hours immediately prior to application.
 - (2) Construct asphalt concrete base and surface courses when air temperatures are above 30°F and rising, and above 40°F, respectively.

2C.5 MATERIALS.

- a. General Requirements. Provide locally available materials that comply with the State Specifications for asphalt concrete pavements and all requirements herein.
- b. Base (Binder) and Surface Course Aggregates. Provide sound angular crushed rock or crushed stone, sand, and stone screenings.
- c. Asphalt Cement. AASHTO M 226 (ASTM D 3381) for viscosity-graded material and AASHTO M 20 (ASTM D 946) for penetration-graded material.
- d. Prime Coat. Cut-back asphalt type; AASHTO M 82 (ASTM D 2027) MC-30, MC-70, or MC-250.
- e. Tack Coat. Emulsified asphalt; AASHTO M 140 (ASTM D 977) or MC-208 (D 2397); SS-1, SS-1h, CSS-1 or CSS-1h, diluted with one part water to one part emulsified asphalt.

2C.6 ASPHALT-AGGREGATE MIXTURE. Provide plant-mixed, hot-laid asphalt-aggregate mixture complying with ASTM D 3515 and the State Specifications.

2C.7 CONSTRUCTION.

- a. Surface Preparation.
 - (1) Prepare subgrade and provide road stabilization/reinforcement fabric and aggregate base course as required in Sections 2A and 2B herein.
 - (2) Inspect aggregate base for unstable areas and areas requiring additional compaction before proceeding with pavement work and correct all unsatisfactory conditions.
- b. Prime Coat. Apply at a rate of 0.20 to 0.50 gallons per square yard, over compacted aggregate base course. Apply material to penetrate and seal, but not flood, surface. Cure and dry as long as necessary to attain penetration and evaporation of volatile.
- c. Tack Coat. Apply to surface of asphalt concrete base (binder) course and abutting surfaces of existing pavement, at the rate of 0.05 to 0.15 gallons per square yard of surface. Allow to dry before placing surface coat.

d. Placement of Mix.

- (1) General. Place asphalt concrete mixture on prepared surface, spread, and strike off. Spread mixture at a minimum temperature of 225°F (107°C). Place inaccessible and small areas by hand. Place each course to required grade, cross-section, and compacted thickness.
- (2) Course Thickness. Unless indicated otherwise on the drawings, asphalt concrete base and surface courses shall be 3 inches and 1 1/2 inches thick, respectively.
- (3) Paver Placing. Place in strips not less than 10 feet wide, unless otherwise acceptable to the COR. After the first strip has been placed and rolled, place succeeding strips, and extend rolling to overlap previous strips. Complete base course for a section before placing surface course.
- (4) Joints. Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have the same texture, density, and smoothness as other sections of asphalt concrete course. Clean contact surfaces and apply tack coat.

e. Rolling.

- (1) General.
 - (a) Begin rolling when mixture will bear roller weight without excessive displacement.
 - (b) Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
- (2) Breakdown Rolling. Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling, if required, with hot material.
- (3) Second Rolling. Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.
- (4) Finish Rolling. Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

- f. Patching. Remove and replace paving areas mixed with foreign materials, and defective areas. Cut out such areas, and fill with fresh, hot asphalt concrete. Compact by rolling to maximum surface density and smoothness.
- g. Protection. After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

2C.8 FIELD QUALITY CONTROL.

- a. General. Test in-place asphalt concrete courses, at intervals as directed by the COR, for compliance with requirements for thickness and surface smoothness. Repair or remove and replace unacceptable paving as directed by the COR.
- b. Thickness. In-place compacted thickness will not be acceptable if they exceed the following allowable variation from required thickness:
 - (1) Base Course. 1/2-inch
 - (2) Surface Course. 1/4-inch
- c. Surface Smoothness. Test finished surface of each asphalt concrete course for smoothness, using 10-foot straightedge applied parallel with, and at right angles to, centerline of paved area. Surfaces will not be acceptable if they exceed the following tolerances for smoothness.
 - (1) Base Course Surface. 1/4-inch
 - (2) Wearing Course Surface. 3/16-inch
 - (3) Crowned Surfaces. Test with crowned template centered and at right angle to crown. Maximum allowable variance from template: 1/4-inch.

DIVISION - SITEWORK
SECTION 2D
TOPSOIL AND GRASS COVER

- 2D.1 DESCRIPTION OF WORK. The extent of topsoil placement and establishment of grass cover is indicated on the drawings and the provisions of this section.
- 2D.2 GENERAL REQUIREMENTS. All areas of the project site, access road right-of-way, and cable trench routes, which will not be occupied by pavement, crushed rock/stone surfacing, or other construction, shall receive preparation and grass seed planting and maintenance. Included in this work will be off-site turf reconditioning and replacement for those areas damaged by construction operations.
- 2D.3 MATERIALS.

- a. Topsoil. Material shall be that removed from project site location preparatory to trenching and site construction. Reuse only that part of stockpiled topsoil reasonably free of subsoil, trash, roots, stumps, weeds, debris, litter, and stones larger than 2 inches.
- b. Fertilizer. Provide complete fertilizer of 5-10-5 composition (percentages of nitrogen, phosphorous, and potash, respectively).
- c. Grass Seed. Provide fresh, clean, new-crop seed complying with tolerance for purity and germination established by Official Seed Analysts of North America. Provide the following seed mixture composed of grass species and proportions:

<u>Proportion by Weight</u>	<u>Common Name</u>
45%	Kentucky Bluegrass
5%	Perennial Ryegrass
35%	Redtop
15%	White Clover

- d. Anti-Erosion Mulch. Provide clear, seed-free salt hay or threshed straw of wheat, rye, oats, or barley. Anchor the mulch sufficiently to prevent it from being blown away.
- 2D.4 PREPARATION FOR PLANTING.

- a. Subsurface Preparation. After completion of all construction operations that could disturb topsoil areas, subgrades shall be cleared free of waste and stones larger than 2 inches, then tilled to a depth of 3 inches, and graded to remove surface irregularities.

- b. Topsoil and Surface Preparation. Spread topsoil uniformly to provide a 6-inch layer, after compaction, on all fill and backfilled areas to receive grass seed. Compact with a roller weighing 85 to 100 pounds per foot of width. Subgrade and topsoil shall be damp when work is performed, but not wet, dusty, or frozen.
- c. Preparation of Unchanged Grades. Where seed will be planted in areas that have not been altered by grading, prepare soil for planting as follows: till to a depth of 6 inches, apply fertilizer, remove high areas and fill depressions, till soil to a homogenous mixture of fine texture, free of lumps, stones, roots, and trash, and compact as above.
- d. Fertilizer. Apply fertilizer at the rate of 30 pounds per 1000 square feet of area. Mix fertilizer into top 2 inches of topsoil.
- e. Surface Preparation. Fine grade to a smooth, even surface and to a loose, uniformly fine texture. Roll, rake, and drag seeded areas, remove ridges, and fill depressions as necessary to meet finish grades. Limit work to areas that can be planted immediately. Moisten prepared areas before planting if soil is dry. Allow surface mixture to dry and proceed with seeding.

2D.5 SEEDING.

- a. Seed Condition. Do not use old, wet, or moldy seed. The seed shall be dated with the year in which it is being applied.
- b. Sowing. Use spreader or sowing machine. Do not seed when wind velocity exceeds 5 mph. Distribute seed evenly over entire area by sowing equal quantities in two directions at right angles to each other. Seed at rate of 5 pounds of seed per 1000 square feet of area. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with a fine spray.
- c. Protection. Spread mulch uniformly to form a continuous loose blanket after completion of seeding operations. Anchor the mulch sufficiently to prevent it from being blown away.

2D.6 MAINTENANCE. Maintain for a period of 60 days after seeding. If maintenance for a 60-day period is not feasible, the Contractor shall use a commercially available mix of seed, fertilizer, and long-lasting mulch, or a preseeded anchored mat that can be maintained less frequently with the same results. Water, fertilize, regrade, and replant as required to establish smooth, acceptable turf.

DIVISION 2 - SITE WORK
SECTION 2E
MISCELLANEOUS SITE IMPROVEMENTS

- 2E.1 DESCRIPTION OF WORK. The extent of miscellaneous site work is indicated on the drawings and by the provisions of this section.
- 2E.2 CONDUIT INSTALLATION BY JACKING OR BORING.
- a. Materials. Conduit shall be 4-inch diameter, rigid, galvanized steel unless otherwise specified on the drawings. The leading end of the conduit to be jacked shall be equipped with an approved cap or point designed specifically for pipe jacking.
 - b. Excavation and Backfill of Jacking or Boring Pits. Excavation and backfill of all pits used for the installation of conduit shall conform to Section 2A.
 - c. Jacking Equipment. Pipe jacking equipment shall be an approved design for the purpose of jacking pipe and shall be capable of developing sufficient force to overcome frictional and/or other resisting forces built up over the distance involved.
 - d. Location. Conduit shall be located where shown on the drawings and/or as staked out by the COR. Conduit shall be started into place at a minimum of 36 inches below finished grade, if not otherwise specified in the proposal or on drawings. The transverse alignment shall be considered satisfactory only when the terminating or leading end of the conduit exits within 5 feet of its intended location for a conduit length of less than 50 feet. For lengths greater than 50 feet, the transverse location must not be outside of 15 feet of the intended location. The vertical limits of the point of exit of the leading end of the conduit shall be between 24 inches and 50 inches below finished grade for conduits up to 50 feet in length and between 24 inches and 84 inches for conduits of greater length.
 - e. Conduit Length. Unless otherwise specified, conduit, no matter how installed, shall extend a minimum of 5 feet beyond each side of the pavement or structure.
 - f. Conduit Sealant. After completion of conduit and cable installation, both ends of the conduit shall be sealed with Permagum or other approved compound to prevent entrance of moisture.
- 2E.3 REMOVAL OF EXISTING FOUNDATIONS. All foundations of removed buildings, trailers, antenna supports, or other structures shall be removed to a minimum depth of two feet below final grade and backfilled with compacted earth in accordance with Section 2A, unless noted otherwise on the site drawings. The site areas shall be graded smooth and topsoil added to match the original terrain, unless otherwise specified.

2E.4 FENCES.

- a. Materials and Installation. All materials and installations shall be in accordance with project drawing requirements.
- b. Fence Grounding. Grounding materials and procedures shall be in accordance with project drawing requirements. Fence grounding conductors may be attached to the grounding electrodes of a shelter perimeter grounding system if such electrodes are located 22 feet or less from the fences to be grounded.

2E.5 CULVERTS.

- a. Material. When shown on the drawings, corrugated galvanized sheet metal pipe shall conform to the requirements of AASHTO standard specification M-36.
- b. Installation. Excavation for culverts shall provide a firm uniform foundation. Backfill around culverts shall be the same materials used in the road embankment and shall be well compacted in layers of not more than eight inches. Unless otherwise specified, there shall be a minimum of one foot of cover over all culverts. Bed the bottom quadrant of culverts in undisturbed soil.

2E.6 REPLACEMENT OF SURFACING AGGREGATE AND PAVEMENT. For replacement of surfacing aggregate and pavement removed for trenching operations, see Paragraph 2A.9d(4) above.

2E.7 SPECIAL SURFACING.

- a. General. If required on the drawings, surfacing for VASI, PAPI, and REIL light units, and all other small surfacing areas within 300 feet of runway and taxiway edges, shall be the material placed as required below. Special surfacing requirements will preclude displacement onto aircraft operating surfaces.
- b. Material and Installation. Crushed rock or crushed stone surfacing at light unit locations shall be 4 inches deep and centered on the units. Material shall be 1 1/2 to 2 inches nominal size washed crushed rock. No substitutions will be accepted. Rock shall be tamped as tightly as material permits. Finished surface shall be flush with existing surrounding grade.

DIVISION 3 - CONCRETE
SECTION 3A
CONCRETE FORMWORK AND REINFORCEMENT

3A.1 DESCRIPTION OF WORK. Extent of work is indicated on the drawings and by the requirements of this section.

3A.2 CONCRETE FORMWORK.

- a. Design of Forms. Forms shall conform to shapes, lines, and dimensions of the members shown on the plans, and shall be sufficiently tight to prevent leakage of mortar. They shall be properly tied together so as to maintain position and shape.
- b. Form Removal. Forms shall not be loosened or removed until the concrete members have acquired strength sufficient to support their own weight. No additional loads shall be placed on the concrete for at least 48 hours after placing.
- c. Form Ties. Form ties for concrete shall be of a type that will break back 1 1/2 inches from the concrete surface. Ties shall be removed to a minimum depth of 1 1/2 inches, and the surface patched.

3A.3 CONCRETE REINFORCEMENT.

- a. Materials. Reinforcement bars shall conform to "Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement", ASTM A-615. All bars shall be Grade 60 deformed bars.
- b. Cleaning and Bending Reinforcement. At the time concrete is placed, metal reinforcement shall be free from rust scale or other coatings that will destroy or reduce the bond. All bent bars shall be bent cold. No bars partially embedded in concrete shall be field bent except as shown on plans.
- c. Placing Reinforcement. Metal reinforcement shall be accurately placed according to the plans, and adequately secured in position by concrete, metal, or other approved chairs, spacers, or ties.
- d. Splices in Reinforcement. No splices or reinforcement shall be made except as shown on the plans or as authorized by the COR.

- e. Concrete Protection for Reinforcement. The reinforcement shall be protected by the thickness of concrete shown on the drawings. Where not shown, the thickness of concrete over the reinforcement shall be as follows:
- (1) Where concrete is deposited against the ground without the use of forms, not less than 3 inches.
 - (2) Where concrete is exposed to the weather or to the ground but placed in forms, not less than 2 inches for bars larger than number 5, and 1 1/2 inches for number 5 bars or smaller.

DIVISION 3 - CONCRETE
SECTION 3B
CAST-IN-PLACE CONCRETE

- 3B.1 DESCRIPTION OF WORK. The extent of work is indicated on the drawings and by the provisions of this section.
- 3B.2 MATERIALS. Cement shall conform to Specification for Portland Cement ASTM C-150, Type I, or Specification for Air-Entraining Portland Cement ASTM C-175, Type 1A, unless otherwise specified. The concrete shall have a minimum 28-day compressive strength of 3,000 PSI, a maximum slump of 4 inches, and a maximum aggregate size of 1-inch. The concrete mix shall contain an air-entraining admixture. Air content shall be 5 to 7 percent. The Contractor shall give the COR a certificate from the concrete supplier, bearing the intended job mix and certifying that the concrete delivered will meet the above requirements. The Contractor shall obtain approval of the job mix from the COR prior to placing concrete.
- 3B.3 PREPARATION OF EQUIPMENT AND PLACE OF DEPOSIT.
- a. Before placement, all equipment for mixing and transporting the concrete shall be cleaned. All debris and ice shall be removed from the places to be occupied by the concrete. Forms shall be thoroughly wetted (except in freezing weather) and oiled prior to placing reinforcing steel. The reinforcement shall be thoroughly cleaned of ice, dirt, rust scale, or other coatings.
 - b. Water shall be removed from place of deposit before concrete is placed. All laitance and other unsound material shall be removed from hardened concrete before additional concrete is added.
- 3B.4 CONVEYANCE. Concrete shall be conveyed from the mixer to the place of final deposit by methods that will prevent segregation or loss of materials. Equipment for chuting concrete shall be of such size and design so as to ensure a continuous flow of concrete at the delivery end without segregation of materials.
- 3B.5 PLACEMENT.
- a. Concrete shall be placed within 1 1/2 hours after mixing begins. Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. The placing of concrete shall be carried on at such rate that concrete is at all times plastic, and flows readily into the spaces between the bars. No concrete that has been contaminated by foreign material shall be used, nor shall retempered concrete be used.
 - b. When placing is started, it shall be carried on as a continuous operation until placement is completed.

- c. Concrete shall be placed in layers not exceeding 18 inches deep, and vibrated in place. During and immediately after depositing, the concrete shall be consolidated by vibrators. The concrete shall be thoroughly worked around reinforcement, around embedded fixtures, and into corners. Accumulations of water on the surface of the concrete due to water gain, segregation, or other causes, shall be prevented as much as possible by employing proper placement, consolidation, and finishing practices. Provisions shall be made to remove such water as may accumulate, so that under no conditions will concrete be placed in such accumulations.
- d. Vibrators shall be the internal immersion type, operating at speeds of not less than 7,000 RPM. Vibrators shall be kept constantly moving in the concrete and shall be applied at points uniformly spaced not further apart than the radius over which the vibrator is visibly effective. The entire depth of a new layer of concrete shall be vibrated. The vibrators shall penetrate several inches into the layer below to insure thorough union of the layers. The vibrator shall not be held in one location long enough to draw a pool of grout from the surrounding concrete. Vibration shall be such that the concrete becomes uniformly plastic.

3B.6 FOOTINGS. All footings and foundations without footings shall bear on firm, undisturbed soil.

3B.7 CYLINDRICAL CONCRETE PIERS.

- a. All cylindrical concrete piers, if required, shall be formed to full depth in fiber forms. Tops of piers shall be finished flat within the confines of the fiber forms. No spillage (mushrooming) over the tops of forms will be permitted. Where conduit emerges from vertical surfaces of concrete piers, no appreciable amount of concrete shall be permitted to spill through forms adjacent to such conduit.
- b. Fiber forms for cylindrical concrete piers shall be spirally constructed of laminated plies of fiber. The total wall thickness shall be as published by the manufacturer. The width of each ply shall not be less than 6 inches. Plies shall be laminated with an adhesive of a non-water-sensitive type, with a proven record of satisfactory service in concrete forms. The exterior surface shall be uniformly wax impregnated for weather and moisture protection. The interior surface shall be coated with pure polyethylene uncontaminated by paraffin or other additives. A-Coated Sonotube forms by Sonoco Products Company of Hartsville, South Carolina, are among the products that meet these Specifications.

- c. Remove all loose soil from bore holes so that concrete will bear on undisturbed soil. Support forms rigidly and in proper horizontal and vertical alignment. After pouring, remove only that part of each form that will be exposed above grade. Backfill excess space between bore holes and forms with thoroughly compacted inorganic soil. Do not use sand backfill unless adjacent undisturbed soil is sand.

3B.8 ANCHOR BOLT INSERTS. No drilling for or placing of anchor bolt inserts or anchors will be permitted in concrete for a period of three days after placement, unless noted otherwise on the drawings.

3B.9 CURING.

- a. Provision shall be made for maintaining concrete in a moist condition for a period of at least 5 days after placement.
- b. In lieu of wet curing, one coat of a concrete curing sealer which forms a film over the concrete surface, may be used for curing the concrete. The sealer shall meet the ASTM C-309 standard for moisture retention. The compound shall be a type that does not permanently discolor the concrete. Dayton Superior J11W is one of the products which meet this Specification. Where concrete is to receive vinyl composition tile (VCT), or any other flooring, curing compound shall not be used, and only wet sheet curing is allowed. On exposed surfaces, application shall be made immediately after the concrete has been finished. If there is any delay, the concrete shall be kept moist until the application is made. After the forms are removed, the concrete shall be sprayed lightly with water, and then the coat of curing compound applied. If the forms (wood only) cannot be removed within 48 hours, they shall be wetted down and kept wet until their removal, and then the compound applied as above.

3B.10 COLD-WEATHER REQUIREMENTS.

- a. Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing weather. No frozen materials or materials containing snow or ice shall be used. Concrete shall not be placed on frozen soil.
- b. All reinforcement, forms, fillers, and ground which will make contact with concrete shall be free from snow and ice. Whenever the temperature of the surrounding air is below 40°F, all concrete placed in forms shall have a temperature of 45°F or higher, after placement. Adequate means shall be provided for maintaining this temperature for 4 days. Any additional time necessary to ensure proper curing of the concrete shall be provided as directed by the COR. The housing, covering, or other protection used in connection with curing, shall remain in place and intact at least 24 hours after the artificial heating is disconnected. Do not use salt or other chemicals to prevent freezing.

3B.11 HOT-WEATHER REQUIREMENTS.

- a. In hot weather, suitable precautions shall be taken to avoid drying of the concrete prior to finishing operations. Use of windbreaks, sunshades, fog sprays, or other devices shall be provided as directed by the COR.
- b. Concrete deposited in hot weather shall not have a placing temperature that will cause difficulty from loss of slump, flash set, or cold joints. Concrete temperature shall be less than 90°F.

3B.12 SLUMP. Concrete shall be tested for consistency at the mixer or at the place of deposit if delivered ready-mixed. The sample shall be taken immediately from the batch and tested by the Contractor in the presence of the COR in accordance with ASTM C143. Concrete with slump in excess of four inches shall be rejected.

3B.13 DELIVERY TICKETS. At the time of concrete delivery, the Contractor shall give the COR a copy of the delivery ticket bearing the quantity, strength, and air entrainment of the concrete delivered.

3B.14 CONCRETE TESTS. If the COR determines that concrete strength and air entrainment tests are needed, the FAA will make arrangements for and bear costs of such tests.

DIVISION 5 - METALS
SECTION 5A
MISCELLANEOUS METALS

5A.1 DESCRIPTION OF WORK. Extent of metal work is indicated on the drawings and by the provisions of this section.

5A.2 MATERIALS.

- a. Structural Steel Shapes and Plates. ASTM A992 for W-shapes, and ASTM A36 for S, C, MC, and L-shapes, as well as steel plates.
- b. Steel Pipe. ASTM A53, Type E or S, Grade B steel or ASTM 501. Weight schedules shall be as specified on the drawings.
- c. Anchor Bolts. ASTM F1554, grade 36, without heads.
- d. Unfinished Threaded Fasteners. Where not otherwise indicated, ASTM A 307, Grade A, regular low-carbon steel bolts and nuts of hexagonal design, hot-dipped galvanized.
- e. Finished Threaded Fasteners. Stainless steel cap screws and heavy semi-finished nuts of hexagonal design for exterior connections, unless otherwise indicated.

5A.3 FABRICATION.

- a. General.
 - (1) After performing all fabrication and welding operations, remove all sharp edges and burrs that could cause injury. Properly finish surfaces of exposed items so as to be free of visible defects.
 - (2) Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes.
- b. Welding. Comply with AWS D1.1 Code for procedures, appearance, and quality of welds. Weld all work to produce assemblies free of warpage.
- c. Galvanizing.
 - (1) All steel members, plates, and assemblies shall be hot-dipped galvanized in accordance with ASTM A123, unless otherwise specified.

- (2) Prepare all structural steel items for galvanizing by solvent cleaning, hand and power tool cleaning, and/or sandblasting as required for permanent adhesion of galvanizing.

5A.4 INSTALLATION.

- a. Install all work plumb, level, and square in accordance with the drawings.
- b. Apply high zinc-dust-content paint for repair of galvanized surfaces damaged by welding. Paint shall conform to ASTM A780.

DIVISION 6 - WOOD AND PLASTICS
SECTION 6A
ROUGH CARPENTRY

6A.1 DESCRIPTION OF WORK. The extent of exterior carpentry work is indicated on the drawings and by the provisions of this section. Refer to Section 13E for MALSR and ILS shelter carpentry.

6A.2 MATERIALS.

a. Service Pole.

- (1) Electrical service pole, if required, shall be Southern Pine, Douglas Fir, or Western Red Cedar, complying with American National Standard Specifications and Dimensions for Wood Poles, ANSI O5.1, American National Standards Institute.
- (2) Poles shall be ANSI O5.1 class 6 or larger as dictated by height requirements.
- (3) Poles shall be pressure preservative treated in accordance with American Wood Protection Association (AWPA) Standard U1, Commodity Specification D: Poles, to the requirements of AWPA Use Category 4 (UC4B).

b. Lumber. Lumber shall be stress-rated and marked #2 structural grade, regardless of species. Sizes indicated are nominal. All lumber shall be dressed S4S, seasoned, and have 19 percent moisture content. Hand select all lumber pieces for straightness and freedom from defects.

c. Plywood. Plywood shall be all-veneer construction of sizes indicated on the drawings, and comply with APA- The Engineered Wood Association, grade designation: APA BC, Exterior, or better.

d. Lumber and Plywood Preservative Treatment.

- (1) All exterior lumber and plywood shall be preservative treated, and shall comply with AWPA Standard U1, Commodity Specification A: Sawn Products (Lumber) and Commodity Specification F: Composites (Plywood) to the requirements of AWPA Use Category UC3B. All material shall be quality marked in accordance with AWPA Standard U1 and shall bear the mark of an agency accredited by the American Lumber Standard Committee.
- (2) Pressure treatments for lumber and plywood shall be with water-borne preservatives.
- (3) Treat all cut surfaces and drilled holes in accordance with AWPA Standard M4.

- e. Fasteners. Provide type, size, and finish of fasteners indicated on the drawings. All exterior fasteners shall be hot-dipped galvanized or stainless steel.

6A.3 CONSTRUCTION.

- a. Discard units of material with defects that could impair quality of work. Set carpentry work to required lines and levels with members plumb, level, and square. Accurately cut and fit all work.
- b. Secure all carpentry work by anchoring or fastening as required by recognized standards. Make tight connections between members. Install all fasteners without splitting wood. Pre-drill as required.
- c. Coat all exterior exposed cut edges and ends of lumber and plywood pieces with wood preservatives as required above.

DIVISION 9 - FINISHES
SECTION 9A
PAINTING

9A.1 DESCRIPTION OF WORK. Extent of work is indicated on the drawings, in the special specifications and by the provisions of this section. Refer to Section 13E for MALSR and ILS shelter painting.

9A.2 GENERAL REQUIREMENTS.

- a. Unless otherwise specified all surfaces to be painted shall receive one coat of primer and two finish coats of paint. Primer shall be compatible with the surface being painted as recommended by the paint manufacturer.
- b. At completion of painting or work of other trades, painted surfaces shall be touched-up and restored where damaged or defaced, to the satisfaction of the COR.
- c. A completely finished job is required, regardless of whether every individual item is specified or not. Work requiring paint, which is not specifically mentioned, shall be finished in the same manner specified for other similar work.
- d. Work shall be accomplished by skilled tradesmen, and resulting work shall be uniform in appearance.

9A.3 APPLICABLE MASTER PAINTER INSTITUTE (MPI) STANDARDS.

MPI #9	"Alkyd, Exterior Gloss (MPI Gloss Level 6) (for Exterior and Interior Surfaces)"
MPI #79	"Primer, Alkyd, Anti-Corrosive for Metal"
MPI #80	"Primer, Vinyl Wash"
MPI #95	"Primer, Quick Dry, for Aluminum"
MPI #134	"Primer, Galvanized, Water Based"

9A.4 MATERIALS.

- a. Only materials listed in the latest edition of the Master Painters Institute (MPI) Approved Product List (APL) are acceptable for use. All such material shall be from a single manufacturer for each system used.
- b. Other painting materials such as linseed oil, shellac, thinners, solvents, etc., shall be the highest quality product of an MPI listed manufacturer and shall be compatible with paint materials being used as required.
- c. Where required, use only materials having a minimum MPI "Environmentally Friendly" E rating based on VOC (EPA Method 24) content levels. Where indoor air quality (odor) is an issue, use only MPI listed materials having a minimum E# rating.

9A.5 PREPARATION OF METAL SURFACES.

- a. Unpainted or shop painted ferrous metal shall first be washed free of grease, dirt, and oil with mineral spirits, and primed or spot primed if the metal is exposed. Prime with rust prohibitive primer after removing any existing rust.
- b. Previously painted existing ferrous metal shall be cleansed of grease, dirt, oil, and all other foreign substances. Existing paint which shows signs of deterioration, loosening, or chalking shall be removed. Further surface preparation shall be made as recommended by the paint manufacturer for the particular surface and type of paint being used.
- c. Exposed galvanized surfaces shall be solvent cleaned as necessary to remove all oil, grease, and other foreign substances. Nonferrous metal surfaces to be painted shall be treated with vinyl type wash coat. The vinyl type wash coat shall have a dry film thickness of .5 mils. The wash coat shall be permitted to dry as recommended by the manufacturer.

9A.6 APPLICATION.

- a. Do not apply exterior paint in damp, rainy weather, or until the surface has dried thoroughly from the effects of such weather.
- b. The temperature of the surface to be painted and the surrounding air temperature shall be maintained between 45°F and 95° during the application and drying period.
- c. The surface to be painted shall be clean, dry, smooth, and adequately protected from dampness. Each coat of paint shall be applied smoothly, worked out evenly, and allowed to dry completely before the subsequent coat is applied.
- d. Finished work shall be uniform and of the approved color. It shall be completely covered and shall be smooth and free from runs and sags. Make edges of paint adjoining other materials or colors sharp and clean without overlapping.
- e. All painting shall be completed according to the manufacturer's printed instructions.

9A.7 PAINT SYSTEM SCHEDULE.

- a. Ferrous Metals (Unpainted).
 - (1) Primer - MPI #79
 - (2) Intermediate and Finish Coats - MPI #9

b. Galvanized Metal.

- (1) Primer - MPI #134
- (2) Intermediate and Finish Coats - MPI #9

c. Aluminum.

- (1) Primer - MPI #95 (or #80 for non-anodized aluminum)
- (2) Intermediate and Finish Coats - MPI #9

DIVISION 13 - SPECIAL CONSTRUCTION
SECTION 13A
APPROACH LIGHT SYSTEMS

13A.1 DESCRIPTION OF WORK. This section is applicable for construction required for a Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR) and other approach lighting systems utilizing similar construction.

13A.2 INSTALLATION OF MALSR LIGHTS.

- a. Screw Anchor Foundations. Comply with Section 13D and project drawings if screw anchor foundations are required on the drawings.
- b. Installation Tolerances. Installation tolerances for the various types of light bars and flasher units shall be as follows:
 - (1) Longitudinal (along the runway centerline) + 6 inches
deviation from design station.
 - (2) Lateral (perpendicular to the runway
centerline). ± 3 inches
 - (3) Horizontal distance between individual
frangible lights. ± 1 inch
 - (4) Mounting height.
 - (a) Up to 6 feet. ± 1 inch
 - (b) 6 to 40 feet. ± 2 inches
 - (c) Over 40 feet. ± 3 inches
 - (5) All lights in a frangible bar shall be installed within
± 1 inch of a line perpendicular to the runway
centerline.
- c. Assembly of PAR-56 Lights. If installation of PAR-56 lights is included in the Contract, the Contractor shall assemble the PAR-56 lampholders, lamps, and, if included, filter-holding clips, colored glass filters, and (for ALSF-2 facilities) shorting devices, into complete units, from unassembled condition. Use the spring-loaded lamp-retaining hardware supplied with the lampholders.
- d. Frangible EMT Mountings.
 - (1) Frangible Coupling Installation. Each frangible coupling has a hexagonal throat with a break-off groove in the middle, designed to break at low impact, thereby minimizing damage to colliding aircraft. When installing the frangible coupling, take care to use a

wrench which will grip only the lower portion of the hexagonal throat of the coupling, i.e., that portion immediately below the break-off groove. If the wrench grips the upper portion of the hexagonal throat, the coupling may break when torque is applied. See Paragraph 16A.20 for thread remediation. Whether thread remediation is performed or not, the Contractor shall apply anti-seize compound to the threads of the frangible coupling, and to the internal threads of the receiving coupling or hole, to facilitate removal. The compound shall be an anti-seize assembly lubricant formulated to provide protection for stainless steel and dissimilar metal threaded fasteners against galling, seizure, and heat-freeze. Do not use plumber's pipe-joint compound. The frangible coupling shall be screwed down tightly into the conduit coupling or light base cover plate threaded hole, to prevent the EMT mounting from turning.

- (2) Cable Connectors. Where cable connectors are required within the frangible couplings, the connectors shall have the capability of separating easily upon breakage of the frangible couplings. Therefore, apply silicone grease of high dielectric strength to the mating surfaces of the plug and receptacle connectors. Do not allow the silicone grease to make contact with the plug and receptacle terminals, and do not place electrical tape over the connector joints. A cable clamp or cable connector clamp shall firmly grip the receptacle connector of the lower cable assembly (never the plug connector of the upper cable assembly). The connectors shall be vertically positioned such that the joint between the two connectors is as close as feasible to the breakoff groove. If the receptacle cable connector is the 1"-diameter style (e.g., 90R-B6), the connector shall be gripped by an aluminum split-ring cable clamp. The Multi Electric Part No. 961-X cable clamp is among the clamps which meet this specification. If the receptacle cable connector of the style having a 1.75-inch-diameter donut for use in a light base (such as on the secondary lead of isolation transformers), the connector shall be gripped by the cable connector clamp which comes with the base plate.
- (3) Upper Cable Assembly. Sufficient slack shall be left in the upper cable assembly at the point of entering the lampholder to permit:
 - (a) Removal of the lampholder.
 - (b) Disconnection of the cable connectors in the frangible coupling without disturbing connections to the lampholder.

- e. Plumbness Tolerance for EMT Frangible Light Masts. EMT frangible light masts shall be installed to a plumbness tolerance of 1/16-inch per foot of mast height. This requirement is in addition to all other placement tolerances. If the mast foundation is concrete, the plumbness tolerance shall be met by proper placement of the concrete-embedded section of conduit, not by bending the mast. To insure plumbness, temporary rigid conduit masts shall be threaded into the conduit couplings, and clamped in place in a rigid brace during concrete placement, finishing, and setting. If the masts are to rise from a steel channel attached to a screw anchor foundation, the plumbness tolerance shall be met by proper attachment of the conduit couplings to the channel, not by bending the masts. In this case, temporary rigid conduit masts shall be threaded into the conduit couplings, and clamped in place in a rigid brace during the welding of the couplings to the channel.
- f. Fiberglass LIR Approach Lighting Towers. LIR means Low Impact Resistance. An LIR tower is a tower designed to disintegrate when struck by an aircraft, offering low impact resistance to the aircraft, thus minimizing aircraft damage. The fiberglass LIR towers, if required by the drawings, shall be assembled from knocked-down (unassembled) condition according to the manufacturer's assembly instructions. Install the towers on foundations constructed in accordance with the drawings. On drawings, for brevity, fiberglass LIR towers are sometimes also called masts and poles.
- g. Aiming and Alignment of Lights. Each light shall be adjusted so that its optical axis is parallel to the runway centerline, directed outward from the runway threshold, and aimed upward to the required vertical angle. An aiming device is furnished for vertical aiming of the PAR-56 and the PAR-38 lampholders and flashing light units.

13A.3 MALSR BRIGHTNESS. The Contractor shall adjust the MALSR to operate as follows:

<u>Step</u>	<u>% Relative Intensity</u>	
	<u>MALS</u>	<u>RAIL</u>
High Intensity	100	100
Medium Intensity	20	8
Low Intensity	4	1

13A.4 OPERATIONAL TESTS. The Contractor shall demonstrate, by operational tests, that the entire system will operate satisfactorily. If the Contract requires the establishment of remote control, satisfactory system operation shall be demonstrated on remote and local control. If the Contract does not require the establishment of remote control, satisfactory system operation shall be demonstrated on local control only. The test shall demonstrate that the system meets all requirements of this Specification and of the manufacturer's instruction manual.

13A.5 MALS LAMPS. If MALS lamps are not shown on the Government-Furnished Property List, the Contractor shall furnish ninety (90) PAR-38, 120-watt spot lamps. The lamps must also be physically shaped to fit the PAR-38 lamp aiming device supplied as part of the MALSR equipment from the MALSR manufacturer. The General Electric PAR-38 120V, 120W, Wattmiser spot lamp (GE Designation 150 PAR/SP/120/WM) is one of the products which meet these specifications. If the Contractor intends to furnish a substitute lamp, the Contractor shall submit to the Contracting Officer, complete manufacturer's information, including vertical and horizontal brightness beam spread candela values, and a sample lamp, to demonstrate that the lamp will fit the MALSR manufacturer's PAR-38 lamp aiming device. See Paragraph 1A.4 above. The Contractor shall install the required number of these lamps on the MALS structures. The remaining lamps shall be delivered to the COR as spares.

13A.6 MALSR CABLE SPLICES.

- a. Restrictions. The only underground MALSR cable splices which will be permitted under this Contract will be the splices shown on the drawings. The Contractor shall inventory the reels of Government-furnished cable and Contractor-furnished cable, to verify that sufficient continuous lengths are available to preclude any other splices. If the Contractor discovers that insufficient continuous lengths are furnished, he shall report this condition to the COR immediately.
- b. Mold and Compound. Every 600-volt power cable splice shall be made with a flexible film plastic mold with a built-in spacer web to provide cable and connector centering, and proper coverage by the insulating and sealing compound. The applied mold shall be filled with a flexible polyurethane electrical insulating and sealing compound capable of continuous operation at 90°C, with an emergency overload temperature rating of 130°C. The splices shall be rated for direct burial applications. The splicing kits shall be sized properly to the application. Splicing kits of the 3M Scotchcast 85 series are among products which meet these Specifications. If kits of this series are selected, splices at the threshold bar, at EMT light bars, and at 5-tower bars, shall be made with 85-16 kits, unless specified otherwise. Splices at the MALS T-bar towers shall be made with kits no smaller than 85-12, unless specified otherwise. Substitute splicing kits require submittals per Paragraph 1A.4 above.

- c. Connectors. Connectors used in the splices shall be compact compression tap connectors properly sized to the application. The connectors shall be copper, except aluminum connectors are permitted if they are designed for use with copper conductors. The Contractor shall furnish and use the proper crimping tools and dies for the connectors, and shall execute the number of crimps required by the manufacturer. Mechanical (bolted) tap connectors shall not be used in splices below grade. The following connectors, primarily for underground splices at MALS bars, are approved, as they are among the products which meet these specifications (substitutes require submittals per Paragraph 1A.4 above):

- (1) The following Burndy Crimpit Type YC-C compression connectors:

<u>Cat. No.</u>	<u>Run</u>	<u>Tap</u>
YC10C10	#10 AWG	#10 AWG
YC8C8	#8 AWG	#10 AWG
YC26C2	#2/0 AWG	#2 AWG
YPC26R8U	#2/0 AWG	#10 AWG

- (2) For #2, #4, or #6 run cable to #10 tap cable, Burndy street lighting tap, Catalog Number YPC2A8U.

13A.7 MALS POWER DISTRIBUTION PANEL CIRCUIT DIRECTORY. The Contractor shall mark the MALS power distribution panel circuit directory, identifying each branch circuit breaker by the MALS bar station(s), each breaker serves. Spare breakers shall be so identified.

DIVISION 13 - SPECIAL CONSTRUCTION
SECTION 13B
INSTRUMENT LANDING SYSTEM

- 13B.1 DESCRIPTION OF WORK. This section applies to special construction required for an Instrument Landing System (ILS).
- 13B.2 SCREW ANCHOR FOUNDATIONS. Comply with Section 13D and project drawings if screw anchor foundations are required on the drawings.
- 13B.3 CABLE SPLICES. No splices will be permitted in radio frequency cables.
- 13B.4 OBSTRUCTION LIGHTS. The obstruction lights on the glide slope antenna mast shall be installed and lighted continuously when the tower is 20 feet high or higher.

DIVISION 13 - SPECIAL CONSTRUCTION
SECTION 13C
VASI, REIL, PAPI, AND RVR SYSTEMS

13C.1 DESCRIPTION OF WORK. This section applies to special construction required for a Visual Approach Slope Indicator (VASI), Runway End Identifier Lights (REIL), Precision Approach Path Indicator (PAPI), and New Generation Runway Visual Range (RVR).

13C.2 FRANGIBLE SUPPORTS FOR VASI, REIL, PAPI, AND RVR EQUIPMENT.

- a. Description. Frangible couplings will be used to support VASI, REIL, PAPI, and RVR equipment installed near runways. Each frangible coupling has a hexagonal throat with a break-off groove in the middle, designed to break at low impact, thereby minimizing damage to colliding aircraft. The frangible point shall not be more than 3" above the finished grade.
- b. Coupling Installation. When installing the frangible coupling, take care to use a wrench which will grip only the lower portion of the hexagonal throat of the coupling, i.e., that portion immediately below the break-off groove. If the wrench grips the upper portion of the hexagonal throat, the coupling may break when torque is applied. See Paragraph 16A.20 for thread remediation. Whether thread remediation is performed or not, apply anti-seize compound to the threads of the frangible coupling, to facilitate removal. The compound shall be an anti-seize assembly lubricant formulated to provide protection for stainless steel and dissimilar metal threaded fasteners against galling, seizure, and heat-freeze. Do not use plumber's pipe-joint compound. The frangible coupling shall be screwed down tightly into the conduit coupling.
- c. Cable Connectors. Where cable connectors are required within the frangible couplings, the connectors shall have the capability of separating easily upon breakage of the frangible couplings. Therefore, apply silicone grease of high dielectric strength to the mating surfaces of the connector plug and receptacle housings in the frangible couplings. Do not allow the silicone grease to make contact with the plug and receptacle terminals, and do not place electrical tape over the connector joints. A cable clamp shall firmly grip the receptacle connector of the lower cable assembly (never the plug connector of the upper cable assembly). The connectors shall be vertically positioned such that the joint between the two connectors is as close as feasible to the breakoff groove.

13C.3 EQUIPMENT ELEVATIONS.

- a. Elevations of Record. After the Contractor has installed the VASI, REIL, PAPI, or RVR lighting unit foundations (concrete or screw anchor), he shall survey and record all such independent foundation top elevations to the nearest 0.01 foot and deliver this information to the COR for as-built drawing record. Elevations should be clearly referenced to locations where measured, such as a specific corner of a screw anchor or anchor plate. It is emphasized that all foundations of every lighting unit shall be measured such as the four legs of an individual VASI box.
- b. Elevation Verification. Runway elevations indicated on the drawings were established on the date indicated. Prior to using these elevations for construction survey proposes, the Contractor shall verify, through the COR, that such runways have not been resurfaced after the date of the engineering survey. If resurfacing has occurred, new benchmarks will be established by the COR. The VASI unit light slot elevations shall not be altered from those indicated on the drawings.

13C.4 ALIGNMENT AND AIMING ANGLE TOLERANCES.

- a. Aiming Angles. Refer to site drawings for locations and aiming angles for individual VASI, REIL, PAPI, or RVR lighting units.
- b. VASI and PAPI Lamp Housing Assembly (LHA) Unit Tolerances.
 - (1) Longitudinal Alignment Tolerances. Front face of each LHA unit shall be located within ± 6 inches of single line perpendicular to the runway centerline.
 - (2) Azimuthal Alignment Tolerance. Longitudinal axis of each LHA unit shall be parallel to the runway centerline within $\pm 1/2$ degree.
 - (3) Mounting Height Tolerance. Light beam centerline of each LHA unit (within a bar for VASI) shall be located on a single horizontal plane within \pm one inch.
 - (4) Aiming Angle Tolerance. Aiming angle of each LHA unit shall be within ± 2 minutes of angle specified.

13C.5 SYSTEM CONTROL. Unless otherwise indicated, VASI, REIL, or PAPI system construction shall include a method of on/off control shown on the drawings or specified herein. REIL control will also include provision for varying the lighting intensity.

13C.6 OPERATIONAL TESTS. The Contractor shall demonstrate that the VASI, REIL, or PAPI system will operate satisfactorily by a series of operational test cycles and a continuous test run of 24 hours minimum. The tests shall clearly indicate that the system meets all the requirements of the Drawings, Specifications, and the manufacturer's instruction manuals.

DIVISION 13 - SPECIAL CONSTRUCTION
SECTION 13D
SCREW ANCHOR FOUNDATIONS

- 13D.1 DESCRIPTION OF WORK. This section is applicable if screw anchor foundations are required on the drawings.
- 13D.2 SCREW ANCHOR FOUNDATION DESIGN AND USAGE. Screw anchor foundations are commonly used for certain ILS and ALS facilities. A. B. Chance foundations, Cat. No. CT112-0837 is a product that meets the requirements of the specifications below.
- 13D.3 PLATES. The following specifications apply to the round top plate (base plate) which is an integral part of the screw anchor foundation. The flat, smooth, plate top surface shall not have any curvature or other deformity induced by the manufacturing process. The plate shall be flame cut, deburred, and machined smooth both on the external edges and on the inner holes and slots. During fabrication, the base plate edge shall be permanently and plainly marked in a highly visible manner, indicating the shaft cableway slot location, manufacturer, and date. All tapped holes are to be center tapped within 1 degree of perpendicular to the plate. The threads shall be fully cleaned after hot dip galvanizing, such that a bolt may be hand run in the threads.
- 13D.4 SHAFT. Foundation shafts shall be machine flame cut to the length specified on the figure. The shaft shall be 90° square-cut on the top end, and to the true helical shape on the bottom end. The cableway slot be machine smoothcut on one side of the shaft. The sides of the cableway openings shall be within 1/2 degree of parallel, as measured along their full length. The round shaft material shall be new, unused, and mill traceable.
- 13D.5 ASSEMBLY. The completed assemblies must be hot dip galvanized after fabrication. Each foundation shall be supplied with four sets of carriage bolts, hex nuts, and lock washers. When bolts, nuts, and lock washers are shipped assembled, the nuts shall be tightened securely to prevent loss in shipment. Otherwise, the hardware shall be supplied in a burlap bag securely taped to the foundation.
- 13D.6 QUALITY ASSURANCE. No screw anchor foundations will be accepted from a manufacturer, unless the manufacturer has in place and in operation, a quality assurance department as a separate and distinct element of the manufacturer's organization.

13D.7 INSTALLATION EQUIPMENT. If screw anchor foundations are shown on the drawings, the Contractor shall furnish the installation equipment. The digger derrick or other driving equipment shall have sufficient clearance between the driving head and the ground to accommodate the screw anchor foundations specified. Pre-drilling (see Paragraph 13D.8c, below) or any other excavation at the anchor installation site for the purpose of gaining clearance under the driving head to accommodate the length of the anchor foundations, is expressly prohibited.

13D.8 SCREW ANCHOR FOUNDATION INSTALLATION REQUIREMENTS.

- a. Plumbness. The foundations shall be installed plumb, within a tolerance of 1/8" horizontal per foot vertical.
- b. Foundation Top Elevation and Cableway Orientation. The foundation shall not be backed out to meet a specific foundation top elevation. Therefore, the top elevation must be checked as the foundation is driven. Foundations shall be turned down an additional fraction of a revolution in order to properly align the bolt holes. If a specific orientation of the cableway slot in the shaft is required (e.g., facing the RVR power and control stand), the Contractor shall so orient the shaft.
- c. Pre-drilling.
 - (1) Pre-drilling is defined as augering a hole centered on the design location of a foundation. Pre-drilling is sometimes necessary in very stiff soils, to permit driving the foundation to design depth without exceeding a torque which would damage the foundation.
 - (2) Pre-drilling, if authorized by the COR, shall be accomplished using an auger not larger in diameter than the foundation shaft diameter (not helix diameter).
 - (3) The need for, and depth of, pre-drilling shall be determined solely by the COR, with information from the Contractor. The Contractor shall do no pre-drilling until the COR authorizes him to do so, and if authorized, shall not pre-drill to a depth greater than the depth authorized by the COR.

13D.9 Procurement. Unless specified otherwise, screw anchor foundations shall be furnished by the Contractor. If the Contractor intends to furnish foundations other than the A. B. Chance foundations accepted in Paragraph 13D.2, the Contractor shall submit complete manufacturer's information, including the quality assurance manual, and shop drawings, to the Contracting Officer. The Contractor shall not procure the substitute screw anchor foundations before receiving the Contracting Officer's approval. See Paragraph 1A.4 above.

DIVISION 13 - SPECIAL CONSTRUCTION
SECTION 13E
MALSR AND ILS EQUIPMENT SHELTERS

13E.1 DESCRIPTION OF WORK. This section is applicable if equipment shelter construction is required for a MALSR or ILS. Extent of work is indicated on the drawings. All wood-frame shelters shall be constructed on their foundations, unless specified otherwise.

13E.2 SHELTER CARPENTRY.

a. Lumber and Wood Structural Panel (WSP) Materials.

(1) General Requirements.

- (a) Factory mark each piece of lumber and WSP identifying grading agency, grade, and species.
- (b) All lumber sizes are nominal, dressed S4S and seasoned to 19 percent moisture content.
- (c) WSP shall conform to the requirements for their type in the latest editions of the Voluntary Product Standard PS-1 Structural Plywood, and Voluntary Product Standard PS-2 Performance Standard for Wood-Based Structural-Use Panels.

(2) Dimension Lumber.

- (a) Studs. "Stud" grade, any species.
- (b) Joists, Rafters and Plates. "Structural Joists and Planks" Number 2 grade or better, any species. Plates in contact with concrete shall be pressure treated.

(3) WSP Sheathing. Plywood and oriented strand board (OSB) complying with following:

- (a) Exterior Sheathing. APA Performance Rated Panels Exterior, Exposure 1, or Structural 1 for roofs, and OSB for walls of sizes indicated.
- (b) Interior Sheathing. APA AC Exterior Plywood.

b. Installation.

- (1) Securely attach carpentry work by anchoring and fastening as shown or as required by recognized standards. Set work to required lines and levels with members plumb and accurately cut and fitted.
- (2) Use common nails except as indicated. Select fastener sizes that will not conflict with other work.

13E.3 SHELTER DOOR AND FRAME.

- a. Quality Assurance. Provide doors and frames complying with Steel Door Institute "Recommended Specifications: Standard Steel Doors and Frames" (SDI-100) and as herein specified.
- b. Fabrication.
 - (1) General. Fabricate steel door and frame units to be rigid, neat in appearance, and free from defects, warpage, and buckle. Wherever possible, fit and assemble units in the manufacturer's plant.
 - (2) Door Type/Grade. Doors shall be SDI-100, Grade III, extra heavy duty, Model 1, full flush, minimum 16 gage faces, 1 3/4 inch thick.
 - (3) Construction.
 - (a) Fabricate exposed faces of door and panels from cold-rolled steel only. Fabricate concealed stiffeners, reinforcement, and edge channels from either cold or hot rolled steel at fabricator's option. All door and frame materials shall be galvanized.
 - (b) Close top and bottom edges of exterior doors flush as an integral part of construction or by the addition of 16-gage channels.
 - (4) Thermal Insulation. Door and frame shall be thermal-rated (insulated) assemblies tested in accordance with ASTM C1199, C1363, and E1423. Provide thermal insulation with maximum U factor of 0.39 BTU/(hr ft² °F), SDI rating of 4.
 - (5) Finish Hardware Preparation.
 - (a) Prepare doors and frames to receive mortised and concealed finish hardware in accordance with Subsection 13E.4, and templates provided by the hardware supplier. Comply with applicable requirements of ANSI A115 series specifications for door and frame preparation for hardware.
 - (b) Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied finish hardware may be done at project site.
 - (c) Locate finish hardware in accordance with "Recommended Locations for Builder's Hardware", published by the Door and Hardware Institute.

- (6) Door Frames. Fabricate door frames of style shown on the drawings. Conceal fastenings and fabricate frames from minimum 16-gage galvanized cold rolled furniture-quality steel. Fabricate frames with mitered and welded corners.
- (7) Shop Painting. Apply shop coat of primer paint to provide a uniformly finished surface ready to receive finish coats.

c. Installation.

- (1) Placing Frame.
 - (a) Comply with provisions of ANSI/SDI A250.11 "Recommended Erection Instructions for Steel Frames".
 - (b) Install at least 3 wall anchors per jamb at hinge and strike levels. Anchor to wood stud framing using fasteners and devices for rigid attachment.
- (2) Doors. Fit hollow metal doors accurately in frames, within clearances specified in ANSI/SDI A250.8.
- (3) Adjust and Clean.
 - (a) Immediately after erection, sand smooth any corroded or damaged areas of prime coat and touch-up paint with compatible primer.
 - (b) Apply finish paint coats per Division 9.
 - (c) Check and readjust operating finish hardware items, leaving steel doors and frames undamaged and in complete and proper operating condition.

13E.4 DOOR HARDWARE.

a. General Requirements.

- (1) Templates. Furnish hardware templates to fabricator of doors and frames to be factory-prepared for installation of hardware.
- (2) Finish. BHMA #626 satin chromium plated for hinges and lock set.
- (3) Fasteners. Provide Phillips flat-head machine screws, matching finish and of proper design size for hardware item furnished.

b. Materials.

- (1) Hinges. Provide 1 1/2 pair 4 1/2 x 4 1/2 hinges, full mortise type, heavyweight, ball bearing, five knuckle, square corner, swaged, steel with steel pin, non-removable and non-rising pin, flat button and matching plug tips. Stanley #FBB-168 is one of the products meeting these Specifications.
- (2) Lockset. Provide mortise lockset, Best Lock Corporation Catalog Number 45H-7-TA-4-J-626-RHRB having a 7-pin cylinder and furnished without core. The FAA COR will supply the construction core which the COR receives from FAA SSC personnel. The Contractor shall install the construction core. No substitution for the above lockset will be permitted.
- (3) Doorholder. Provide a door holder, overhead surface type, exterior door use, with safety release, combination door stop, and shock-absorbing cushion. Glynn-Johnson #GJ90H Series is one of the products meeting these Specifications.
- (4) Threshold. Provide an aluminum threshold not less than 3 1/2 inches wide, and of such height that weatherstripping insert will contact inner face of door. Threshold shall include rabbeted design with replaceable neoprene insert in step. Zero #563 Rabbeted Saddle is one of the products that meets these Specifications.
- (5) Weatherstripping at Door Jambs and Head. Provide continuous weatherstripping at all edges of doors. Provide only those units where resilient seal strips are easily replaceable and readily available from the manufacturer. Construction shall include flexible neoprene bulb insert in extruded aluminum channel with snap-on cover, hidden fasteners, surface-mounted design. Zero #475 is one of the products that meet these Specifications.

c. Installation.

- (1) Hardware Mounting Heights. Mount units of hardware at heights indicated in "Recommended Locations for Building Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute.
- (2) Procedures.
 - (a) Install each item per manufacturer's instructions.

- (b) Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- (c) Drill and countersink units which are not factory prepared for anchor fasteners. Space fasteners in accordance with industry standards.
- (d) Set thresholds in full bed of butyl-rubber or polyisobutylene mastic sealant.

13E.5 INSULATION.

- a. Material. Wall and ceiling installation shall be fiberglass batt insulation faced with coated Kraft paper. Insulation batts shall have staple flanges. The batts shall be nominally 6 inches thick, with R-19 insulation value. Batt width shall be compatible with stud spacing.
- b. Installation. Install insulation batts between all studs and joists such that batts will retain full thickness. Stuff loose fiberglass insulation into cracks impossible to fill with batts. Compress loose insulation no tighter than 50 percent of normal volume when needed to hold it in place.

13E.6 RESILIENT FLOORING.

- a. General.
 - (1) Manufacturer. Provide resilient flooring and accessories as produced by a single manufacturer including recommended primers, adhesives, and leveling compounds.
 - (2) Temperatures. Maintain 65° minimum temperature in space to receive flooring for at least 48 hours before installation, during installation, and for at least 48 hours thereafter. Store flooring materials in space where they will be installed for 48 hours prior to installation.
 - (3) Order of Work. Install resilient flooring and accessories after completion of painting and other finishing work. Do not install over concrete slab until the concrete is cured to the satisfaction of the COR.
- b. Materials.
 - (1) Floor Tile. Material shall be vinyl composition tile complying with FS SS-T-312, Type IV, 12" x 12", 1/8-inch gage, composition 1 (asbestos free). Armstrong: Standard Excelon, Imperial Texture - #51809 Desert Beige, is a product that meets the Specifications:

- (2) Vinyl Wall (Cove) Base. Material shall be vinyl base complying with FS SS-W-40, Type II, with matching end stops and preformed or molded corner units. Height shall be 4 inches, thickness 0.080 inch. Style shall be standard top-set cove with toe.
Armstrong: #75 Desert Sand is a product that meets these Specifications:
- (3) Adhesive (Cements). Waterproof, stabilized type as recommended by flooring manufacturer for material and substrate conditions.
- (4) Concrete Slab Primer. Non-staining type as recommended by flooring manufacture.
- (5) Leveling and Patching Compounds. Latex types as recommended by flooring manufacturer.
- (6) Floor Wax. Product recommended by floor tile manufacturer.

c. Installation.

- (1) Preparation.
 - (a) Use leveling and patching compounds as recommended by flooring manufacturer for filling small cracks, holes, and depressions in slabs.
 - (b) Remove coatings from slab surfaces that would prevent adhesive bond, including curing compounds if incompatible with flooring adhesive.
 - (c) Broom clean or vacuum surfaces.
 - (d) Apply concrete slab primer, if recommended by flooring manufacturer.
- (2) Floor Tile.
 - (a) Install in strict compliance with manufacturer's printed instructions. Extend floor tile into door reveals and similar openings.
 - (b) Scribe, cut, and fit floor tile to permanent fixtures, columns, walls, conduit and similar construction.
 - (c) Tightly cement floor tile to slab without open cracks, voids, raising, and puckering at joints, telegraphing of adhesive spread marks or other imperfections. Hand roll at perimeter of each covered area to assure adhesion.

- (d) Lay tile from center marks established with principal walls, discounting minor offsets, so that tile at opposite edges of room area are of equal width. Adjust as necessary to avoid use of cut widths less than 1/2 tile at room perimeters.
 - (e) Cut tile neatly around all obstructions. Broken, cracked, chipped or deformed tiles are not acceptable.
 - (f) Lay tile in "checkerboard" fashion with grain reversed in adjacent tiles.
 - (g) Adhere tile flooring to slab using full spread of adhesive applied in compliance with flooring manufacturer's directions.
- (3) Wall Base. Install base in lengths as long as practical with preformed corner units or fabricated from base material with mitered or coped inside corners. Tightly bond base to substrate throughout length of each piece, with continuous contact at horizontal and vertical surfaces.
- d. Cleaning and Protection. Perform the following operations immediately upon completion of tile installation work. Sweep or vacuum floor thoroughly, but do not wash until tile adhesive has cured as recommended by manufacturer. Damp mop and remove any excess adhesive and other blemishes using cleaners recommended by manufacturer. Apply wax as recommended by manufacturer.

13E.7 PAINING.

- a. General Requirements. Comply with all requirements of Section 9A, excepting paint system schedule, and the requirements of this subsection.
- b. Surfaces to be Painted.
 - (1) Interior.
 - (a) Plywood ceiling and wall surfaces.
 - (b) Wood trim and all other exposed finish carpentry work.
 - (c) Steel door and frame.
 - (d) All exposed conduit, outlet and switch boxes, but not pre-finished large electrical wall-mounted equipment enclosures.

- (2) Exterior.
 - (a) Steel door and frame.
 - (b) Air intake hood.
 - (c) Air conditioner sleeve surfaces and supports.
- (3) Ancillary Items. Major surfaces to be painted are those listed above. Paint minor items affixed or adjacent to such surfaces the same color as primary items.
- (4) Exclusions. The following equipment shall not be painted:
 - (a) Pre-finished safety switch, power panelboard, electrical equipment enclosures and other large similar electrical items.
 - (b) Exhaust fan.
 - (c) Air conditioner.
 - (d) Ventilation dampers and motor operators.

c. Materials.

- (1) Single Source Responsibility. Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer, and use only within recommended limits.
- (2) Colors.
 - (a) Interior and exterior surfaces of door and frame shall be a medium gray color approved by the COR.
 - (b) Interior wall and ceiling surfaces shall be white.

d. Paint Schedule. In the paint schedule below, choose from manufacturers on the Master Painters Institute Approved Product List.

- (1) Ferrous Metal. Provide two finish coats over primer. Omit primer for items delivered shop primed.
 - (a) Prime Coat. MPI #79, "Primer, Alkyd, Anti-Corrosive for Metal"
 - (b) First and Second Finish Coats. MPI# 9, Alkyd, Exterior Gloss (MPI Gloss Level 6).

(2) Zinc-Coated Metal (New Unpainted Galvanized). Provide two finish coats over primer.

(a) Prime Coat. MPI #134, "Primer, Galvanized, Water Based"

(b) First and Second Finish Coats. MPI# 9, Alkyd, Exterior Gloss (MPI Gloss Level 6), same as for ferrous metal.

(3) Interior Plywood.

(a) Primer. MPI #172 "Alkyd, Water Based, Primer, Interior"

(b) First and Second Finish Coats. MPI #165 "Alkyd, Water Based, Flat (MPI Gloss Level 1)"

e. Application.

(1) Remove hardware, hardware accessories, plates, and similar in-place items not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations. Following completion of painting, reinstall removed items.

(2) Finish exterior door on top, bottom and side edges, the same as exterior face. Sand lightly between each succeeding coat. Omit first coat (primer) on metal surfaces which have been shop-primed and touch-up painted.

f. Clean-Up and Protection.

(1) Upon completion of painting work, clean any paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

(2) Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damage by cleaning, repairing, or replacing, and repainting, as acceptable to the COR.

13E.8 METAL ROOF AND WALL PANEL SYSTEMS. Metal roof and wall panel systems, including all attachments and appurtenances, shall be in accordance with manufacturer's instructions and the following material specifications. These systems, including all appurtenances such as soffit, fascia, and trim pieces shall be fabricated by one manufacturer.

- a. Metal Roof Panel System. The steel sheet shall be 1 1/2" standing seam, 16-inch wide coverage, 24 gauge, 40 ksi yield steel, with a one-piece stainless steel clip system that allows for unlimited thermal movement and reduces panel uplift under negative wind loads. The system shall comply with the latest edition of the following standards:

ASTM E 1592 48 psf @ 2.5' span
ASTM E 1680 0.0 @ 20 psf
ASTM E 1646 0.0 @ 12 psf

The finish shall be glavalume, with a 20 year warranty. A known acceptable source is Fabral's Slim Seam.

- b. Metal Wall Panel System. The steel sheet shall be 1 1/4" ribbed, 36-inch wide coverage, 24 gauge, 50 ksi yield steel, with exposed fasteners. The sytem shall comply with the latest edition of the following standards:

Wind Uplift UL580 Class 90, #169
Class 4 Impact UL2218
Class A Fire UL790

The finish shall be galvalume, with a 20 year warranty. A known acceptable source is Fabral's Mighti-Rib.

- 13E.9 FIBERGLASS REINFORCED PLASTIC WALL PANELS. Fiberglass reinforced plastic (FRP) panels on the interior walls and ceilings of shelters shall be as shown on the Drawings. The panels shall be manufactured by factory laminating a fiberglass resin mix on to an underlying substrate of 3/4-inch exterior plywood. The panels shall comply with the latest edition of the following standards:

Flexural Strength (ASTM D790) 7600 psi
Flexural Modulus (ASTM D790) 854,234 psi
Tensile Strength (ASTM D638) 5000 psi
Surface Burning Charasteristics (ASTM E84) Class C

A known acceptable source is Fiberlite panels by Nudo, Springfield, IL.

13E10 CONCRETE FLOOR COATING.

- a. General. A two-component, pigmented epoxy floor coating shall be provided for concrete shelter floors as shown on the Drawings.
- b. Materials. Products shall be 100% solids epoxy containing no VOCs, low to nearly no odor, non-shrinking, and designed as a moisture insensitive formula. The coating shall be Crownshield 50, Product 320, as manufactured by Crown Polymers, Huntley, IL. No substitutions are allowed for this product.

c. Execution.

- (1) Surface Preparation. Concrete substrate shall be clean, sound, and free of dust, grease, waxes, coatings, curing compounds, and all contaminants. Use surface preparation equipment or methods as approved by the manufacturer. Check concrete for soundness and cleanliness with a Shear Cup Test Method as defined by the polymer manufacturer.
- (2) Application. If required by the manufacturer, prior to placement the concrete shall be tested for moisture vapor emission using ASTM F1869. A moisture reading in excess of 3 lbs. per 1000 ft² per 24 hours, requires treatment to reduce the reading to an acceptable range. The treatment will be recommended by the manufacturer. Placement shall be made by an experienced factory trained contractor who has specialized in installing polymer type flooring systems similar to that required for this project, and who is acceptable to the manufacturer. Apply coating evenly in a minimum thickness of 10 mils. Follow the manufacturer's recommendation for temperature and moisture limitation, protection of surfaces before and during the curing process, and curing the system.

DIVISION 13 - SPECIAL CONSTRUCTION
SECTION 13F
RVR SYSTEMS

13F.1 SCOPE. This section applies to special construction of Runway Visual Range (RVR) systems. The work includes all non-electronics facility construction, such as the installation of Visibility Sensor sites (VS), Runway Light Intensity Monitors (RLIM), and Ambient Light Sensors (ALS). RVR electronics installation will be performed by others.

13F.2 VISIBILITY SENSOR SITE (VS).

- a. General. Fiberglass LIR tilt-down poles will support the electronic sensors used to measure runway visibility. The Contractor shall fabricate and furnish the VS foundation adapter base plate. All of these parts shall be assembled and mounted on screw anchor foundations furnished by the Contractor. For screw anchor foundations, see 13D above. Install all items per drawings and manufacturers' instructions. See the site plan for anchor location.
- b. LIR Pole Cutting and Assembly. The Contractor shall calculate the pole length required to put the RVR lamp centerline 14'-0" above the adjacent runway centerline elevation. The top of the fiberglass pole must be cut 1'-6" below the required RVR lamp centerline elevation. Do not cut the pole before the COR verifies the required length. The Contractor shall cut the fiberglass pole to proper length, according to the instructions shown on the project Drawings. The pole shall be cut only in the presence of the COR. See standard drawing GLSD-D-RVR-S001 for pole cutting and assembly details.
- c. Vertical Tolerance. After the assembled tube and preassembled mounting frame have been installed on the screw anchor foundation, adjust the leveling nuts on the base plate of the LIR structure such that the mast centerline is vertical within a tolerance of 1/2-inch between top and bottom of tube.
- d. Test. The Contractor shall demonstrate to the satisfaction of the COR that the installed LIR structure will tilt down smoothly without evidence of binding or use of undue force. The pole must also rest squarely between the pole maintenance stand supports when in the down position. Adjust as necessary and repeat testing until accepted by the COR.

e. Power and Control Stand.

- (1) Structure. A power and control stand shall be constructed not more than 4 feet away from the visibility sensor pole. The stand shall be located to prevent interference with tilting down the sensor pole, as indicated on the drawings. The base channel shall be shimmed, if necessary, to level it.
- (2) Electrical Components. SIE boxes will be installed later by others. The power disconnects and control junction boxes shall be Contractor-furnished and installed. Power and control wiring that is above grade shall be run thru 3/4" UV resistant liquid-tight conduits to the SIE box location. If more than one SIE box is shown on the Drawings, separate sets of power and control cables shall be run in 3/4" liquid-tight conduits to each SIE box location. Install 3/4" female end connectors on the ends of all conduits that will attach to the future SIE boxes.

13F.3 AMBIENT LIGHT SENSOR (ALS). One or two Ambient Light Sensor (ALS), will be required per airport, as per project Drawings, to check lighting conditions on the field. The ALS shall be collocated with one of the visibility sensor sites where shown on the Drawings. The 1 1/2" ALS mounting pipe position shall be such that the sensor unit will have an unobstructed view of the north horizon sky 6° above the horizon combined with a 6° field of view. To prevent false readings, the ALS sensor unit shall not be pointed parallel to the runway, towards brightly lighted areas, or toward the VS pole. Also ensure that the obstruction light is positioned to the side of or behind the ALS sensor. Take these criteria into account when positioning the 1 1/2" ALS mounting pipe on the power and control stand.

13F.4 OBSTRUCTION LIGHTS.

- a. General. Obstruction lights for an RVR are only required when a runway requires a midpoint RVR, or a rollout RVR not collocated with another facility. However, where one is required, a double (L-810) steady-burning aviation red obstruction light fixture shall be installed 3'-0" above the top of the power and control stand as shown on the Drawings. The lights shall be made to operate from the first night and thereafter following the installation of the LIR structure. The lights shall operate continuously, and be operational before the VS pole is raised. Do not install the obstruction light where the illumination will interfere with the operation of the Ambient Light Sensor.
- b. Obstruction Light Fixtures. Fixtures shall be FAA certified type L-810 double-lamp steady-burning LED units, with cast aluminum fittings, aviation red fresnel lens globes, or red polycarbonate lens, and a 1" inch threaded conduit bottom fitting. Dialight Model Number 860-1R01-002 or RTO-1R01-002, is among the products that meet this Specification. These

dual light fixtures shall be mounted on a 1" rigid galvanized conduit.

- c. Photo Cell. All obstruction lights shall be controlled by a photo cell installed on rigid conduit with protection from being damaged. The photo cell shall be adequately rated for the installation, but not to exceed 3000W and shall be installed in a weaterproof housing. The cell shall be pointed north, and shall turn on when the northern sky illuminance reaching a vertical surface falls below a level of approximately 35 foot candles (376.7 LUX). The control device should turn off the lights when the northern sky illuminance rises to a level of not more than 60 foot candles (645.8 LUX).

13F.5 RLIM INSTALLATION. Runway Light Intensity Monitoring (RLIM) equipment shall be installed in the appropriate power vault(s) to sense the appropriate runway edge and/or centerline cable current. All conduits shall be routed around or over existing conduits, and shall avoid all "live" or exposed wires. Extreme care shall be exercised while working in the vaults, due to the numerous high voltage cables.

13F.6 AC SURGE ARRESTER. The AC surge arrester shall be Rayvoss 120-1P-M3-2-06-A. No substitutions are allowed for this product.

13F.7 CONTROL JUNCTION BOX. The exterior control junction box mounted on the power and control stand shall be a 12" x 12" x 6", 16-gauge stainless steel NEMA 4X hinged cover enclosure, meeting the requirements of Paragraph 16A.15 below. Hoffman Cat. No. A-1212CHNFSS hinged cover enclosure with a A-12P12SS panel is one of the products that meets this Specification.

13F.8 TERMINAL BLOCKS. The terminal blocks in the control junction box on the power and control stand, shall be fastened in a vertical array to the left side of the interior panel. This arrangement reserves space on the right side for later installation, by others, of lightning protection equipment. The terminal blocks shall be as specified in Paragraph 16A.19.

DIVISION 16 - ELECTRICAL
SECTION 16A
BASIC METHODS AND MATERIALS

16A.1 APPLICABLE DOCUMENTS.

- a. Standards. The following UL standards in effect on the date of the invitation for bids or request for proposals, form a part of this Specification.
 - (1) UL 6 Electrical Rigid Metal Conduit - Steel,
 - (2) UL 797 Electrical metallic Tubing - Steel
 - (3) UL 360 Standard for Liquid-Tight Flexible Steel Conduit
- b. Electrical Codes. The following publications and regulations, in effect on date of the invitation for bids or request for proposals, form a part of this Specification and are applicable to the extent specified herein.
 - (1) NFPA Number 70 National Electrical Code.
 - (2) The rules and regulations of local utility companies providing service.
 - (3) Local governing body rules and regulations.

16A.2 REQUIREMENTS.

- a. General. The Contractor shall install all electrical work in accordance with the applicable Drawings and Specifications. All electrical work shall be installed to meet the provisions of the current issue of the National Electrical Code, NFPA-70, and all state and local regulations.
- b. Contract Drawings.
 - (1) Where the electrical drawings indicate (diagrammatically or otherwise) the work intended and the functions to be performed (even though some minor details are not shown), the Contractor shall furnish all equipment, material (other than Government-furnished items) and labor to complete the installation work, and accomplish all the indicated functions of the electrical installation.

- (2) Minor departures from exact dimensions shown on the drawings may be permitted where required to avoid conflict or unnecessary difficulty in placement of the dimensioned item, provided all other contract requirements are met. The Contractor shall promptly obtain approval from the FAA Contracting Officer's Technical Representative (COR) for any such proposed departure.
- c. Materials. Materials and equipment, to be acceptable, must comply with all Contract requirements. Materials to be furnished by the Contractor under this Specification shall be new and, unless specified otherwise, the standard products of a manufacturer's latest designs. Wherever standards have been established by Underwriters Laboratories, Inc., the materials shall bear the UL label.

16A.3 WIRING METHODS.

- a. General. All wiring shall consist of insulated copper conductors installed in metallic raceways, unless otherwise specified.
 - (1) Conductor Routing. Panelboards, surge arresters, disconnect switches, etc., shall not be used as raceway for conductor routing other than conductors that originate or terminate in these enclosures. Isolated ground conductors will be allowed to traverse these enclosures.
 - (2) Conductor Separation. Power conductors shall be routed separately from all other conductor types. This may be accomplished by routing power conductors and other conductors in separate raceways, or by a metallic divider between the power conductors and the other conductors in the same raceway.
 - (3) Neutral Conductor: Shared/common neutrals shall not be permitted, i.e. each overcurrent device shall have its own separate neutral conductor. Neutral conductor sizes shall not be less than the respective feeder or phase conductor sizes.
- b. Conductors.
 - (1) Uninsulated Conductors: Uninsulated conductors shall be copper and in accordance with Military Specification A-A-59551.

- (2) Insulated Conductors: Unless otherwise indicated, insulated conductors shall be copper with thermoplastic or thermosetting insulation, type THW, THWN and XHHW for general use or type THHN for use in dry locations only. All insulated for 600 volts in accordance with Federal Specification A-A-59544. Unless otherwise indicated, conductors #10 AWG and smaller shall be solid, conductors #8 AWG and larger shall be stranded. Minimum branch circuit conductor size shall be #12 AWG. Stranded conductors may be used with wire compression connectors or a pressure washer type lug; lugs with screw only compression are not allowed. Minimum control wire size shall be #14 AWG unless noted otherwise. Stranded conductors smaller than #10 AWG are allowed in applications where vibration and flexing may be encountered.
- (3) Fixture Wiring: fixture wiring shall be thermoplastic insulated copper, rated for 600 volts, in accordance with federal Specification A-A-59544 and the NEC.
- (4) Color Coding: All feeder and branch circuits, including neutral conductors, shall be identified at both ends of the conductor with panel and circuit number indicated. This shall be accomplished using shrink embossed labels only. The color coding shall be continuous throughout the facility on each phase conductor to its point of utilization so that the conductor phase connection is readily identifiable. Equipment grounding conductors shall be color coded green. Conductors covered with green insulation with yellow, orange, violet, or red tracers shall be used for other grounding systems. Neutral conductors shall be white insulated for 120/208/240 volt systems and gray insulated for 277/480 volt systems. For conductors #4 AWG and larger, where appropriate insulation color is not available, color coded tape, half lapped for a minimum length of 3 inches shall be used. Switch leg conductors shall be violet insulated. Green, white, and gray insulated conductors shall not be reidentified. All conductor color codes, including reidentified conductors, shall be visible at all junction boxes, pullboxes, panelboards, outlets, switches, access locations in closed raceways, every 3 feet in open raceways, under all raised floors, and at all terminations. Phase conductors shall be color coded as follows:

Single Phase

120 Volts

Line 1 - Black

Neutral - White

120/208/240 Volts

Line 1 - Black

Line 2 - red

Neutral - White

Three Phase

120/208/240 Volts

Phase A - Black

Phase B - Red

Phase C - Blue

277/480 Volts

Phase A - Yellow

Phase B - Brown

Phase C - Orange

Color coding for conductors in control cables shall be in accordance with Standard ICEA S-61-402. DC power conductors shall be color coded as follows: positive conductor, red with brown tracer; negative conductor, brown with red tracer; neutral conductors, if used, shall be white.

16A.4 CONDUIT.

- a. Where electrical metallic tubing is shown on the drawings, at exterior or interior locations, it shall be used without substitution.
- b. Except where specified otherwise, conduit exposed to the weather, in concrete, or below grade shall be galvanized rigid steel with threaded joints. All conduit and conduit fittings in contact with earth shall have a factory PVC coating.
- c. Except where otherwise specified, conduit used entirely indoors shall be rigid or electrical metallic tubing. Compression type fittings shall be used with metallic tubing.
- d. Minimum size of conduit shall be 3/4-inch unless otherwise noted on the drawings. Each conduit run shall be installed complete before cable is pulled through.

- e. All outdoor connections of conduit to enclosures shall be made with weatherproof hub fittings unless otherwise specified. Hub fittings shall have an external ground to maintain raceway grounding and be UL listed for grounding. Indoor connections of rigid conduit to enclosures shall be made with double locknuts and bushings. Refer to grounding section for disconnect switch conduit terminations.
- f. Ends of conduits installed but not used, shall be closed with bushings and pennies. All underground conduit shall be temporarily plugged during construction to prevent entrance of foreign material.
- g. Wherever conduit from outdoors or underground enters an enclosure or junction box, either indoors or outdoors, seal space between conduit and cables with conduit seal.
- h. Exposed conduit shall be installed parallel to or at right angles with equipment and building wall surfaces unless shown otherwise. Field bends shall be avoided where possible, and where necessary shall be made with a hickey or conduit-bending device. Radius of field bends shall not be less than ten times the inside diameter of the conduit. Conduit shall be fastened securely to adjacent members or surfaces with galvanized clamps, straps.
- i. Flexible metal conduit shall be used for terminal connections to motors or motor driven equipment, and in lengths only up to 6 feet for other applications permitted by the NEC. Liquid-tight flexible metal conduit shall be used outdoors and in wet locations. All flexible metal conduit shall be of a type where both the conduit and fittings are listed for grounding.

16A.5 GROUNDING.

- a. Equipment, Structures, and Raceways.
 - (1) All metallic non-current carrying parts of electrical equipment (including enclosures) and supporting structures installed under this contract, whether used either for power or control, shall be grounded with an equipment grounding conductor, whether or not shown on the drawings. The grounding conductor shall be sized in accordance with the National Electrical Code, but shall be of larger gauge if so shown on the drawings. In no case shall the grounding conductor be smaller than #12 AWG, unless shown otherwise on the drawings.
 - (2) A service entrance conduit or any other power feeder conduit emerging from below grade and supplying power to another facility or system component shall terminate with grounding bushings at both ends. These

requirements apply unless shown otherwise on the drawings.

- (3) The equipment grounding conductor shall be:
 - (a) connected to the grounded conductor (neutral) only at the service entrance disconnecting means.
 - (b) installed in the same conduit as its related branch and feeder conductors, and connected to the ground bus in the branch or distribution panelboard.
 - (c) connected to all grounding bushings on conduits through which the conductor passes.
 - (d) connected to all other grounding conductors in enclosures and bodies through which the conductor passes.

Each overcurrent device shall have its own equipment grounding conductor. No sharing of grounds between circuits is permitted.

- (4) Where there are parallel feeders installed in more than one raceway, a properly sized equipment grounding conductor shall be installed in each raceway. The metallic conduit carrying the equipment grounding conductor shall be electrically continuous, forming a path parallel to the equipment grounding conductor. Under no circumstances shall the equipment grounding conductor be omitted from the electrical system. Nor shall any separate grounding system such as the signal ground, be used for an alternate grounding system or an alternate path to the grounding electrode, unless so shown on the drawings.
- (5) All connections to the equipment to be grounded shall be made with a grounding connector specifically intended for that purpose. Connecting screws or mounting bolts and screws are not suitable for use as grounding connections. All ground lugs shall be of a non-corroding material suitable for use as a grounding connection, and must be compatible with the type of metal being grounded. Remove paint and other non-conducting materials from surfaces of grounding connections. After the connection is completed, apply touch-up paint or cold galvanizing to match existing.
- (6) Unless otherwise specified, control equipment enclosures, pull boxes, and raceways, shall be grounded as above for power wiring.
- (7) Where metallic conduit, surface-mounted square duct, or cable tray systems are installed, a separate copper

conductor shall be installed in the raceway, and shall be properly bonded to each section. Unless otherwise specified, the minimum size ground conductor shall be #6 AWG green insulated copper.

- b. Service Entrance Disconnect Switches and Breakers. All facility service entrance disconnect switches and breakers shall be grounded as follows:
 - (1) The neutral bar or lug shall be grounded with a green insulated copper grounding electrode conductor, running directly to the grounding electrode. The grounding electrode conductor size shall be in accordance with the NEC, but in no case shall the wire size be smaller than #2 AWG.
 - (2) The switch box or panelboard enclosure shall be grounded to the grounded neutral bar or lug with a green insulated conductor, or other service grounding means.
- c. Grounding Electrode. Grounding electrodes (rods) shall be copper clad steel, 3/4-inch by 10 feet, except where otherwise specified. The top of the grounding electrode shall be a minimum of 12 inches below finished grade. Conductors shall be attached to electrodes with exothermic welds only, except where fire or explosion hazards exist, as near existing fuel tanks. Where such hazards exist, hydraulically crimped connections will be permitted as specified below.
- d. Grounding Conductor. All grounding conductors shall be copper. All grounding conductors which are totally above grade shall be green-insulated conductors. All grounding conductors which are either entirely or partially direct-earth buried, shall be #6 AWG bare conductors, unless noted otherwise on the drawings.
- e. Buried Guard Wire. A #1/0 AWG bare copper stranded guard wire shall be provided for all buried cables and conductors not routed in ferrous conduit. The guard wire shall be embedded in the soil a minimum of 10 inches above the cable to be protected and located directly above and parallel to the lines or cables being protected. When the width of the cable run or duct does not exceed 3 feet, one guard wire, centered over the cable run or duct, shall be installed. When the cable run or duct is more than 3 feet in width, two guard wires shall be installed. The guard wires shall be spaced at least 12 inches apart and be not less than 12 inches nor more than 18 inches inside the outermost wires or the edges of the duct. The guard wire shall be bonded to the earth electrode system (EES) at each end and to ground rods at approximately 90-foot intervals using exothermic welds. The spacing between ground rods must vary 10 percent to 20 percent to prevent resonance. Install the ground rods at approximately 6 feet on either side of the trench.

Where cables run parallel to the edge of a runway, they shall be located 10 feet from the edge lights on the outside of the lights.

- f. Exothermic Process for Connecting Grounding Conductors to Metal Objects. Where the Drawings and/or Specifications require connection of a grounding conductor to a metal object by exothermic process, the Contractor shall supply the correct exothermic welding kit for the application. The mold and cartridge used shall be selected on the basis of size, number, and type of conductors to be connected, composition and surface shape of object, and position in which the weld will be made. Regardless of the source of the kits selected, the Contractor shall submit catalog cuts or other manufacturer information, demonstrating that the kits fit their intended applications on the above described basis. See Paragraph 1A.4 above. The Contractor shall provide and use the proper preparation tools in applying the exothermic process to ensure an adequate weld. Torch welds and/or brazing will not be permitted. No single-use exothermic weld molds, such as Thermoweld "Single Shot" and Cadweld "One Shot", will be permitted.
- g. Hydraulically Crimped Connections. Hydraulically crimped connectors shall only be allowed where fire or explosion hazards prevent the use of exothermic welds. In such instances, grounding conductors shall be connected to each other or grounding electrodes with compression connectors crimped with a force of at least 24,000 pounds. Connectors, tools, dies, and crimping procedures shall be compatible to the application and to each other, and shall conform to the manufacturer's catalog and instructions. Each connector shall be clearly marked with catalog number, conductor size, and installation die information. The tooling shall be of the type that embosses or engraves the die index number on the connector in the crimping process. All connectors shall be listed in conformance with Underwriters Laboratories Standard UL467 and the National Electrical Code. Burndy Hyground Compression System connectors, matching tools, and crimping procedures, are one system of products which meet these Specifications. Regardless of the source of the connectors, tools, and dies selected, the Contractor shall submit catalog cuts or other manufacturer information, demonstrating that these items fit their intended applications as described above. See Paragraph 1A.4 above.
- h. Testing. The Contractor shall measure the resistance of the grounding electrode system in the presence of the COR. Tests shall not be conducted within 48 hours of a rainfall or in frozen soil. The resistance shall not exceed 10 ohms, unless otherwise indicated. If the measured resistance exceeds 10 ohms, the COR shall be notified immediately for further guidance. Upon project completion, the Contractor shall also submit a written test report to the COR. A tabulated report of the final resistance value at each location shall be provided in the report.

- 16A.6 GROUND FAULT INTERRUPTING RECEPTACLE. All outdoor receptacles provided by the Contractor shall be ground fault interrupting duplex receptacles in properly sized weatherproof boxes.
- 16A.7 CABLE ABANDONMENT. Ends of cables to be abandoned shall be buried two feet below grade unless otherwise specified. All above ground unused conduits, conductors, and cables shall be removed, unless the facility manager disapproves.
- 16A.8 WATERPROOFING CABLE ENDS. All cable ends which will be exposed to weather, water, ground, or corrosive environment prior to termination, shall be sealed against these elements while awaiting termination. This also applies to all cable ends in manholes or handholes. The sealing material shall be properly sized, easily removable heat shrinkable end caps, or electrical tape with an application of brushed-on protective electrical coating.
- 16A.9 CONDUIT AND CABLING FOR ENGINE GENERATOR. Where engine generator standby power will be extended to a facility, conduit shall run continuously, without intermediate manholes or handholes, from the engine generator to the facility. In the continuous conduit, power cables shall be installed without splices from the engine generator bypass switch to the facility service entrance switch.
- 16A.10 ELECTRICAL EQUIPMENT NAME PLATES.
- a. Each of the following types of equipment shall be identified with a name plate showing the functional name of the unit, voltage utilized, one or three phase as applicable, and additional information if specified or requested by the COR:
 - Switches (Except Local Lighting)
 - Panelboards
 - Main Circuit Breakers
 - Motor Controllers
 - b. Name plates shall be non-ferrous metal or rigid plastic, stamped, embossed, or engraved with 3/8-inch minimum height letters and numerals. Name plates shall be secured to the equipment with at least two screws, except main breaker plates may be epoxy glued.
- 16A.11 PANELBOARD CIRCUIT DIRECTORIES. The Contractor shall clearly and neatly mark panelboard circuit directories, identifying each circuit established, re-established, or changed, as to the circuit's function.

- 16A.12 COVERING HOLES IN ENCLOSURES. No electrical enclosure will be accepted which has an unused open hole, except weep holes or vent holes. Holes in enclosures where conduits, bolts, or other objects were removed and not reinstalled, shall be closed with panels of the same material, thickness, color, and shade as the enclosure.
- 16A.13 SAFETY DISCONNECT SWITCHES AND FUSES. Safety disconnect switches and fuses shall meet the following Specifications.
- a. General. Unless specified otherwise, all switches for circuit voltages of 600VAC or less, shall be heavy duty (Type HD), UL listed, and shall bear the UL label. The switches shall be NEMA 1 or NEMA 3R, as required by the drawings or special Specifications.
 - b. Switch Interiors. All switches shall have switch blades which are fully visible in the OFF position when the switch door is open. All current-carrying parts shall be of high-conductivity copper, designed to carry the rated load without excessive heating. Switches shall have removable arc suppressors where necessary to permit easy access to line side lugs. Lugs shall be front removable and UL listed for 60°C or 75°C, aluminum or copper wires.
 - c. Switch Mechanism. Switches shall quick-make, quick-break, such that during normal operation of the switch, the operation of the contacts will not be capable of being restrained by the operating handle after the closing or opening action of the contacts has started. The operating handle shall be an integral part of the box, not of the cover. Switches shall have provisions for padlocking the switches in the OFF position with at least three locks. Switches shall have a dual cover interlock to prevent unauthorized opening of the switch door when the handle is in the ON position, and to prevent closing of the switch mechanism with the door open. The handle position shall indicate whether the switch is ON or OFF.
 - d. Enclosures. Covers on NEMA 1 enclosures shall be attached with pin type hinges. NEMA 3R enclosures shall be securable in the open position. NEMA 3R enclosures for switches through 200 amperes shall have provisions for interchangeable bolt-on hubs. Hubs shall accommodate the conduits of the diameters indicated on the drawings. NEMA 3R enclosures shall be manufactured from galvanized steel. All enclosures shall have a gray baked enamel finish, electrodeposited on cleaned, phosphatized steel.

- e. Ratings. All fusible switches rated 100 through 600 amperes at 240 volts, and 30 through 600 amperes at 600 volts, shall have a UL-approved method of field conversion from standard Class H fuse spacing to Class J fuse spacing. The switch also must accept Class R fuses, and have provisions for field installation of a UL-listed rejection feature to reject all fuses except Class R. The UL-listed short circuit rating of the switches shall be 200,000 rms symmetrical amperes when Class R or Class J fuses are used with the appropriate rejection scheme. The UL-listed short circuit rating of the switch, when equipped with Class H fuses, shall be 10,000 rms symmetrical amperes.
- f. Fuses. All fused switches meeting the above Specifications shall be fused with dual element, time-delay, UL Class RK5 fuses, of the continuous current rating specified on the drawings. One set of spares shall be furnished for each fusible device. The fuses' interrupting rating shall be at least 10,000 rms symmetrical amperes.

16A.14 PANELBOARDS AND CIRCUIT BREAKERS.

- a. General. Panelboards shall be dead-front type, shall conform to Federal Specification W-P-115, Type I, Class 1, and shall be listed by UL except for installations which require special panelboards to incorporate items not available as UL listed. Panelboards shall be mounted so that the height to the top of the panelboard shall not exceed 81 inches above the finished floor level. Unless otherwise specified, panelboards shall have a full hinged front cover with a hinged door in that cover for access to circuit breaker switches. Doors shall have flush-type cylinder locks and catches. Doors over 48 inches in height shall have auxiliary fasteners on top and bottom. All locks in a project shall be keyed alike, and two keys shall be furnished with each lock. Directories shall be typewritten to indicate the load served by each circuit and shall be mounted on the inside of the door in a holder with a protective covering. Circuits shall be connected as indicated on the drawing. The directory shall be arranged so that the typed entries simulate circuit breaker positions in the panelboard.
- b. Wiring Gutters. The minimum size of side wiring gutters shall be 4 inches for power feeders up to and including 100 amperes, 6 inches for power feeders over 100 amperes and up to 225 amperes, and 8 inches for power feeders over 225 amperes and up to 600 amperes.

- c. Circuit Breakers. All circuit breakers shall be UL listed thermal magnetic type or electronic solid state type, as described herein, and with a minimum rating of 10,000 AIC. Circuit breakers shall also have trip ratings, voltage ratings, and number of poles as defined on the drawings. All circuit breakers shall have a trip indicating feature. Single-pole breakers shall be full-size modules. Two-pole and three-pole breakers shall be physically sized in even multiples of a single-pole breaker. Breakers shall be sized so that two single-pole breakers cannot fit in a single housing. Multi-pole circuit breakers shall have an internal common trip mechanism. All circuit breakers and the panelboards in which the breakers are installed shall be products of the same manufacturer. Plug-in type load centers and/or plug-in type branch or feeder circuit breakers shall not be used.
- (1) Thermal Magnetic. All thermal magnetic breakers shall be quick make, quick break type conforming to Federal Specification W-C-375. Adjustable breakers shall have setting adjustments readily accessible and visible from the front of the panelboard, after installation.
- (2) Solid State. Adjustable, solid-state or microprocessor-controlled circuit breakers shall have adjustments readily accessible and visible from the front of the panelboard, after installation. Individual circuit breaker frame size shall not exceed the panelboard bus rating.
- d. Bussing Assembly and Temperature Rise. Panelboard bus structure and main lugs or main circuit breaker shall have current ratings as shown on the drawings. Such ratings shall be established by heat rise tests, conducted in accordance with UL Standard 67. Bus structures shall be insulated. All current carrying parts shall be of high-conductivity copper, designed to carry the rated load without excessive heating.
- e. Cabinets and Fronts. The panelboard bus assembly shall be enclosed in a steel cabinet. The rigidity and gauge of the steel shall be as specified in UL Standard 50 for cabinets. Wiring gutter space shall be in accordance with UL Standard 67 for panelboards. The box shall be fabricated from galvanized steel or equivalent rust-resistant steel. Fronts shall have adjustable indicating trim clamps which shall be completely concealed when the doors are closed. Doors shall be mounted with completely concealed steel hinges. Fronts shall not be removable with the door in the locked position.

16A.15 ELECTRICAL ENCLOSURES AND WIREWAYS. Unless specified otherwise, electrical enclosures and wireways shall meet the following Specifications.

- a. Material. Electrical enclosures and wireways shall be constructed of code gauge sheet steel.
- b. Corrosion-Resistant Coating. Enclosure and wireway sheet steel shall be coated by ASTM 525 G90 (galvanneal) galvanizing or corrosion-resistant phosphate primer, or both.
- c. Finish. Finish shall be dark gray enamel inside and out, or ANSI 61 gray polyester coating inside and out, or ASA-49 gray epoxy paint inside and out.
- d. Industry Standards.
 - (1) Enclosures. NEMA 1 enclosures shall meet NEMA Type 1 and UL 50 Type 1 standards. NEMA 3R enclosures shall meet NEMA Type 3R and UL 50 Type 3R standards.
 - (2) Wireway. NEMA 1 wireway (including troughs) shall meet NEMA 1 and UL 870 standards. NEMA 3R wireway (including troughs) shall meet NEMA 3R and UL 870 standards.
- e. Hardware. All hardware shall be plated to prevent corrosion.

16A.16 ELECTRICAL SURGE PROTECTION

- a. General. All electrical surge protection systems shall be installed in accordance with FAA Standards.
- b. Supply Transformer. For utility owned transformers, protective devices shall be at the discretion of the utility. For FAA owned transformers, proper protection shall be provided on the primary side of the transformer.
- c. Service Entrance Surge Arrester. The arrester shall be compatible with the service voltage, and shall be wired to avoid loops, sharp bends and kinks, and to minimize the number of bends. There shall be no interconnection between neutral and ground within the arrester. Arrester conductors shall be #4 AWG insulated copper or larger, unless a smaller size is recommended by the arrester manufacturer.
- d. Transient Suppression Installations. Where transient suppression devices are installed in the electrical power distribution system, they shall be installed in accordance with the manufacturer's instructions unless otherwise specified.

- e. Landline/cable Penetration Installations. Supression systems shall be provided for landline and cable penetration systems. High energy grounding conductors shall be bonded directly to the earth electrode system or to the perimeter ground cable under raised floors in equipment rooms with an approved fastener not more than 24 inches from the box.

16A.17 WIRING DEVICES.

- a. Receptacles. All receptacles shall be specification grade in accordance with NEMA Standard WD-1. Unless otherwise indicated, general purpose duplex receptacles shall be specification grade, 20 ampere rating, 125 volt, ground type NEMA 5-20R. Receptacles with push-in connections or a combination of screw-type and push-in connectors are not acceptable. Unless noted otherwise, receptacles shall be installed 12 inches above finished floor. All receptacles, unless they are of the isolated-ground type, shall be grounded by the installation of a green grounding pigtail from the receptacle grounding screw directly to the grounding screw on the outlet box where the green equipment grounding conductor is terminated.

For all critical power circuits, the receptacles shall be twist lock type, except where the receptacles are not subject to being kicked or bumped (e.g., receptacles mounted inside an equipment rack).

- b. Ground Fault Circuit-Interrupter (GFCI) Receptacles. GFCI receptacles shall be installed in all locations required by the NEC and in other locations as indicated on the Drawings. GFCI receptacles shall be 125 volt, duplex, UL Group I, Class A, rated for 20 amperes minimum. All exterior GFCI receptacles shall be mounted in weatherproof boxes with weatherproof covers.
- c. Isolated Ground Terminal Receptacles. When isolated ground terminal receptacles are shown in the Contract documents, they shall be installed in accordance with the NEC. Isolated ground terminal receptacles shall only be used where shown on the Drawings. All isolated ground terminal receptacles shall be colored orange.

d. Plug-in Strip Outlets

- (1) General. Fixed multi-outlet assemblies shall consist of a surface metal raceway with grounding type receptacles. Phase and neutral conductors shall not be smaller than #12 AWG and shall have the type of insulation specified for branch circuit conductors. In addition, a #12 AWG or larger green insulated equipment grounding conductor having the same insulation as the phase conductors shall be installed. This grounding conductor shall connect all receptacle ground terminals and each section of the surface metal raceway, and shall be securely connected to the equipment grounding conductor from the branch power panel. Where more than one circuit is indicated as serving a group of similar receptacles in a common raceway, adjacent receptacles shall not be connected to the same circuit.
- (2) Associated Hardware. Surface metal raceways shall be provided with snap-on blank covers and/or snap-on receptacle covers for the receptacles furnished, all manufactured by the raceway manufacturer. They shall be installed to prevent open cracks. Where industry standard device plates are to be installed on raceways, snap-on blank covers shall be accurately cut to avoid open cracks. Fittings, elbows, clips, mounting straps, connection blocks, and insulators, shall be provided as required for a complete installation.

e. Emergency Light Receptacles. Emergency light receptacles shall be grounding type single receptacles in accordance with NEMA Standard WD-1.

f. Wall Switches. Single-pole and three-way wall switches shall be specification grade, rated 120/277 volts, and shall be fully rated 20 amperes, AC only. Wiring terminals shall be of the screw type. Switches with push-in connections or a combination of screw-type and push-in connections are not acceptable. Switches shall be equipped with grounding terminals and shall be grounded with a green grounding pigtail connected from the switch grounding screw directly to the grounding lug or screw on the outlet box where the green equipment grounding conductor is terminated. Switches shall be the quiet-operating type. Not more than one switch shall be installed in a single gang position.

- g. Device Plates. Plates of the one-piece type shall be provided for all outlets and fittings to suit the devices installed. Plate screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Telephone and communication outlets shall be provided with a blank cover plate unless otherwise indicated. Plates shall be installed with all four edges in continuous contact with finished wall surfaces with the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional type device plates will not be permitted. Plates installed in wet locations shall be gasketed. Device plates for telephone and intercommunication outlets shall have a 3/8-inch bushed opening in the center or a dome-shaped grommet on the side.
- h. Photoelectric Control. Unless otherwise indicated, photoelectric controls for floodlighting or obstruction lighting shall be 120 volt, 3000 watt, single-pole, single-throw, double-break type. Photoelectric controls shall be mounted in an appropriate weatherproof housing installed on the building exterior. The housing should be vented if possible, faced in a northerly direction. At no time shall the controllers be mounted in the same enclosure with the batteries.

16A.18 SHELTER LIGHTNING PROTECTION EQUIPMENT. All shelters (buildings) shall have a lightning protection system installed per the requirements of the Lightning Protection Code, National Fire Protection Association (NFPA 78), and Underwriters Laboratories Master Labeled System (UL96A). Lightning protection equipment items shall meet the following Specifications:

- a. Air Terminal Point. Air terminal points shall be nickel-tipped copper, 1/2" diameter x 36" long.
- b. Point Bracket. For a roof ridge, the point bracket shall be made of pressed copper, shall bend to fit any roof slope, and shall hold the point and cable slightly above the center of the roof ridge. The bracket shall have a pressure cable clamp, and a stud to engage the point.
- c. Air Terminal Brace. The air terminal brace shall be a 24"-long galvanized tripod assembly, with legs adjustable to accommodate any roof slope.
- d. Roof and Down Conductors. Roof and down conductors shall each have 32 strands of #17 AWG copper wire, 7/16" overall diameter, braided smooth twist, 65,500 circular mils, and a net weight of 215 pounds per 1000 feet.

- e. Ridge Cable Support. Ridge cable supports shall be pressed copper cable supports at least 2" wide, to hold the roof cable above the top of the roof. The ridge cable supports shall be sized to accommodate the roof conductor.
- f. Cable Holder. Cable holders shall be 1"-wide copper bent-strap type loops with 1/4" mounting holes. The cable holders shall be sized to accommodate the roof conductor.
- g. Parallel Clamp. Parallel clamps shall be bronze 2"-long clamps for connecting two conductors together, one conductor of maximum diameter 1/2", and the other conductor from 1/6" diameter to 5/16" diameter.
- h. Flexible Bonding Strap. Flexible bonding straps, for connecting steel doors to steel door frames, shall be braids each composed of 480 #30 AWG copper wires, with flat bronze or copper connectors crimped on at each end. The connectors shall have holes to take either 5/16" or 3/8" machine screws.
- i. Pipe Clamp. Pipe clamps shall be adjustable tinned bronze clamps for bonding cables to pipes, and fitting pipes up to and including 1 1/4" O.D., and cables up to and including 1/2" diameter.
- j. Bonding Equipment. Bond the steel siding, vent fan, hood, door frame, junction boxes, and any miscellaneous exterior metal objects to down conductors. If included, air conditioners, junction boxes, and flight check antenna masts shall be likewise bonded. Use the following equipment to perform the bonding:
 - (1) Bonding Plate. Bonding plates shall be 8-sq. inch tinned bronze plates with 2"-long pressure type cable connectors, designed to bond a continuous run of cable to metallic objects along their path. Each plate shall have two holes fitting sheet metal screws or 1/4" machine screws.
 - (2) Bonding Conductor. Bonding conductor shall be minimum #6 AWG bare soft drawn copper, 1/6" diameter, 26,250 circular mils, net weight 80 pounds per 1000 feet.

16A.19 CONTROL CABLE TERMINAL STRIPS. Unless specified otherwise, Contractor furnished control (telephone) cable terminal strips shall be units assembled from compatible components all from the same manufacturer. The individual blocks of the strips shall be miniature style (6mm O.C.) nylon blocks with screw-activated tubular conductor clamps. The blocks shall be rated for a maximum voltage of at least 300 volts and a maximum current of at least 30 amperes. The conductor clamps shall accept wire sizes at least from #14 AWG to #22 AWG. Stab-in wire connection blocks shall not be used. The blocks shall be mounted in a standard 35mm DIN rail mounting channel. The assembled strip of blocks shall have a marking strip and holding plugs or end barriers. For terminating control cables on these strips, see Paragraph 16F.11 below.

16A.20 FRANGIBLE COUPLINGS.

- a. Material Specification. Unless specified otherwise, Contractor-furnished frangible couplings shall be 2" diameter cast aluminum couplings having a hexagonal clamping ring. The couplings shall accommodate 2"-diameter EMT conduit, and shall meet the FAA's testing, certification and approval requirements.
- b. Thread Remediation. Often, the conduit threads of frangible couplings (both Contractor-furnished and Government-furnished) are cast with mismatched halves. Often, this imperfection causes the threads to bind in the rigid coupling threads conduit threads of the required mating object, before the required engagement is reached, even when anti-seize compound is used. When this binding occurs, the Contractor shall rework the frangible coupling threads to achieve the required thread engagement. This remediation may consist of rethreading with a straight conduit thread die, and/or of grinding off the threads on the two diametrically opposite sides of the thread helix where the cast thread discontinuity is found. This remediation must continue until the required thread engagement is achieved. All burrs and galls must be removed from the reworked threads.

- 16A.21 ELECTRICAL TAPE. Unless specified otherwise, electrical tape shall meet the following Specifications. The tape material shall be based on PVC polyvinyl and/or PVC copolymers. The tape shall have a rubber-based, pressure-sensitive adhesive. The tape shall be 8.5 mils thick, and be UL listed and marked per UL Standard 510 as "Flame Retardant, Cold and Weather Resistant." The tape must be applicable at temperatures ranging from 0°F through 100°F (-18°C through 38°C). The tape shall be classified for both indoor and outdoor use. The tape shall be compatible with synthetic cable insulations, jackets, and splicing compounds. Scotch Super 88 Vinyl Electrical Tape by 3M is one of the products that meet these Specifications.
- 16A.22 PRE-STRETCHED RUBBER TUBING. Pre-stretched rubber tubing shall be open-ended tubular rubber sleeve, factory expanded and assembled onto a removable core. The tubing is supplied for field installation in this pre-stretched condition. The tube is positioned for installation over an inline connection, terminal lug, sleeve splice, or other cable insulation discontinuity requiring protection. Then the core is removed, allowing the tube to shrink to produce a waterproof seal.

The tubing shall be made of EPDM (ethylene propylene diene monomer) rubber containing no chlorides or sulfurs. The tubing must be capable of operation at emergency overload cable temperatures of 130°C. It must be usable without additional covering or adhesive, both indoors and outdoors, in overhead, direct buried or submerged applications, on cables rated up to 1,000 volts. The tubing must be applied without additional heat or flame and, when applied per the manufacturer's instructions, be immediately energizable. It must not be adversely affected by moisture, mild acids or alkalies, ozone or ultraviolet light. It must conform to the requirements of ANSI C119.1, appropriate sections of Western Underground Guide 2.14 and UL 486D. The tubing must have been accepted by the U.S. Department of Agriculture, Rural Utilities Service (RUS), for both submersible and aerial application. PST Cold Shrink Connector Insulators 8420 Series by 3M are among products which meet these Specifications. All applications must be performed per the manufacturer's instructions.

16A.23 FIRE AND ARC PROOFING. Fire and arc proofing shall consist of a flexible conformable unsupported (having no adhesive) intumescent elastomer. The intumescent property causes the tape to expand in fire, thus providing an insulating firewall between the flame and cable. The tape shall be not less than .030 inches thick. The tape shall be capable of over 100% elongation. The tape shall be non-corrosive to metallic cable sheaths. It shall be compatible with synthetic cable jackets such as semi-conducting URD type, polyethylene, and PVC. The tape shall be self-extinguishing, i.e., shall not support combustion. The tape shall not deteriorate when subjected to water, salt water, gases, and sewage. The wrapped tape shall be secured by a band consisting of two layers (the second wrapped directly over the first) of glass cloth electrical tape at both ends of the fire and arc proofing wrap. The completed installation of a single half-lapped layer of fire and arc proofing shall be capable of withstanding a high 60 Hz current fault arc temperature of 13,000°K for 70 cycles. Scotch 77 Fire and Arc Proofing tape secured with Scotch 69 Glass Cloth Electrical Tape are among products that meet these Specifications, when applied per the manufacturer's instructions. All applications must be performed per the manufacturer's instructions.

16A.24 CABLE CONNECTOR PROTECTION.

- a. Primary Connections. Where single-conductor plug and receptacle cable connectors are joined in light bases or other underground enclosures, the joint shall be sealed with heat-shrinkable tubing specifically designed for this purpose. Each tubing unit shall consist of a polyolephin heat-shrinkable sleeve with sealant at each end. The tubing shall meet the performance Specifications of ANSI C-119.1 and Western Underground Guide 2.5, and shall be RUS listed under "secondary" tap or splice cover, submersible.

The sleeve is placed over the cable connectors, their joint, and a short length of cable at the ends of the connectors. The sleeve is shrunk with a torch or heat gun, with heat applied from the center of the sleeve toward the ends, to avoid trapping air. The sleeve shrinks under the heat, to conform to the shape of the connectors and the cables. The sealant at the ends of the sleeve forms a watertight seal around the cables. These sleeves shall be applied to cable connector joints between two isolation transformer primary leads, a primary lead and a cable, or two cables, wherever these joints are specified in a light base or other underground enclosure. The sleeves must be of a type designed for easy removal by applying a small amount of heat, slitting the sleeve with a knife, and peeling away the sleeve.

- b. Secondary Connections. Where two-conductor plug and receptacle cable connectors are joined in light bases or other underground enclosures, the joint between the two connectors shall be sealed with at least two layers of electrical tape and an application of protective electrical coating. Where two-conductor plug and receptacle connectors are joined in a frangible coupling, apply no tape or any other protection.
- 16A.25 ELECTRICAL COATING. Cable connections, splices, or other joints wrapped with plastic electrical tape, shall be sealed with an electrical coating. Scotchkote Electrical Coating is among the products meeting this Specification.
- 16A.26 COMMERCIAL METAL FRAMING. Where specified for mounting of electrical equipment or other purpose, the Contractor shall furnish and install commercial metal framing. The channel framing members shall be formed from strip steel, with one side of the channel having a continuous slot with inturned lips. The principle of attachment is application of nuts which engage the inturned lips of the channel. For outdoor applications, framing members shall be hot-dip galvanized per ASTM Specification A-123 or A-153. For indoor applications, framing members shall be factory coated with enamel or epoxy coatings, or electro-galvanized per ASTM Specification B633. Uncoated framing members, or framing members coated only with oil, are not acceptable. Properly sized and matched channel framing members, fittings, and hardware from Unistrut Corporation of Wayne, Michigan, and from B-Line Systems, Inc. of Highland, Illinois are among products meeting the above Specifications. Installation shall be in accordance with manufacturer's instructions.
- 16A.27 EXPANSION COUPLING. Where shown on the drawings, rigid metal conduits which emerge vertically from below grade to make a direct connection to an above-grade junction box or structure, shall be fitted with an expansion coupling. The purpose of the expansion coupling is to accommodate relative vertical movement, such as the movement due to frost heave. The coupling shall be rigid metal, and shall be threaded onto the rigid conduits at both ends of the coupling. The coupling must accommodate 8 inches of movement, unless space limitations prohibit installing such a coupling. If there are such space limitations, a coupling allowing only 4 inches of movement may be substituted. Electrical continuity across the expansion coupling must be maintained by installing a bonding jumper.

16A.28 LAMPS AND LIGHTING FIXTURES

- a. General. Lamps and lighting fixtures shall be of the types indicated on the drawings. All lighting fixtures shall be UL approved and shall bear the UL label. All incandescent lamps shall be rated for 130 volts unless otherwise indicated. Flexible metal conduit, minimum 3/8 inch nominal trade size is permitted. External bonding jumpers are not required across the lighting fixture flexible conduit.
- b. Fluorescent Fixtures. Unless otherwise indicated, fluorescent fixture lenses shall be the prismatic-type, made of virgin acrylic. Fluorescent lamps shall be rapid, states, cool white, unless otherwise indicated. Ballasts for fluorescent fixtures shall be Class P, protected (including inherent automatic thermal reset and fuse) rapid start, high power factor type, conforming to UL Standard UL 935. Unless otherwise indicated, all ballasts shall be provided with factory installed choke-type radio frequency interference suppressers. Lampholders shall have silver plated contacts, and shall conform to standard UL 542.
- c. Recessed Fluorescent Fixtures. Recessed fluorescent fixtures shall conform to NEC Article 410, and shall be installed in suspended ceiling openings. These fixtures shall have adjustable fittings to permit alignment with ceiling panels.
- d. Suspended Fluorescent Fixtures. Pendant-mount fluorescent fixtures shall be of the types indicated on the drawings. Single-unit suspended fluorescent fixtures shall have twin-stem hangers. Multiple-unit or continuous row fluorescent units shall have tubing or a stem for wiring at one point, and tubing or a stem suspension provided for each unit length of chassis, including one at each end.
- e. Suspended Incandescent Fixtures. Pendant-mounted incandescent fixtures shall be provided with swivel hangers to insure a plumb installation.
- f. Emergency Lights. Emergency lights shall be as indicated on the drawings, and the light sets shall be connected to the wiring system by a cord no more than 3 feet in length to a single receptacle.
- g. High Intensity Discharge (HID) Lamps. HID lamps, including mercury vapor, metal halide, and high or low pressure sodium shall be as indicated on the drawings. High power factor, constant wattage ballasts shall be furnished with HID lamps. Mercury vapor lamps shall be the color improved type.

16A.29 SIGNAL AND COMMUNICATIONS

- a. Entrance Conduits. Conduit materials shall be rigid steel unless otherwise indicated. Except where otherwise indicated, underground conduits shall be a minimum of 2 feet below finished grade and extend at least 5 feet beyond the grounding electrode system. The conduits shall be bonded to the grounding electrode system with #2 AWG bare copper conductor by exothermic welds. Conduits installed for future use by others, such as for telephone, communications, electronic signals, etc., shall have both ends capped.
- b. Transient Protection Demarcation Box for Electronic Landlines. A metallic, appropriately rated NEMA junction box, shall be installed where electronics landlines or conduits enter the facility. This box will house terminal boards, cables, and circuit transient protectors as shown on the Contract Drawings.
- c. Fiber Optics. The use of fiber optics is recommended to replace metallic, control cables. Using fiber optics will eliminate outages and loss of service due to lightning strikes.

16A.30 PAINTING AND FINISHING. Where factory finishes are not adequate to protect metal surfaces from corrosion, the Contractor shall paint exposed surfaces prior to or after installation. All marred or damaged surfaces, except exposed metal for grounding purposes, shall be refinished to leave a smooth, uniform finish at final inspection.

16A.31 REPAIR OF EXISTING WORK. Electrical work shall be carefully planned. Where cutting, channeling, chasing, or drilling of floors, all partitions, ceilings, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, it shall be carefully done. The Contractor shall repair, with equal material by skilled workers, any damage to facilities caused by the Contractor's workers or equipment. The Contracting Officer's prior approval must be obtained for the materials, workers, time of day or night, repair method, and for temporary or permanent repair purposes. On completion, repair work shall be inspected and approved by the COR with the concurrence of any other affected parties such as utility companies and airport authorities.

16A.32 QUALITY ASSURANCE PROVISIONS

- a. List of Materials and Equipment. When required by the contract, the Contractor shall submit a list of materials and equipment to the Contracting Officer for approval.

- b. Information Required. This list shall include manufacturer's style or catalog numbers. Partial lists submitted from time to time shall not be considered as fulfilling this requirement. Approval of materials will be based on manufacturer's published data. Approval of materials and equipment will be tentative, subject to submission of complete shop drawings, when required, indicating compliance with the Contract documents.
- c. Statement. A manufacturer's statement indicating complete compliance with the applicable Federal Specification, Military Specification, or standards of ASTM, NEMA, or other commercial standard, is acceptable as indicating compliance with Contract documents.
- d. Shop Drawings. When required by the Contract or by direction of the Contracting Officer, the Contractor shall submit shop drawings for materials and equipment not completely identified by information submitted in the materials and equipment lists. This information shall include, but is not limited to, panelboards, lighting fixtures, cable trays, switchgear, transformers, busways, cabinets, and lightning protection systems.
- e. Coordination. Drawings and submitted data shall be checked and coordinated with the work of other construction trades involved, before they are submitted for approval, and shall bear the Contractor's stamp of approval as evidence of such checking and coordination.
- f. Required Data. Drawings and submitted data shall be complete, assembled in sets and shall bear the date, drawing revision number, name of project or facility, name of Contractor and subcontractor, and the clear identity of contents and location of work.
- g. Approval. The approval of drawings and submitted data shall not be construed as (1) permitting any departure from the Contract requirements; (2) relieving the Contractor of the responsibility for any errors, including details, dimensions, materials, etc.; or 3) approving departures from full size details furnished by the Contracting Officer.
- h. Variations. If drawings show variations from the contract requirements because of standard shop practice or for other reasons, the Contractor shall describe such variations in a letter of transmittal to the Contracting officer. If acceptable, the Contracting Officer may approve any or all such variations, subject to a proper adjustment in the Contract. Contractors failing to describe such variations shall not be relieved of the responsibility for executing the work in accordance with the Contract, even though such drawings have been approved.
- i. Submission. The Contractor shall submit and obtain approval of shop drawings by the Contracting Officer before ordering materials or proceeding with any work associated with the shop drawings.

16A.33 TESTS

- a. General. Unless otherwise indicated, the Contractor shall furnish all test instruments, materials and labor necessary to perform the following tests. All tests shall be performed in the presence of the COR. All instruments shall have been calibrated within a period of 2 years preceding testing. Calibrations shall be traceable to applicable industry recognized standards.
- b. Load Balancing. After the electrical installation has been completed, the Contractor shall take current readings with a true RMS ammeter for the purpose of load balancing. These readings shall be taken at the service entrance, each feeder panelboard, each branch panelboard, and each separately derived source. The Contractor shall redistribute single-phase loads where there is greater than a 20% difference between readings in any two phases. The Contractor shall also be required to notify the Contracting Officer of current readings taken before and after installation, and any phase loaded above 80% of the rating of its overcurrent protective device.
- d. Neutral Isolation Tests. For all new installations, the neutral in the service entrance switch shall be tested for isolation from ground with an ohmmeter capable of reading greater than 20,000 ohms.
- e. Earth Resistance Test. The Contractor shall comply with the grounding electrode system testing requirements of paragraph 16A.5h.
- f. Operating Test. After the interior wiring system installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of this Specification. The test shall be performed in the presence of the COR.

DIVISION 16 - ELECTRICAL
SECTION 16B
600-VOLT POWER CABLE FOR UNDERGROUND INSTALLATION

- 16B.1 SCOPE. This section covers the material requirements for all Contractor-furnished single-conductor 600-volt power cable required for direct earth burial installation. Installation of power cable is covered in Section 16F.
- 16B.2 GENERAL REQUIREMENTS. Cable construction shall include copper single conductor and XLP (thermosetting crosslinked polyethylene) insulation. Cable shall be UL listed as Type USE or RHW or RHH for use in circuits not exceeding 600 volts at conductor temperatures of 90°C for continuous normal operation, 130°C for emergency overload conditions, and 250°C for short circuit conditions. Cables shall be suitable for direct burial and above-grade installation in wet or dry locations.
- 16B.3 APPLICABLE SPECIFICATIONS.
- a. Underwriters Laboratories Standard 854 for Service Entrance Cables.
 - b. Underwriters Laboratories Standard 44 for Thermoset-Insulated Wires and Cables.
 - c. ICEA Publication Number S-95-658, NEMA WC70 for Nonshielded 0-2kV Cables.
 - d. Federal Specification A-A-59544.
- 16B.4 CABLE CONSTRUCTION. Cable characteristics shall include the following materials and construction:
- a. Conductors. Conductors shall be solid or Class B stranded annealed uncoated copper, per UL Standards 854 and 44.
 - b. Separator. A suitable separator over the conductor may be used at the option of the manufacturer.
 - c. Insulation. Each conductor shall be insulated with XLP (crosslinked polyethylene) complying with the physical and electrical requirements of UL Standard 854 for Type USE and UL Standard 44 for Types RHW and RHH and ICEA Publication Number S-95-658. The insulation shall be applied lightly to the conductor and shall be free-stripping.
- 16B.5 IDENTIFICATION. The cable shall be identified by surface marking indicating manufacturer's conductor size and metal, voltage rating, UL Symbol and type designation, and year of manufacture.

- 16B.6 TESTS. Cable shall be tested in accordance with requirements of UL Standard 854 for Type USE, UL Standard 44 for Types RHW and RHH, and ICEA Publication Number S-95-658.
- 16B.7 DATE OF MANUFACTURE. Year of manufacture of all cable shall be no earlier than one calendar year immediately preceding contract award date.
- 16B.8 PACKAGING. All cable shall be provided on wooden or steel reels, and ends of all cable shall be sealed to prevent entry of moisture. All reels shall identify type, length, and year of manufacture of cable packaged on such reels. All such identification shall be clearly provided by the manufacturer.

DIVISION 16 - ELECTRICAL
SECTION 16C
600-VOLT ARMORED POWER CABLE

- 16C.1 DESCRIPTION. This section covers the material requirements for all Contractor furnished 600-volt 3-conductor armored power cable required for direct earth burial installation. Installation of power cable is covered in Section 16F.
- 16C.2 GENERAL REQUIREMENTS. Cable construction shall include three copper conductors with XLP (thermosetting crosslinked polyethylene) insulation, galvanized steel interlocking armor, and PVC jackets under and over armor. Cable shall be UL listed as type MC for use in circuits not exceeding 600 volts phase to phase at conductor temperatures of 90°C in dry locations, or 75°C in wet locations, 130°C for emergency overload conditions, and 250°C for short circuit conditions in wet or dry locations. Cables shall be designed and labeled for direct burial use.
- 16C.3 APPLICABLE SPECIFICATIONS. The following Specifications form a part of this Specification to the extent specified herein:
- a. UL Standard 1569 for Metal-Clad Cables.
 - b. UL Standard 44 for Thermoset-Insulated Wires and Cables.
 - c. ICEA Publication Number S-95-658, NEMA WC70 for Nonshielded 0-2kV Cables.
 - d. IEEE 383 Type Tests of Class 1E Electric Cables and Field Splices and Connections for Nuclear Power Generating Stations.
- 16C.4 CABLE CONSTRUCTION. Cable construction shall include the following materials and construction:
- a. Conductors. Class B stranded annealed uncoated copper per ICEA.
 - b. Separator. A suitable separator over the conductor may be used at the option of the manufacturer.
 - c. Insulation. XLP crosslinked polyethylene meeting the requirements of ICEA and Type XHHW requirements of UL 44. Average thickness of insulation shall be as specified in UL 44 for Type XHHW conductors and in ICEA. Minimum thickness at any point shall be not less than 90% of the specified average thickness.
 - d. Phase Identification. Insulated phase conductors shall be printed with the numeral "1", "2", and "3" on the surface of the insulation.

- e. Assembly. Three phase conductors shall be cabled together with a Class B stranded, uncoated copper grounding conductor and suitable nonhygroscopic fillers to make round. Length of lay shall not exceed 35 times the phase conductor diameter. The grounding conductor shall comply with the requirements of UL Standard 1569. A suitable nonhygroscopic cable tape shall be applied over the assembly.
 - f. Inner PVC Jacket. PVC meeting the requirements of ICEA, Section 7 and the sunlight resistant requirements of UL 1569. Average jacket thickness shall be in accordance with UL 1569. Minimum thickness at any point shall be not less than 70 percent of the specified average thickness.
 - g. Armor. Galvanized steel interlocked armor shall be applied over the inner PVC jacket. Armor shall be in accordance with UL requirements for Type MC cable and Section 6 of ICEA.
 - h. Outer PVC Jacket. PVC meeting the requirements of ICEA, Section 7 and the sunlight resistant requirements of UL 1569. Average jacket thickness shall be in accordance with UL 1569. Minimum thickness at any point shall be not less than 70 percent of specified average thickness.
- 16C.5 TESTS. Conductors and completed cables shall be tested in accordance with UL requirements for Type MC cables having XHHW conductors.
- 16C.6 IDENTIFICATION. Cable shall be identified by surface marking indicating manufacturer's identification, conductor size and metal, voltage rating, UL symbol and type designation, year of manufacture, and "direct burial" designation.
- 16C.7 DATE OF MANUFACTURE. Year of manufacture of all cable shall be no earlier than one calendar year immediately preceding contract award date.
- 16C.8 PACKAGING. All cable shall be provided on wooden or steel reels, and ends of all cable shall be sealed to prevent entry of moisture. All reels shall identify type, length, and year of manufacture of cable packaged on such reels. All such identification shall be clearly provided by the manufacturer.
- 16C.9 SUBMITTALS. For the specific cable that the Contractor proposes to use, the Contractor shall submit the manufacturer's complete cable specifications, including compliance with all cable requirements, codes, and standards referenced herein, and a drawing showing cable construction details. Submit these items, and receive the Contracting Officer's approval before installing any cable specified herein. See Paragraph 1A.4 above.

DIVISION 16 - ELECTRICAL
SECTION 16D
5000-VOLT POWER CABLE

16D.1 SCOPE. This section covers the material requirements for all Contractor furnished single-conductor, 5000-volt power distribution cable required for direct earth burial installation. Cable manufactured per FAA Specification L-824 shall not be used for power distribution. Installation of power cable is covered in Section 16F.

16D.2 GENERAL REQUIREMENTS.

- a. Cables shall be XLP-insulated, 5000-volt, single copper conductor, shielded power cable UL listed as Type MV-90. Cable shall be rated at 100 percent insulation level for use in grounded neutral circuits in wet or dry locations below grade at conductor temperatures of 90°C for continuous normal operations, 130°C for emergency overload conditions, and 250°C for short circuit conditions.
- b. Cable construction shall include copper single conductor, conductor shield, XLP (thermosetting crosslinked polyethylene) insulation, metallic tape or wire shield over tape bedding, separator tape, and PVC (polyvinyl chloride) jacket.

16D.3 APPLICABLE SPECIFICATIONS. The following Specifications shall form a part of this Specification to the extent specified herein.

- a. Underwriters Laboratories Standard 1072 for Medium-Voltage Power Cables.
- b. ICEA S-93-639/NEMA WC74 Shielded Power Cable 5-46kV.

16D.4 CABLE CONSTRUCTION. Cable characteristics shall include the following materials and construction:

- a. Conductors. Class B stranded annealed copper per Section 2 of ICEA.
- b. Conductor Shielding. The conductor shall be covered with a layer of semiconducting tape or extruded conducting compound. The extruded conducting compound or tape layer shall be firmly bonded to the cable insulation, and shall meet the requirements of Section 5 of ICEA.

- c. Insulation. Directly over the conductor shielding shall be applied a homogeneous wall of XLP insulation. The average thickness of insulation shall be as specified in Section 4 of ICEA. Minimum thickness at any point shall be not less than 90 percent of the specified thickness. Physical and electrical properties of the insulation shall be in accordance with Section 4 of ICEA.
 - d. Shielding.
 - (1) A thin uniform layer of black conducting polymeric coating shall be applied directly over the insulation. A semiconducting non-metallic tape shall be wrapped over this coating to act as a conductive bedding between coating layer and the metallic shielding. A special marker tape applied over the semiconducting tape shall identify the tape and coating layers as conducting.
 - (2) A metal shield shall be applied over the semiconducting tape. Shield shall be helically applied copper tape or concentrically and evenly spaced #22 AWG solid uncoated copper wires meeting requirements of ICEA Section 6.
 - e. Separator Tape. A suitable separator shall be applied over the cable shielding system.
 - f. Jacket. A polyvinyl chloride jacket shall be applied overall. This jacket shall meet the requirements of Section 7 of ICEA and the Sunlight Resistant requirements of UL Standard 1072. The average thickness of the jacket shall be as specified in Section 7 of ICEA. The minimum thickness at any point shall be not less than 80 percent of that specified.
- 16D.5 IDENTIFICATION. Cable shall be identified by means of surface ink printing indicating manufacture, conductor size, insulation type, voltage rating, UL designations, and year of manufacture.
- 16D.6 TESTS. Cables shall be tested in accordance with ICEA S-93-639/NEMA WC74 and UL Standard 1072.
- 16D.7 DATE OF MANUFACTURE. Year of manufacture of all cable shall be no earlier than one calendar year immediately preceding contract award date.
- 16D.8 PACKAGING. All cable shall be provided on wooden or steel reels, and ends of all cable shall be sealed to prevent entry of moisture. All reels shall identify type, length, and year of manufacture of cable packaged on such reels. All such identification shall be clearly provided by the manufacturer.
- 16D.9 SUBMITTALS. Prior to installing any cable specified herein, the Contractor shall submit the following documents, for the specific cable that the Contractor proposes to use, to the Contracting Officer, and receive approval therefrom for its use (see Paragraph 1A.4 above):

- a. Manufacturer's complete cable specifications, including compliance to all cable requirements, codes, and standards referenced herein and drawing showing cable construction details.
- b. Manufacturer's recommended practices for maximum cable pulling tensions and minimum bending radii.

DIVISION 16 - ELECTRICAL
SECTION 16E
CONTROL CABLE

16E.1 SCOPE. This section covers the material requirements for all Contractor furnished exterior standard and gopher-resistant filled control (telephone) cable to be installed as shown on the Drawings. Installation of control cables is covered in Section 16F.

16E.2 GENERAL REQUIREMENTS.

- a. Definition. The term "control cable" used throughout these Specifications and on the project drawings is a general FAA term for cable used to transmit voice and control functions. The required cable is termed "telephone" or "telephone exchange" cable by the cable manufacturing industry.
- b. Quality. All control (telephone) cables shall be the standard products of a single major cable manufacturer and shall be designed and manufactured according to the highest industry standards. All cables shall be free of any imperfection which could affect serviceability and design life.

16E.3 APPLICABLE SPECIFICATIONS.

- a. United States Department of Agriculture, Rural Utilities Service (RUS), Specification REA Bulletin 1753F-205 (PE-39) for "Filled Telephone Cable" latest edition, including all addendums and attachments thereto, forms a part of these Specifications and is applicable in its entirety.
- b. Certain requirements, specified herein, supplement the requirements of Specification REA Bulletin 1753F-205 (PE-39), and shall receive special attention by the cable manufacturer and Contractor.
- c. Cable conforming to Specification REA Bulletin 1753F-208 (PE-89) is an acceptable substitute for PE-39 cable. For purposes of brevity, only the standard cable construction for PE-39 cable is specified herein.

16E.4 STANDARD CABLE CONSTRUCTION. Cable characteristics shall include the following materials and construction.

- a. Conductors. #19 AWG solid annealed copper.
- b. Conductor Insulation. Solid polypropylene or polyethylene color coded in accordance with telephone industry "standard" coding.
- c. Twisted Pairs. Individual conductors twisted into pairs with varying lays to minimize crosstalk.

- d. Forming of Cable Core. Cables having 25 pairs or less are assembled into a single cylindrical group. Cables having more than 25 pairs are assembled in units, each individually identified by color coded unit binders.
- e. Filling Compound. Water resistant non-hardening compound to fill and seal all interstices between the conductor pairs.
- f. Core Covering. Non-hygroscopic dielectric tape.
- g. Flooding Compound. Water resistant and bonding compound to fill all voids between the core wrap and shield and between the shield and jacket.
- h. Shield. Corrugated electrically continuous and longitudinally applied 0.008 inch coated aluminum or 0.005 inch copper.
- i. Jacket. High molecular weight polyethylene or high-molecular weight ethylene copolymer.

16E.5 GOPHER-RESISTANT CABLE CONSTRUCTION.

- a. General. If gopher-resistant cable is required by drawings or special Specifications, cable construction shall comply with all construction requirements for standard cable in Subsection 16E.4 above (including conformance with RUS Specification REA Bulletin 1753F-205 (PE-39) except for Item h, "Shield", which shall comply with the following:
- b. Gopher-Resistant Shield. Corrugated electrically continuous and longitudinally applied overlapping metal shield consisting of one of the following materials:
 - (1) 0.010 inch copper.
 - (2) 0.006 inch copper/stainless steel/copper bimetallic alloy.
 - (3) 0.007 inch Alloy 194 for 6 pr #19 cable.
 - (4) 0.006 inch Alloy 194 for cables larger than 6 pr #19.
 - (5) 0.008 inch coated aluminum with 0.006 inch coated steel.

16E.6 CABLE IDENTIFICATION. In accordance with Specification REA Bulletin 1753F-205 (PE-39), all cable shall have jacket printed at periodic intervals with the name of the manufacturer, manufacturer's standard designation, year of manufacture, number of pairs, conductor gauge, sequential length marks, and notation signifying compliance with the specification (if not clearly referenced in the manufacturer's submittals). In addition, the gopher-resistant shield shall be clearly identified.

16E.7 DATE OF MANUFACTURE. Year of manufacture of all cable shall be no earlier than one calendar year immediately preceding contract award date.

16E.8 PACKAGING. In accordance with Specification REA Bulletin 1753F-205 (PE-39), all cable shall be stored and shipped on reels affording the required protection. Thermal wrapping shall be provided and ends of all cables shall be capped against exposure to moisture. All reels shall be labeled by the manufacturer and shall bear the manufacturer's name, year of manufacture, REA cable designation, description of cable, actual shipping length, and identification referenced to tests of record as required herein.

16E.9 TESTS.

- a. All project cable furnished shall satisfy all test requirements of Specification REA Bulletin 1753F-205 (PE-39). Records of all such tests shall be retained by the manufacturer, and shall be promptly made available to the Federal Aviation Administration upon request. All tests shall be specifically and clearly referenced to all reels of cable furnished.
- b. Basic cable design, for all project cable furnished, shall have proven acceptable to RUS through "qualification testing" according to their specification.
- c. Electrical tests, according to their specification, shall be performed on 100 percent of all project cable furnished.
- d. Quality assurance (capability) tests, according to their specification, shall be performed on such periodic production basis so as to represent quality of all project cable furnished.

16E.10 SUBMITTALS. Prior to procuring any cable specified herein, the Contractor shall submit the following documents for the specific cable that the Contractor proposes to use, to the Contracting Officer, and receive written approval therefrom (see Paragraph 1A.4 above):

- a. Manufacturer's complete cable specifications, including manufacturer's statement of compliance with REA Specification PE-39 or Pe-89.
- b. Drawing showing cable construction details.

DIVISION 16 - ELECTRICAL
SECTION 16F
CABLE INSTALLATION

16F.1 DESCRIPTION OF WORK. The extent of work is indicated on the drawings and by the provisions of this section. Included in this section are installation, splicing, and testing of power and control cables.

16F.2 GENERAL REQUIREMENTS.

- a. Service Interruptions. Existing sources of power and control are indicated on the drawings. For circuits actively in use, the Contractor shall coordinate temporary interruptions of service with users and suppliers, the COR, and the airport management.
- b. Precautions. The Contractor shall take all reasonable precautions to protect existing underground equipment and utilities such as fuel tanks, water lines, and buried control and power cables. All known FAA power and control cables leading to and from any operating facility will be marked in the field by the COR for the information of the Contractor before starting work in the general vicinity. The Contractor shall contact utility companies and the airport sponsor for the location of existing utility lines and airport sponsor cables. Thereafter, through the entire construction period, buried equipment and utilities shall be protected from damage. The Contractor shall immediately repair, with equal material, by skilled workmen, any underground cables damaged by contract workers, equipment, or work. Prior approval from the Contracting Officer shall be obtained for the materials, workers, time of day or night, methods of repairs, and for any temporary or permanent repairs the Contractor proposes to make. Upon completion, any repair work shall be inspected and approved by the COR with the concurrence of the affected utility company or airport sponsor.
- c. Cable Protection.
 - (1) All cable ends which will be exposed to weather, water, ground, or corrosive environment prior to termination, shall be sealed against these elements while awaiting termination or splicing. This requirement also applies to all cable ends in manholes or handholes. The sealing material shall be properly sized, easily removable heat shrinkable end caps, or electrical tape, with an application of brushed-on electrical coating.

- (2) Cables shall not be bent at radii less than radii recommended by the manufacturer, or 10 times cable diameter (12 times diameter for armored cable), whichever is greater. Any cables damaged in any way by sharp bending shall be replaced.
- (3) Special care should be taken when working with filled cables, especially when the temperature is below 35°F. This type of cable becomes more difficult to bend and work as the temperature decreases, and there is a possibility of cable damage at temperatures near 0°F.

d. 600-Volt Wire and Cable Color Coding.

- (1) All single conductor 600 volt wire and cable for 120/240 volt power circuits shall be color coded black for line 1, red for line 2, and white for the neutral.
- (2) For conductor sizes smaller than #8 AWG, conductor insulation shall be color coded. For sizes #8 AWG and larger, and for armored power cable, colored tape shall be used to identify the conductors if insulation is not color identified.
- (3) Conductors shall be color-coded in junction boxes, square duct, terminal boxes, or any other place accessible to view. In no case shall green be used for other than grounding, nor white for other than the system grounded (neutral) conductor.

e. Cable Lengths.

- (1) Wherever possible, cable shall be run in one piece, without splices, from connection to connection. The number of splices shall be minimized. If the job plans do not include a schedule for laying each reel of cable, the Contractor shall provide such a plan for approval to the Contracting Officer prior to installing any of the cable. The plan shall be predicated on the use of the longest practicable lengths of cable to minimize splicing requirements.
 - (a) When cable cutting is required, cable ends shall be effectively sealed against moisture immediately after cutting. The method of sealing shall be approved by the COR. Bands of a radius less than eight times the diameter for rubber-covered or plastic-covered cable, or twelve times the diameter for metallic armored cable shall not be made. Cable that has been kinked shall not be installed.

- (b) When unreeling, an observer shall be stationed at the reel to report any cable irregularities. Unless specifically stated in the plans, non-armored cable shall be used in duct and armored cable used for direct-earth burial. Non-armored coaxial and series lighting cable may be direct earth buried when not otherwise specified. Grounding conductors, where required, shall be #6 AWG bare copper wire, minimum.
- f. Workmanship. All work shall be done by experienced personnel regularly engaged in this type of work. All cable splices shall be performed only by experienced and qualified cable splicers. Before any cable splices are made, the Contracting Officer may request a sample splice be made for approval.

16F.3 DIRECT-EARTH BURIAL CABLE INSTALLATION.

- a. Installation Method. Direct-earth burial cables shall be installed either by the trench and backfill method or by the cable plowing method in accordance with all the requirements specified herein.
- b. General Requirements.
 - (1) Underground cables shall be installed in straight lines between terminating locations or points of directional change.
 - (2) Unless otherwise specified, cables shall be installed a minimum of 24 inches and 36 inches below finished grade on airport property and off airport lands, respectively. When cable is routed under railroad tracks, it shall be in rigid-steel conduit or concrete encased duct with the top of the duct not less than 42 inches below the base of the rail.
 - (3) The Contractor shall prepare a schedule for installing each reel of underground cable and shall submit it to the COR for approval before installing any cable. The plan shall be predicated on use of the longest practical lengths of cable, in order to minimize splicing.
 - (4) A cable loop of at least 3 feet shall be left on each and of every cable run, on at least one side of every splice, and at all points where cable is brought above ground. A 3-foot minimum surplus cable length shall be left on both sides of splices in handholes and light bases. The slack loop shall be installed with the same minimum depth requirements as the cable run. Where cable is brought above ground, enough additional slack cable shall be left to make the required connections.
- c. Trench and Backfill Installation Method.
 - (1) Comply with all trenching, backfilling, compaction, and restoration requirements in Division 2.
 - (2) Where turf is well established and sod can be removed, it shall be carefully stripped and properly stored. The Contractor shall excavate all trenches for direct earth burial cable as follows:
 - (a) At the depth specified in Paragraph 16F.3.b(2) above.
 - (b) To a width of not less than 6 inches for a single or multiple runs of power, or control and signal cable.

- (c) To a width and depth which will provide horizontal or vertical separation of power cables as specified in Paragraph 16F.3.f from other power cables of different voltage ratings, or from any power cable and any control or signal cable.
 - (d) Unless otherwise specified, all cables in the same location and running in the same general direction shall be installed in the same trench. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. The bottom surface of trenches shall be essentially smooth and free from coarse aggregate. Unless otherwise specified, trenches shall be opened only for the time required to install and inspect cables. The trench shall be closed in the same working day.
- (3) Where rock is encountered, it shall be removed to a depth of 3 inches below the required cable depth, and shall be replaced with a bedding material of earth or same containing no mineral aggregate particles that would be retained on a 1/4 inch sieve. When a ledge is encountered, the COR shall be consulted regarding alternatives such as re-routing, transition to overhead lines, or installation in rigid steel conduit.
 - (4) The Contractor shall unreel the cable adjacent to or over the trench and manually place it in the trench. Do not pull the cable into the trench or drag it along the trench.
 - (5) Where more than one cable is installed in the same trench, maintain separation as hereinafter specified. Multiple cables shall be installed in the same relative positions throughout the cable trench. Cables shall not be stacked, crossed or intertwined in any manner.
 - (6) After underground cable has been installed, the trench shall be backfilled. The first layer of backfill shall be 3 inches deep, loose measurement, and shall be either earth or natural sand containing no material aggregate particles that would be retained on a 1/4-inch sieve. This layer shall not be compacted. The second layer shall be 9 inches deep, loose measurement, and shall contain no particles that would remain on a 1-inch sieve. The remainder of the backfill shall be excavated or imported material and shall not contain stone aggregate larger than 4 inches maximum diameter. The second and subsequent layers shall be thoroughly tamped and compacted to at least the density of the adjacent undisturbed soil and to the satisfaction of the COR.

- (7) Trenches shall not be excessively wet and shall not contain pools of water during backfilling operations. Trenches shall be completely backfilled and tamped level with the adjacent surface. If necessary to obtain the desired compaction, backfill material shall be moistened or aerated. When sod is to be placed over a trench, backfill shall be stopped at a depth equal to the thickness of the sod to be used. Any excess excavated material shall be removed in accordance with instructions from the COR.
- d. Restoration. Where sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by the trenching, storing of dirt, cable laying, pad construction, and other work shall be restored to the original condition. Restoration shall include any necessary grading, fertilizing, liming, seeding, sodding, sprigging, or mulching as required to restore the disturbed area to match the adjacent area. Where trenching cuts through paved area, the surface shall be properly backfilled and resurfaced with paving similar to the original paving. Resurfaced areas shall be level with original paving, free from cracks and capable of withstanding full traffic loads without settling or cracking. The Contractor shall be held responsible for maintaining all disturbed and restored surfaces until final acceptance.
- e. Cable Plowing Method.
 - (1) Vibratory cable plowing equipment, adequate for installation of the types of cables to be installed and for the depth required, may be used, provided that soil conditions are suitable, equipment is in good working order, and proper installation procedures are utilized.
 - (2) While cable is being plowed into place, one person in addition to the operator of the plowing vehicle shall be present to assure that the cables do not kink or bind tightly while entering the plow.
 - (3) If, during plowing operations, it appears that the soil contains sharp objects, rocks over 2 inches in diameter, or any other hazard to the cable, plowing shall be discontinued, and the COR notified. The COR shall determine whether plowing will be allowed to continue, or whether another cable placement method shall be used.
 - (4) The slice left by the plow shall be closed by tamping or other approved method, after cable placement, to minimize the disturbance of the surface by the slice.

f. Cable Separation - Direct Burial.

- (1) Where new buried power cables cross over or under control or telephone cables, power cables shall be installed in a length of PVC duct extending two feet each side of the crossing. Minimum separation shall be twelve inches.
- (2) Power cables of the same circuit may be laid together in the trench without separation, except as noted below. Series lighting cables may be considered being of the same circuit.
- (3) Power cables, or the same or different circuits of less than 600 volts, may be laid together in the same trench without separation.
- (4) All power cables, 5,000 volts and below, shall be separated from all control, telephone, and coaxial type cables by a minimum of 6 inches.
- (5) Power cables of more than 5,000 volts, shall be separated from all other cables by a minimum of 12 inches.
- (6) Control and signal cables may be installed without separation from each other.

g. Cable Guard Wires. Guard wires shall be provided in accordance with the grounding requirements of Paragraph 16A.5.e above.

16F.4 CABLE INSTALLATION IN UNDERGROUND DUCTS AND CONDUIT.

a. General. All underground ducts shall be:

- (1) Rigid-steel conduit (heavy wall) conforming to UL 6, or
- (2) Rigid non-metallic conduit (duct) conforming to UL 651 and NEMA TC 2.

b. Conduit Burial. Rigid-steel conduits may be direct earth buried. Rigid non-metallic conduits shall be concrete encased.

- c. Duct Size, Material, and Installation. Ducts shall be of the size, material, and type indicated on the Drawings or Specifications. Standard precast spacers shall be used for duct support and alignment. Where no size is indicated on the Drawings or Specifications, the ducts shall not be less than 4 inches inside diameter. All duct lines shall be laid to slope toward handholes, manholes, and duct ends for drainage. Grades shall be at least 3 inches per 100 feet. On runs where it is not practicable to maintain the slope all one way, the duct line shall be sloped from the center in both directions toward manholes, handholes, or duct ends. Pockets or traps where moisture may accumulate shall be avoided.
- d. Access Penetrations. Where a steel conduit penetrates a wall of a manhole or handhole, a grounding bushing shall be provided. These grounding bushings shall be connected to each other and to the earth ground system with #6 AWG bare copper conductors.
- e. Mandrel Requirements. The Contractor shall mandrel each duct he installs and each existing duct in which he installs or replaces cable. An iron-shod mandrel, not more than 1/4-inch smaller than the bore of the duct, shall be pushed through each duct with jointed conduit rods. The mandrel shall have a leather or rubber gasket slightly larger than the duct hole.
- f. Spare Ducts. All spare ducts installed by the Contractor shall be provided with #10 AWG copper-clad steel pull wires or polyolefin pull lines with a minimum tensile strength of 200 pounds. The open ends of the spare ducts shall be sealed with removable tapered plugs of a type recommended by the duct manufacturers. The plug shall be adapted to firmly secure the pull wire.
- g. Duct Protection. All ducts shall be securely fastened in place during construction and progress of the work, and shall be plugged to prevent seepage of grout, water, or dirt. Any duct section having a defective joint shall not be installed. Trenching for ducts shall be in accordance with Paragraph 16F.3 of this Specification.

- h. Ducts Encased in Concrete. Concrete-encased duct shall be installed so that the top of the concrete envelope or conduit is not less than 18 inches below the bottom of paving when installed under runways, taxiways, and other paved areas; and not less than 18 inches below finished grade when installed in unpaved areas.

All concrete encased ducts shall be placed on a layer of concrete not less than 3 inches thick prior to its initial set. Where two or more ducts are encased in concrete, the Contractors shall space them not less than 1-1/2 inches apart (measured from outside wall to outside wall) using spacers applicable to the type of duct. As the duct laying progresses, concrete not less than 3 inches thick shall be placed around the sides and top of the duct bank. End bells or couplings shall be installed flush with the concrete encasement where required. Interlock spacers shall be used every 5 feet to insure a uniform spacing between ducts. All bottom spacers shall be secured to 1-inch by 3-inch boards to prevent sinking and overturning. All joints in adjacent ducts shall be staggered a minimum of 24 inches apart and shall be made completely waterproof prior to concreting.

- i. Ducts Without Concrete Encasement. Underground ducts shall be installed so that the tops of all such ducts are at least 18 inches below finished grade. Underground ducts, except rigid steel conduit, shall not be installed under paved areas, roadways, railroad tracks, or ditches. Trenches for single-duct lines shall be not less than 6 inches nor more than 12 inches wide, and the trench for two or more ducts installed at the same level shall be proportionally wider. Trench bottoms for ducts without concrete encasement shall be made to conform accurately to grade to provide uniform support for the duct along its entire length. A 3-inch layer of bedding material shall be placed around the ducts. The bedding material shall contain no particles that would be retained on a 1-inch sieve. The bedding material shall be tamped until firm. When two or more ducts are installed in the same trench without concrete encasement, they shall be spaced not less than 2 inches apart (outside wall to outside wall) in a horizontal direction or not less than 6 inches apart (outside wall to outside wall) in a vertical direction.
- j. Guard Wires. Ducts, whether encased or not encased, which contain cables that are not routed in ferrous conduit, shall be provided with a guard wire in accordance with the grounding provisions of Paragraph 16A.5.e above.

k. Installation Equipment. Major equipment items, required for installing cable in underground ducts, shall include the following:

- (1) Power winch.
- (2) Cable feed-in tubing guide capable of producing a uniform and rigid 3 and 4-foot and greater radius bend, and having a nominal diameter equal to that of the ducts.
- (3) Single pulleys or sheaves providing a minimum cable bending radius (not overall sheave radius) of 10 times the largest cable diameter. Such sheaves shall be used for minor cable bends within "through cable" manholes and at feed-in manhole rims (if necessary). Sheaves shall have ball or roller bearings.
- (4) Adjustable gang pulleys with three or more pulleys capable of producing up to a 4-foot smooth cable bending radius. Each pulley shall have minimum cable bending radius of 10 times the largest cable diameter.
- (5) Lubrication equipment to pre-lubricate ducts, cables at guide-in tubing, and cables at intermediate pull-through manholes.
- (6) Cable reel support equipment including stands, arbor, and braking mechanism.
- (7) Dynamometer for measuring pulling tensions.
- (8) Communications equipment.
- (9) Pulling ropes or cords having the following characteristics:
 - (a) A working strength at least equal to the maximum allowable cable tensions as specified herein. "Working strength" is normally 10 to 14 percent of published rope "breaking strength."
 - (b) Rope or cord shall be a twisted or braided synthetic fiber unaffected by water and having a low level of elongation under load. Material shall have a texture non-injurious to plastic duct when pulled against bends. Wire rope, if proposed, shall have a smooth and rigidly adhering synthetic material covering.

(c) All pulling ropes or cords shall have swivel devices at cable attachment ends.

- (10) Cable lubricant specifically manufactured for electrical and control (telephone) cables. Do not use soap lubricants or those containing soap which are harmful to polyethylene- sheathed cables.
- (11) Cable pulling devices (secured to ends of cable as specified below).

1. Cable Pulling Devices.

- (1) Pulling devices for securing cable to pulling rope shall be factory-installed pulling eyes, field-installed pulling eyes, or basket weave cable grips. All shall be provided with integral or separate swivels.
- (2) Factory-installed pulling eyes necessitate that each cable pulling segment be cut to length by the cable manufacturer. Greater tensions and longer pulling lengths can be used with factory pulling eyes for straight duct bank segments.
- (3) Field-installed pulling eyes for control cable shall be a 4-crimp series, sized to the cable. Power cable pulling eyes shall be a type secured to conductors and approved by the COR.
- (4) Basket weave cable pulling grips shall be carefully sized to the specific diameters of the cables to be installed. Use grips with a rotating eye feature for power and control (telephone) cables.

m. Duct Cleanout and Pre-Lubrication.

- (1) If any new or existing underground duct or conduit displays any evidence of contamination by soil or other foreign matter, such ducts or conduit shall be cleaned with a stiff bristle brush, swabbed, and flushed clean with water under pressure, before proceeding with cable pulling operations. Even a minor amount of soil or sediment in the bottom area of a duct will greatly increase the coefficient of friction and pulling tension required. With soil contamination, cable lubricant is of little value. Therefore, it is of utmost importance that conduit be cleaned prior to installation of cable.

- (2) It is the Contractor's responsibility to determine whether ducts designated for occupancy should be cleaned. The Contractor shall assume complete responsibility for any difficulties or damage to the cable in placing cable in ducts.
- (3) In addition to cable lubrication as specified elsewhere, all ducts to receive cables under this contract, shall be pre-lubricated using the same lubricant as for cables. Lubrication shall be thoroughly applied with applicators designed for this purpose. Lubrication on cable only, will rub off to a large degree, especially at duct bank offsets at manholes.

n. Setting Up Cable Reels and Apparatus.

- (1) The Contractor shall inspect cable reels for flange protrusions which could damage the cable sheath. Also, the Contractor shall inspect for any obstructions that could interfere with proper unwinding of the cable.
- (2) Careful control shall be exercised in the movement of cable reels. Where it is necessary to roll a reel to a desired location, it shall be rolled in the direction indicated by the arrows painted on the reel flanges. The reel shall not be allowed to tilt. A substantial runway of heavy planks should be employed where uneven ground conditions exist that may cause the reel to tilt. Where it is necessary to move a reel of cable with heavy equipment, a cable reel sling or equivalent should be used.
- (3) In conduit sections containing curves, the cable reel shall be set up at the manhole near the curve unless other conditions do not permit.
- (4) Cable reels shall be set up on the same side of the manhole as the conduit section in which the cable is to be placed. The reel shall be made level and brought into proper alignment with the conduit section so that the cable may be passed from the top of the reel in a long smooth bend at maximum radius into the duct without twisting and making more than a 90-degree bend. This is of utmost importance in handling filled type cable in temperature ranges of 35°F and lower. Under no circumstances shall the cable be pulled from the bottom of a reel.
- (5) It is essential that the cable reel be in proper alignment and level during the placing operation. Incorrect location of the reel will cause unnecessary binding which will result in uneven cable feed.

- (6) Do not permit adjacent turns of cable on the reel to stick together and cause binding as the cable is payed off the reel. Feed the cable by rotating the reel manually.
- (7) Other cable support equipment, such as pulleys, sheaves, and gang-pulley equipment shall be set up rigidly within intermediate manholes to smoothly guide cables to exiting ducts.
- o. Attaching Pulling Grips. All pulling grips shall be stretched onto the cables such that the entire lengths of the grip woven material will exert tension on the cable, thereby distributing stress. If the end of any cable grip (furthest from the cable end) does not grip as tightly as the lead end, secure same to cable with a steel banding. Inspect cable grips frequently, and the first pull of control (telephone) cable in particular (in the first intermediate manhole), to ascertain that this requirement is fulfilled. If any uneven gripping is evident, banding will be required for all remaining cable installation of the applicable cable type and size.
- p. Feeding and Pulling Cable.
 - (1) All cable shall be installed using methods that will prevent excessive and harmful stretching, twisting, and flexing of the cable. Such damaging treatment will mechanically weaken the cable and destroy the electrical properties immediately or in a short time.
 - (2) Cable may be pulled by hand or power winch. Pull rope shall be attached to cables with pulling eye or basket weave pulling grips (all equipped with swivels) for each cable pulled. Do not exceed maximum allowable pulling tension as hereinafter specified. Do not use cable manufacturer's maximum pulling tensions except for cable factory-installed pulling eyes.
 - (3) All splices shall occur in manholes only. Splices shall not be pulled into ducts or manholes.
 - (4) Cable feed-in tubing guide, same size as conduit, of suitable length shall be secured in the manhole between the cable reel and the face of the duct to protect the cable and guide it at the maximum possible smooth radius into the duct as it is payed off the reel.

- (5) A cable lubricator (funnel) shall be placed around the cable just ahead of the cable feed-in guide to facilitate lubrication of the cable. The quantity of lubricant shall conform to the lubricant manufacturer's recommendations.
- (6) Before starting to pull, check the equipment carefully to make sure that it is properly set up in order to minimize the chance of interruption once pulling has started. Tension shall be kept on both the cable reel and the pulling line at the start of the pull. Excessive slack and the twist of the pulling line may cause the connecting links to turn and catch in the duct. As far as possible, the cable shall be pulled in without stopping. A pulling speed of 80 to 100 feet per minute is recommended to minimize friction forces.
- (7) A person experienced with cable handling shall be posted continuously at the cable reel while pulling cable. In addition to braking the reels and observing cable lubrication, he shall carefully inspect cable paying off the reel for cable sheath and other defects. If defects are noticed, the pulling operation shall be stopped immediately and the COR promptly notified of the defect. Kinks and/or irregularities in the cable sheath shall be removed or corrected as directed by the COR.
- (8) Careful attention shall be paid to signals from the installation crew as the cable is being pulled so that pulling may be stopped instantly whenever necessary to avoid damage to the cable.
- (9) If for any reason the pulling operation is halted between manholes, the winch operator shall not release the tension on the winch unless directed to do so. In restarting the pulling operation, the inertia of the cable shall be overcome by gradually increasing the tension in steps a few seconds apart until the cable once again is in motion.
- (10) The leading end of the cable at intermediate manholes shall be guided into the duct and a feeder tube nozzle placed around the cable to prevent the cable from rubbing on the edge of the duct.
- (11) All pulled ends shall be examined for evidence of damage due to the pulling operation. The cable sheath shall not be pulled beyond the cable core. Notify the COR for inspection, and for repair or replacement action that must be taken where cracks or openings are

found in the cable sheath following the pulling operations.

- (12) Cable ends shall be kept sealed at all times using RUS approved cable end caps and electrical tape. After the cable has been placed, the exposed cable in the manholes should be wiped clean of cable lubricant with a cloth before leaving the manhole.
- (13) All individual cable segments shall be pulled in one direction only. Both ends of a cut cable segment shall not be introduced into an intermediate manhole and pulled in two different directions. Also, no cable segments shall be pulled out of any manhole and introduced into the same manhole for a continuation of a cable segment pull. These unacceptable pulling practices, used to avoid splicing, result in abrasion from dragging over ground surfaces and manhole frame, exposure to pedestrian and vehicular traffic, damage to cable layers from twisting and small bending radii when pulling cable loops through manhole frame. Shields of cables so pulled are almost always damaged.
- (14) Sidewall cable pressure from duct bends, feed-in tubes, and pulleys, frequently govern the length of cable that can be pulled. The greater the radii, the less the sidewall pressure. Therefore, the Contractor shall use the maximum radius at every manhole where a 90-degree pull is permitted. Adjustable gang pulleys with three or more pulleys shall be used for horizontal bends in manholes. Individual pulleys within the gang pulley device shall have a cable bending radius of minimum 10 times outside diameter of largest cable to be pulled. Width of pulleys shall be adequate to support the cable group to be pulled. Adjust gang pulleys to produce a smooth 90 degree curvature bend where such changes in direction occur.
- (15) If cables will be spliced in a manhole where duct banks enter and leave 90 degrees apart, separate cable segments shall be introduced into the manhole and pulled in different directions unless pulling is permitted around a horizontal gang pulley within the manhole.
- (16) Where more than one cable will be installed in a single duct, all shall be pulled into the duct concurrently.

q. Cable Spoil. All cable pulling ends shall be trimmed back to remove cable material always damaged by pulling eyes or basket weave pulling grips. To remove such spoil, cut each cable off a distance from the end equal to three times the length of pulling eye or twice the length of the basket weave pulling grip as a minimum. These amounts shall be cut off for all cables including those to be spliced or terminated by others.

r. Use of Dynamometer.

(1) The dynamometer shall be accurately calibrated and secured to properly indicate tension exerted on the cable. The dynamometer reading will usually give the resultant force exerted on the anchoring device, which shall be converted to the horizontal component to give correct value of pulling tension.

(2) Dynamometer readings shall be made only in the presence of the COR. If any pulling tension is approaching the maximum allowable, and if in the judgment of the COR, the allowable will be appreciably exceeded for the proposed run, pulling operations shall be immediately stopped, and the cable run spliced in the preceding manhole.

s. Maximum Cable Pulling Tensions. Maximum allowable cable pulling tensions, as measured by dynamometer, shall not exceed the following values for single cables. For multiple cables, add the tension values for the number of cables being pulled. Use a pulling rope having a working strength [not breaking strength, reference subsection 16F.4k(9)] at least equal to the "maximum allowable pulling tension" values below.

<u>Cable</u>	<u>Maximum Allowable Pulling Tension (lbs)</u>
1-1/C #8	125
1-1/C #6	200
1-1/C #4	325
1/1-C #2	500
1-6 PR #19	125
1-12 PR #19	250
1-25 PR #19	500

t. Separation of Cables Installed in Conduit or Duct.

(1) Power cables of the same voltage may be installed in the same duct.

(2) Power cables of less than 600 volts may be installed in the same duct.

- (3) Power cables of less than 600 volts shall not be installed in the same duct with control, telephone, or coaxial type cables.
- (4) Power cables of more than 600 volts shall not be installed in the same duct with control, telephone, coaxial, or power cables of less than 600 volts.
- (5) Control, telephone, and coaxial cables may be installed in the same duct.
- (6) Power cables may be installed in the same duct system as control and signal cables, but power cable shall be installed in a different duct separated a minimum of 3 inches (outside wall to outside wall) from ducts that encase control and signal cables. Power cables rated more than 600 volts shall be separated from control and signal cables to the maximum extent possible in the duct system.

u. Cable Installation in Manholes or Handholes.

- (1) Power and control cables shall be installed in separate manholes or handholes unless otherwise specified. If installed in same manhole, install power and control cables on opposite sides. At splice locations, use cable racks at different elevations to separate power and control cables.
- (2) Cable racking surplus shall be pulled back by hand into intermediate manholes. Pull surplus one manhole at a time beginning near both ends of cable segment. Do not use power winch unless permitted by the COR.
- (3) Cables shall be carefully routed around manhole interiors, taking all necessary precautions to prevent sharp bending. Cable racks shall be plastic or galvanized steel with properly sized porcelain insulators for the latter. Fasten all cables to plastic racks with nylon ties and to steel racks by means of the insulators.
- (4) Where a splice occurs, cable shall make one loop around , and the splice located near the center of the loop.
- (5) Where power and control cables are installed in the same manhole, the entire exposed length of all power and control (telephone) cables shall be fireproofed by applying fire and arc proofing tape.

16F.5 CABLE LABELING.

- a. All cables shall be labeled in each manhole and in each terminal cabinet with not less than two labels per cable, one near each duct entrance hole. Labels shall be attached to cables immediately after installation of each cable.
- b. Labels shall be military grade, pre-cut, heat-shrinkable flattened polyolefin and shall readily accept thermal transfer print. The product shall meet the material requirements and physical properties of AMS-DTL-23053/5C (Class 1 and Class 3). Label size shall be consistent with the manufacturer's maximum size for a particular cable size range, have a white background with 1/4-inch high black lettering, or the maximum size letters for labels that cannot accommodate the 1/4-inch height.
- c. Labels shall consist of an abbreviation of the facility served, e.g., "ASR", "VORTAC", "ALS", and abbreviations for all the types of cables installed, e.g. "P" for power, "C" for control, and "R" for radio frequency (coaxial). Where like multiple control cables are routed between the same facilities, further identify such cables throughout the run with a single-digit number following the letter "C". All individual-conductor power circuits shall be bundled under the same label as opposed to separate labels for each conductor.

16F.6 WARNING TAPE. Warning tape shall be placed 12 inches above cables that are installed by direct burial, and ducts both with and without concrete encasement. The tape shall be detectable warning tape, 3 inches wide, and yellow in color with the words "CAUTION BURIED CABLE LINE BELOW" printed on it..

16F.7 CABLE MARKERS. The location of direct earth-burial cables, and ducts both with and without concrete encasement, shall be marked at grade surface with concrete slabs, 2 feet square by 6 inches thick. These markers shall be placed every 200 feet along a cable run, at each change of direction of the cable, and at each cable splice. These markers shall be installed within 24 hours of the final backfill of the cable trench. Markers shall be installed flat in the ground with the top approximately 1 inch above the finished grade. After the concrete marker has set a minimum of 24 hours, the top surface shall be painted with bright orange paint manufactured specifically for uncured exterior concrete. Markers shall not be installed in concrete or asphalt surfaces. Each cable marker shall have the following information impressed upon its top surface:

- a. The word, "CABLE."
- b. Name of facility served, e.g., "ASR," "VORTAC," "ALS."
- c. Abbreviations for all the types of cables installed, e.g., "P" for Power, "C" for Control, and "R" for Radio Frequency (coaxial).
- d. An arrow to indicate the direction or change of direction of the cable run.
- e. Any additional information, as directed by the Contracting Officer.

Manholes and handholes shall be identified by "FAA POWER" or "FAA-CONTROL" markings on the covers. These markings shall be cast into steel covers, or die-stamped into a nominal 1/16 inch minimum thickness copper plate razed or fastened to the cover with a minimum of two 10-32 brass screws.

The Contractor shall obtain approval from the Contracting Officer for the information to be impressed on the cable markers and the method used to make the impressions. Letters shall be 4 inches high, 3 inches wide, and 1/2 inch deep.

16F.8 SPLICING.

a. General Requirements.

- (1) Splices shall be performed only by experienced and qualified cable splicers regularly engaged in this type of work.
- (2) Cable armor and/or shielding shall be bonded together across splices to provide continuous electrical paths.
- (3) Where a cable is cut preparatory to splicing, the work shall proceed without delay. When an unavoidable delay is encountered in completing a splice, the opened cable shall be protected to prevent the entrance of moisture and foreign matter.
- (4) Any splicing material (such as resin) older than the do-not-use-after date on the package, shall be replaced with new material at the Contractor's expense.
- (5) Unless otherwise specified, where multiple runs of single-conductor underground power cables are spliced, each single-conductor cable shall be spliced in a separate envelope.

- (6) Approved stress reduction methods shall be used in splicing all shielded high voltage power cables (5KV and higher voltage).
- b. Underground Power Cable Splices (600 Volts or Less). All low voltage splices shall be encapsulated in pressure resin in clear plastic envelopes, except as otherwise specified in Paragraph 13A.6 above, on drawings, or in special Specifications. All low voltage splices shall be made with compression connectors specified in Paragraph 13A.6 above, except as otherwise specified on drawings and in special Specifications.
- c. Underground Control (Telephone Cable) Splices.
- (1) Kit and Resin. The splices shall consist of a rigid polypropylene mold body with a built-in spacer web to provide cable centering and proper compound coverage. The mold body shall be filled with a flexible polyurethane electrical compound capable of continuous operation at 90°C, with an emergency overload temperature rating of 130°C. Splices must have provisions for inline splicing of shielded or non-shielded plastic or rubber-jacketed control (telephone) cables. The splices shall be rated for direct burial applications. For control cables with outside diameters between 0.25 inches and 3.25 inches, 3M Scotchcast Signal and Control Cable Inline Splicing kits of the 72N series are approved, as they are among kits which meet Specifications.
- (2) Connectors. Control cable splice connectors shall be in-line type, in which two conductors are spliced by laying one conductor in each end of the connector, and crimping the connector with a special tool selected to match the connector type and size. Before crimping, the connector is open on one side of its length. After crimping, the connector is closed all around its length. The connector bodies shall be made with a tin-plated phosphor bronze piece on the inside, to contact the cable conductors, and bonded polyester insulation on the outside, to insulate the connection. The insulation shall be color coded to denote wire size range. The cable splice connectors and tools shall incorporate the insulation displacement termination technique which uses a slotted, tin-plated contact to displace the conductor insulation, thus providing four redundant electrical contact points. Connectors which require pre-stripping the conductor shall not be used. AMP, Inc. (Harrisburg, PA) Picabond connectors sized for conductor size, and matching AMP tooling, are among products meeting the above Specifications, and are approved.

d. Submittals. See Paragraph 1A.4 above. If the Contractor

- (1) Intends to splice using materials different from those specified in Paragraphs b and c above, or
- (2) Intends to splice a 5KV or higher voltage power cable, then the Contractor shall submit to the Contracting Officer, shop drawings or catalog cuts for all splicing materials, tools, and dies. The Contractor shall splice no cables before he has received the Contracting Officer's approval of these items.

16F.9 CONTROL (TELEPHONE) CABLE TERMINATIONS.

a. Cable Routing and Support.

- (1) Cable jackets shall be removed within terminating enclosures such that no more than 2 inches of jacket material is visible within the enclosures. Ground shielding and armor as specified below.
- (2) Exposed cable conductor bundles shall be lock-stitched laced together with nylon lacing twine spaced at approximate 5/8- inch intervals. Each bundle shall contain maximum 25 pairs of conductors which shall be neatly routed and secured to backing panels with nylon clamps.

b. Cable Pair Terminations.

- (1) Terminated pairs shall have the same sequence on each terminal strip. (For terminal block Specifications, see Paragraph 16A.19, above.) The color code termination sequence on the terminal strips shall be in accordance with the following schedule. The white mates shall start at the top or left-hand side of the terminal block with color continuing down or across the block according to the following schedule:

MATE COLORS

WHITE

"

"

"

"

RED

"

"

"

"

BLACK

"

"

"

"

YELLOW

"

"

"

"

VIOLET

"

"

"

"

PRIMARY WIRE COLORS

BLUE

ORANGE

GREEN

BROWN

SLATE

BLUE

ORANGE

GREEN

BROWN

SLATE

BLUE

ORANGE

GREEN

BROWN

SLATE

BLUE

ORANGE

GREEN

BROWN

SLATE

BLUE

ORANGE

GREEN

BROWN

SLATE

- (2) When cables do not have the preceding color code, like pairs shall be terminated in the same sequence at both ends of the cable.

16F.10 CABLE ARMOR AND SHIELD GROUNDING.

a. Grounding Locations.

- (1) Control cable armor and/or shielding shall be grounded at both ends of each cable run. Ground unused pairs of control cable at both ends.
- (2) Power cable armor shall be grounded at both ends of each cable run.
- (3) Shielding and armor of control and power cables shall not be grounded at splice locations.

b. Grounding Procedures.

- (1) Use #16 AWG stranded copper grounding conductors for grounding shielding and armor. Secure grounding conductors to shielding and armor by using UL-approved grounding connectors specifically designed for this purpose. Neatly tape ends of butted cable to conceal the connections.
- (2) Attach crimp-type lugs of proper size to free ends of grounding conductors, and secure lugs to enclosure interior wall with a machine screw and nut.

DIVISION 16 - ELECTRICAL
SECTION 16G
CABLE TESTING

16G.1 DESCRIPTION OF WORK. The extent of work is indicated on the drawings and by the provisions of this section. Included in this section are testing of power, control, and coaxial cables.

16G.2 GENERAL REQUIREMENTS.

- a. Both before and after installation, all Contractor-furnished and Government-furnished power and control (telephone) cables shall be tested as required herein. Testing after installation shall be accomplished across splices.
- b. All testing shall be accomplished in the presence of the COR. Furnish two signed and dated copies of all test results, clearly tabulated for all segments of cable tested, to the COR.
- c. The Contractor shall use his own test equipment, which shall bear current calibration certification from a certified instrument calibration laboratory.
- d. Any measured values not conforming to specified values shall be cause for rejection of the defective cable installation. After repair or replacement, if so required by the COR, cable shall be retested and additional remedial work performed until satisfactory test results are obtained. All repair and replacement work shall be accomplished at no additional cost to the Government.

16G.3 INSULATED POWER CABLES, 600 V. Insulation-resistance measurements must be made with both ends of the insulated conductors disconnected from source and load terminals, arresters, and large surge protectors. Apply a 500-volt dc voltage to the conductors being tested with an insulation-resistance test instrument and read the insulation directly on the instrument meter scale. Apply the test voltage for at least 1 minute after the meter reading has stabilized, to allow even distribution of the test voltage throughout the insulation. Apply the test voltage between each insulated conductor and all other conductors, and between each insulated conductor and ground. Record the measured resistance. It shall be a minimum of 30 megahms.

- 16G.4 INSULATED POWER CABLES, 5kV. Insulation-resistance measurements must be made with the cable's insulated conductors disconnected on both ends. Apply 10kV dc voltage to the conductor being tested with an insulation-resistance test instrument. Where a 10,000 volt dc test instrument is not available, these tests may be performed at 500 volts dc using a 500 volt dc insulation-resistance test instrument. Apply the test voltage for at least 1 minute after the meter reading has stabilized, to allow even distribution of the test voltage throughout the insulation. Read the insulation leakage current directly from the instrument meter scale. Use the instrument calibration chart to determine the insulation resistance from the leakage current previously on the meter scale. Record the insulation resistance shown by the chart. Apply the test voltage between each insulated conductor and all other conductors in multiconductor cables, and between each conductor and ground. If the conductor-to-conductor or conductor-to-ground insulation resistance measurements of any conductor are below the minimum resistance value of 50 megaohms, part the cable at the splices and measure the insulation resistance of each cable section to isolate the current leakage path.
- 16G.5 APPROACH LIGHTING SYSTEM SERIES LOOP CABLE, 5kV. Apply a 10kV dc voltage to the cable being tested with an insulation-resistance test instrument, connected between one end of the cable and the substation ground. Where a 10,000 volt dc test instrument is not available, the test may be performed at 500 volts dc using a volt dc insulation-resistance test instrument. Apply the test voltage for at least 1 minute after the meter reading has stabilized, to allow even distribution of the test voltage throughout the insulation. Record the insulation resistance shown by the chart. If the cable fails to meet the 50 megaohm standard, sectionalize the loop to determine if the cable or isolation transformers have defective insulation.
- 16G.6 CONTROL CABLE TESTING. For continuity, shorts, crosses, and grounds testing, make these tests with both ends of each conductor disconnected from terminal strip jumper wires, surge protectors, and equipment. The tests should be as follows:
- a. Continuity Tests. Make continuity tests with an ohmmeter at the near end of the cable. Temporarily short each conductor to its paired conductor, common connector, or to a shield or armor, at the far end of the cable. Record the meter readings. Remove the temporary short at the far end of the cable after each conductor or conductor pair is tested for continuity.

- b. Shorts, Crosses, and Grounds Tests. Make the tests with an ohmmeter connected at either end of a cable. Test between all paired or unpaired conductors within a shielded or unshielded conductor group. Test between each conductor and its nearer designated grounding conductor, pair shield, group shield, cable shield, or armor.

For insulation-resistance measurements, apply a 500-volt dc test voltage to the conductors being tested with an insulation-resistance test instrument, and read the insulation resistance directly on the instrument meter scale. Apply the test voltage for at least 1 minute after the meter has stabilized. Apply the test voltage between paired conductors, between conductors of a conductor group, and between conductors of an ungrouped cable. Apply the test voltage between each conductor and its designated common grounded conductor, pair-shield, group shield, and overall cable shield or armor. The resistance shall be a minimum of 50 megohms.

16G.7 COAXIAL CABLE TESTING. Test new solid-dielectric coaxial cable for shorts, continuity, and dielectric resistance after installation as follows:

- a. Short-Circuit Test. Test the coaxial cable for a short circuit before the continuity test and dielectric-resistance measurements are made. Test a spliced cable for a short circuit before putting it into service. Disconnect both ends of the cable. Test before a connector is attached to both ends. The connectors are to be attached after the continuity test and dielectric-resistance measurements are completed. After the connectors are attached to the ends of the cable, repeat the short test to ensure that neither connector is shorted internally after attachment to the cable. The connectors are to remain on the ends of the cable for all performance tests thereafter. The test shall be made by connecting the high range of an ohmmeter between the center and outer conductors of the cable, and between the outer conductor and armor of armored cables. The meter needle may deflect toward the zero end of the ohms scale, then move slowly toward the infinite ohms end of the scale. This is caused by the ohmmeter battery voltage stress field being distributed throughout the cable dielectric.
- b. Continuity Test. Test the cable for continuity of its inner and outer conductors. If the test reveals an open conductor, the short-circuit test will have to be repeated after correcting the conductor break. Disconnect both ends of the cable. Unground the outer conductor if covered by a plastic outer jacket. Test before the cable connectors are attached to the ends.

- c. Dielectric Resistance Measurement. Test before the cable connectors are attached, then repeat the test after the connectors are attached. Apply the test voltage between the inner and outer conductor of the cable with an insulation-resistance test instrument. The test voltage should be 500 volts dc, and the minimum resistance shall be 50 megohms.

ATTACHMENT B

FAA-STD-019e

**LIGHTNING AND SURGE PROTECTION,
GROUNDING, BONDING AND SHIELDING
REQUIREMENTS FOR FACILITIES AND
ELECTRONIC EQUIPMENT**

FAA-STD-019e
December 22, 2005



DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION STANDARD

LIGHTNING AND SURGE PROTECTION,
GROUNDING, BONDING AND SHIELDING
REQUIREMENTS FOR FACILITIES AND
ELECTRONIC EQUIPMENT

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FOREWORD

All construction of Federal Aviation Administration (FAA) operational facilities and the electronic equipment installed therein shall conform to this standard. This document defines minimum requirements for all FAA facilities. When the specific needs of a facility exceed these minimum requirements, the facility shall be designed and installed to meet these specific needs. These needs are influenced by the equipment to be installed at the site, the configuration of the structures and location of the equipment, and by the physical environment present at the location.

The requirements contained in this document reflect investigation and resolution of malfunctions and failures experienced at field locations. The requirements thus are considered the minimum necessary to harden sites sufficiently for the FAA missions – to prevent delay or loss of service, to minimize or preclude outages, and to enhance personnel safety. Further, the requirements in the document have been coordinated with industry standards, and in some cases exceed industry standards where necessary to meet the FAA missions.

In this document the use of “shall” or verbs such as “construct”, “weld”, “connect”, etc indicates a requirement necessitating mandatory compliance. In cases when implementation of certain requirements is not technically feasible, a National Airspace System (NAS) Change Proposal (NCP) must be submitted with adequate justification and technical documentation and approved by the NAS Configuration Control Board (CCB) before a deviation is permitted.

This document is organized in accordance with MIL-STD-962D.

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1 SCOPE

1.1 Scope

This document mandates standard lightning protection, transient protection, grounding, bonding and shielding configurations and procedures and control of electrostatic discharge (ESD) for new facilities, modifications and upgrades to existing facilities, new equipment installations, and new electronic equipment used in the National Airspace Systems (NAS). It provides requirements for the design, construction, modification or evaluation of facilities and equipment. (It is recommended that the OPR of this document be contacted to obtain technical guidance on the applicability of the requirements to modifications, upgrades and new equipment installations in existing facilities.)

This document is not mandatory for programs that have been funded prior to the issue date of this document, nor is it mandatory for construction contracts associated with programs funded prior to the issue of the document. Application of this document is at the discretion of the user for programs that have been funded prior to the issue of the document. The Office of Primary Responsibility (OPR) can mandate the use of this document for programs started before the issue date of this document, if funding is provided.

The interface between contractor owned equipment or electronic equipment not used for operational purposes (administrative local area network (LAN), administrative telephone, etc.) and the operational facility shall be in accordance with this document.

1.2 Purpose

The requirements of this standard provide a systematic approach to minimize electrical hazards to personnel, electromagnetic interference and damage to facilities and electronic equipment from lightning, transients, ESD, and power faults.

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2 APPLICABLE DOCUMENTS

2.1 Government Documents

Due to the continuous updating of Government documents, the Contracting Officer and/or the Implementation Engineer must specify the version current at contract award or project design. These documents form a part of this standard and are applicable to the extent specified elsewhere in this document. If conflicts occur between these documents and the contents of this standard, the contents of this standard provide the superseding requirements.

FAA Specifications

FAA-C-1217	Electrical Work, Interior
FAA-G-2100	Electronic Equipment, General Requirements
NAS-SS-1000	Functional and Performance Requirements for the National Airspace Air Traffic Control Element

FAA Orders

Order 6950.19	Practices and Procedures for Lightning Protection, Grounding, Bonding and Shielding Implementation
Order 6950.20	Fundamental Considerations of Lightning Protection, Grounding, Bonding and Shielding

(Copies of these specifications, standards, orders, and other applicable FAA documents may be obtained from the Contracting Officer issuing the invitation-for-bids or request-for-proposals. Requests should fully identify material desired, i.e. specification, standard, amendment, drawing numbers and dates. Requests should cite the invitation-for-bids, request-for-proposals, the contract involved, or other use to be made of the requested material.)

Military Documents

MIL-HDBK-232	Revision A Red/Black Engineering-Installation Guidelines
MIL-HDBK-237	Electromagnetic Compatibility Management Guide for Platforms, Systems and Equipment
MIL-HDBK-253	Guidance for the Design and Test of Systems Protected Against the Effects of Electromagnetic Energy
DOD/MIL-HDBK-263	Electrostatic Discharge Control Handbook
DOD-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
MIL-HDBK-419	Grounding, Bonding, and Shielding for Electronic Equipment and Facilities
MIL-PRF-87893	Performance Specification, Workstations, Electrostatic Discharge Control

MIL-W-87893	Military Specification, Workstations, Electrostatic Discharge (ESD) Control
MIL-STD-461	The Control of Electromagnetic Interference Emissions and Susceptibility
MIL-STD-889	Dissimilar Metals
MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically Initiated Explosive Devices)
NACSIM 5203	Guidelines for Facility Design and Red/Black Installation (Confidential Document)

Single copies of Military specifications, standards, and handbooks may be requested by mail or telephone from Document Automation and Production Service Customer Service, Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D Philadelphia, PA 19111-5094 or via dodssp.daps.dla.mil. Not more than five items may be ordered on a single request; the Invitation for Bid or Contract Number should be cited where applicable. Only latest revisions (complete with latest amendments) are available; slash sheets must be individually requested. Request all items by document number.

2.2 Non-Government Documents

Due to the continuous updating of Non-Government documents, the Contracting Officer and/or the Implementation Engineer must specify the version current at contract award or project design unless a specific version is called out in the requirements of this standard. These documents form a part of this standard and are applicable to the extent specified herein. While this standard may exceed the requirements of the following documents, Nationally required practices shall always be performed as a minimum.

Electronic Industries Alliance (EIA)

EIA Standard EIA-625	Requirements for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices
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Requests for copies of EIA Standards should be addressed to Electronic Industries Alliance, Corporate Engineering Department, 2500 Wilson Boulevard, Arlington, VA 22201 or telephone 703 907-7500. www.eia.org

National Fire Protection Association (NFPA)

NFPA 70	National Electrical Code (NEC)
NFPA 77	Static Electricity
NFPA 780	Standard for the Installation of Lightning Protection Systems

Requests for copies of NFPA documents should be addressed to the National Fire Protection Association, One Batterymarch Park, Quincy MA 02269. www.nfpa.org

Underwriters Laboratories, Inc. (UL)

UL 96	Lightning Protection Components
UL 96A	Installation Requirements for Lightning Protection Systems
UL 779 (ANSI-A148.1)	Electrically Conductive Floorings
UL 1449	Transient Voltage Surge Suppressors

Requests for copies of UL documents should be addressed to Global Engineering Documents, 1500 Inverness Way, East Englewood, CO 80112. Telephone 303 397-7945, 800 854-7179. www.ul.com

Institute of Electrical and Electronic Engineers (IEEE)

ANSI/IEEE C62.41	Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits
ANSI/IEEE C62.45	IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits
ANSI/IEEE 1100	Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book)

Requests for copies of IEEE documents should be addressed to Institute of Electrical and Electronic Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-9916. www.ieee.org

Electrostatic Discharge (ESD) Association Documents

ESD ADV53.1	ESD Protective Workstations
ANSI/ESD S4.1	Worksurfaces – Resistance Measurements
ANSI/ESD S7.1	Floor Materials, Characterization of Materials
ANSI/ESD S8.1	Symbols – ESD Awareness
ANSI/ESD S11.11	Surface Resistance Measurement of Static Dissipative Planar Materials
ANSI/ESD S20.20	Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment
ANSI/ESD STM5.1	Sensitivity Testing, Human Body Model (HBM), Component Level
ANSI/ESD STM12.1	Seating - Resistive Measurement
ESD TR20.20	Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment – Handbook

Requests for copies of ESD Association documents should be addressed to the ESD Association, 7900 Turin Road, Bldg 3, Suite 2, Rome, NY 13440-2069. Telephone 315 339-6937. www.esda.org

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3 DEFINITIONS

3.1 Access Well

A covered opening in the earth using concrete, clay pipe or other wall material to provide access to an EES connection.

3.2 Air Terminal

That component of a lightning protection system specifically designed to accept lightning strikes.

3.3 Armored Cable

Power, signal, control or data cable having an overall armor or covering constructed of ferrous (steel) material that provides both structural protection and electromagnetic shielding for direct buried cables.

3.4 Arrester

Components, devices or circuits used to attenuate, suppress, limit, and/or divert adverse electrical (surge and transient) energy. The terms arrester, suppressor and protector are used interchangeably except that the term arrester is used herein for components, devices and circuits at the service disconnecting means.

3.5 Bond

The electrical connection between two metallic surfaces used to provide a low resistance path between them.

3.6 Bond, Direct

An electrical connection utilizing continuous metal-to-metal contact between the members being joined.

3.7 Bond, Indirect

An electrical connection employing an intermediate electrical conductor between the bonded members.

3.8 Bonding

The joining of metallic parts to form an electrically conductive path to assure electrical continuity and the capacity to conduct current imposed between the metallic parts.

3.9 Bonding Jumper

A conductor installed to assure electrical conductivity between metal parts required to be electrically connected.

3.10 Branch Circuit

The circuit conductors between the final overcurrent device protecting the circuit and the load served.

3.11 Building

The fixed or transportable structure which provides environmental protection.

3.12 Bulkhead Plate

A metallic plate located where conduits, conductor, waveguides etc first enter the facility. The bulkhead plate provides a central point for the grounding of conduits, conductors and waveguides entering the facility or structure.

3.13 Cabinet

An enclosure designed either for surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.

3.14 Cable

A fabricated assembly of one or more conductors in a single outer insulation. Types include axial, armored and shielded.

3.14.1 Cable, AC (not the same as armored (DEB) cable)

Type AC cable is a fabricated assembly of insulated conductors in a flexible metallic enclosure.

3.14.2 Cable, Armored Direct Earth Burial (DEB)

Cable with a ferrous shield designed to provide both physical and electromagnetic protection to the conductors.

3.14.3 Cable, Axial

Cable where all conductors are oriented on a single axis. Examples include coaxial, biaxial, and triaxial cables

3.14.4 Cable, Shielded

Cable with a metalized or braid shield to improve resistance to electromagnetic interference (EMI).

3.15 Case

A protective housing for a unit or piece of electrical or electronic equipment.

3.16 Catenary Wire

A catenary lightning protection system consisting of one or more overhead ground wires and supporting masts.

3.17 Chassis

The metal structure that supports the electrical or electronic components which make up the unit or system.

3.18 Clamp Voltage

Clamp voltage is the voltage that appears across the SPD terminals when the suppressor is conducting a surge or transient current.

3.19 Conductor, Bare

An electrical conductor that has no covering or electrical insulation.

3.20 Conductor, Insulated

An electrical conductor encased within material of composition and thickness recognized by the NEC as electrical insulation.

3.21 Conductor, Lightning Bonding (Secondary)

An electrical conductor used to bond a metal object, within the zone of protection and subject to currents induced by lightning strikes, to the lightning protection system.

3.22 Conductor, Lightning Down

The down conductor serves as the path to the earth grounding system from the roof system of air terminals and roof conductors or from an overhead ground wire.

3.23 Conductor, Lightning Main

The main conductors are the conductors intended to carry lightning currents between air terminals and ground terminations. These can be the roof conductors interconnecting the air terminals on the roof, the conductor to connect a metal object on or above roof level that is subject to a direct lightning strike to the lightning protection system, or the down conductor.

3.24 Conductor, Lightning Roof

Roof conductors interconnecting all air terminals to form a two-way path to ground from the base of each air terminal.

3.25 Crowbar

The term “crowbar” refers to a method of shorting a surge, voltage, or current using surge protective devices.

3.26 Earth Electrode System (EES)

A network of electrically interconnected rods, plates, mats, piping, incidental electrodes (metallic tanks, etc.) or grids installed below grade to establish a low resistance contact with earth.

3.27 Electromagnetic Interference (EMI)

Any emitted, radiated, conducted or induced voltage which degrades, obstructs, or interrupts the desired performance of electronic equipment.

3.28 Electronic Multipoint Ground System

An electrically continuous network consisting of interconnected ground plates, equipment racks, cabinets, conduit junction boxes, raceways, duct work, pipes, copper grid system, building steel, and other non-current-carrying metal elements. It includes conductors, jumpers and straps that connect individual items of electronic equipment to the SRP or MPG system.

3.29 Electronic Single Point Ground (SPG) System

An SPG signal reference network provides a single point reference in the facility for equipment that requires single point grounding. It consists of conductors, plates and equipment terminals, all of which are isolated from any other grounding system except at the main ground plate.

3.30 Enclosed Ferrous Cable Tray

A cable tray with steel sides and bottom with a steel cover or lid. This tray may have small holes and gaps.

3.31 Equipment Areas

Areas that contain electronic equipment used to support NAS operation. These include electronic equipment rooms, TELCO rooms, VORs, Radars etc.

3.32 Equipment Grounding Conductor

The conductor with the phase and neutral conductors used to connect non-current-carrying metal parts of equipment, raceways, and other enclosures to the system grounded conductor and/or to the grounding electrode conductors at the main service disconnecting means or at the point of origin (X_o bond) of a separately derived system.

3.33 Equipment

A general term including materials, fittings, devices, appliances, fixtures, apparatus, machines, etc, used as a part of, or in connection with, an electrical installation.

3.34 Facility Ground System

Consists of the complete ground system at a facility including the EES , SRP or MPG system, electronic single point ground system (SPG), equipment grounding conductors, grounding electrode conductor(s), and lightning protection system.

3.35 Faraday Cage

A closed conducting surface, such as wire mesh, completely surrounding an object or person so as to protect from impinging electromagnetic waves.

3.36 Feeder

All circuit conductors between the service equipment or the source of a separately derived system and the final branch circuit overcurrent device.

3.37 Ferrous Conduit

Material composed of and/or containing iron. Rigid Galvanized Steel Conduit (RGS) thick walled threaded conduit (NEC Rigid Metal Conduit (RMC)). For the purpose of this document, conduits not adequate for magnetic shielding include Electrical Metallic Tubing (EMT), Intermediate Metal Conduit (IMC) and conduits made from silicon bronze and stainless steel.

3.38 Fitting, High Compression

See “Pressure Connector”.

3.39 Ground

A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

3.40 Grounded Conductor

A system or circuit conductor that is intentionally grounded at the service disconnecting means

or at the source of a separately derived system. This grounded conductor is the neutral conductor for the power system.

3.41 Grounded

Connected to earth through a connection of sufficiently low impedance and having sufficient current carrying capacity so that fault current which occurs cannot build up to voltages dangerous to personnel.

3.42 Grounding Conductor

A conductor used to connect equipment or the grounded circuit of a wiring system to the grounding electrode system. (In this standard, grounding conductors not related to or not used as part of NEC required electrical system grounding, are used for the electronic equipment grounding system).

3.43 Grounding Electrode

Copper rod, plate or wire embedded in the ground for the specific purpose of dissipating electric energy to the earth.

3.44 Grounding Electrode Conductor

The conductor used to connect the grounding electrode to the equipment grounding conductor and/or to the grounded (neutral) conductor of the facility at the service disconnecting means or at the source of a separately derived system.

3.45 High frequency

All electrical signals at frequencies greater than 100 kilohertz (kHz), and pulse and digital signals with rise and fall times of less than 10 μ s are classified as high frequency signals.

3.46 Horizontal Transitions

Architectural term used to describe horizontal elements in a vertical structure (floors stair landings, etc.).

3.47 Jordan Dissipation Plate Design

Based on original design from W. Jordan FAA OKC.

3.48 Landline

Any conductor, line or cable installed externally above or below grade to interconnect electronic equipment in different facility structures or to interconnect externally mounted electronic equipment.

3.49 Line Replaceable Unit

Hardware elements whose design enables removal, replacement and checkout by organizational maintenance.

3.50 Low Frequency

Includes all voltages and currents, whether signal, control, or power, up to and including 100 kHz. Pulse and digital signals with rise and fall times of 10 μ s or greater are considered to be low frequency signals.

3.51 Main Service Disconnect

Main Service Disconnect is a switch, fused switch or circuit breaker that disconnects main service AC power (generally utility power) from a facility. Also referred to as Service Disconnecting Means (SDM).

3.52 National Electrical Code

A standard containing provisions that govern the use of electrical wire, cable, equipment and fixtures installed in buildings.

3.53 Operational Areas

Areas used to provide NAS support such as IFR rooms, ARTCC control rooms, ATCT tower cabs and operations control centers.

3.54 OPR

OPR is an acronym for Office of Primary Responsibility. The OPR is assigned to maintain and interpret this standard.

3.55 Overshoot Voltage

The fast rising voltage that appears across transient suppressor terminals before the suppressor turns on (conducts current) and clamps the input voltage to a specified level.

3.56 Pressure Connector

For purpose of this document, “FAA approved pressure connectors” shall be those that use hydraulically crimped terminations to effect closure.

3.57 Rack

A frame in which one or more equipment units are mounted.

3.58 Reference Plane or Point, Electronic Signal (Signal Ground)

The conductive terminal, wire, bus, plane, or network which serves as the relative zero potential for all associated electronic signals.

3.59 Rigid Metal Conduit (RMC)

A threadable raceway of circular cross section designed for the physical protection and routing of conductors and cables and for use as an equipment grounding conductor when installed with its integral or associated coupling and appropriate fittings.

3.60 RGS

See Ferrous Conduit.

3.61 Shield

A housing, shield, or cover which substantially reduces the coupling of electric and magnetic fields into or out of circuits or prevents accidental contact of objects or persons with parts or components operating at hazardous voltage levels.

3.62 Signal

Any electromagnetic transmission of information or control function. A signal can be analog, digital data or a control function such as a relay closure.

3.63 Standard Version

The applicable version of the standard is that issue in effect on the date of a contract signing.

3.64 Structure

Any fixed or transportable building, shelter, tower, or mast that is intended to house electrical or electronic equipment or otherwise support or function as an integral element of the air traffic control system.

3.65 Surge

An overvoltage or overcurrent of short duration occurring on a power line.

3.66 Susceptibility Level

The electronic equipment susceptibility level is the least of the damage, degradation, or upset levels considering all electronic components potentially affected by conducted or radiated transients.

3.67 Transient

An overvoltage or overcurrent pulse on a power, signal, control, or data line.

3.68 Transient Suppressor

Components, devices or circuits designed for the purpose of attenuating, absorbing and suppressing conducted transient and surge energy to protect facility equipment.

3.69 Turn-on Voltage

The voltage required across transient suppressor terminals to cause the suppressor to conduct current.

3.70 Zone of Protection

The zone of protection is that space adjacent to a lightning protection system that has a reduced probability of receiving a direct lightning strike.

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4 GENERAL REQUIREMENTS

4.1 Requirements Common to Both Facilities and Equipment

This section provides requirements that are established to ensure the proper operation of FAA facilities and equipment. The use of the term “facilities” in this document can differ from the manner in which it is frequently used in other FAA documents. In this document, physical proximity of equipment(s) defines a single facility, while physical separation would define separate facilities. For example, the cab and electronic/electrical equipment located on the junction and subjunction levels of an Airport Traffic Control Tower (ATCT) are a single facility. An ATCT with a base building containing electronic equipment is an example of two facilities located at the same site. Other examples of two or more facilities include the ARSR-4 (the tower and base building are separate facilities) and Air Route Traffic Control Centers (ARTCC) with multiple buildings that must be treated as separate facilities. An example of a single facility (for purposes of this document) is a Remote Controlled Air to Ground Site (RCAG) collocated in a VHF Omni-directional Range (VOR) building. Contact the Office of Primary Responsibility (OPR) of this document for specific guidance on new facilities/systems.

4.1.1 Bonding Requirements

4.1.1.1 Resistance of Bonds

Unless otherwise specified in this standard, all bonds shall have a maximum DC resistance of 1 milliohm when measured between the bonded components with a 4-terminal milliohmmeter.

4.1.1.2 Methods of Bonding

Bonding for electrical purposes shall be accomplished by a method that provides the required degree of mechanical strength, achieves the value of low and high frequency impedance required for proper functioning of the equipment. Soft soldered or brazed connections shall not be used for any part of the power grounding system, EES or the lightning protection system (air terminals, roof conductors, down conductors, fasteners, and conduit). Soft solder shall only be used to improve conductivity at joints already secured with mechanical fasteners. Soft solder shall not be used to provide mechanical restraint.

4.1.1.2.1 Exothermic Welds

Exothermic welds shall be allowed for any type of bond connection specified herein. Exothermic welds shall be used for all buried or subject to submersion connections. Where exothermic welds are not possible between certain materials, shapes, or in hazardous locations, i.e., near fuel tanks, where nearby objects are subject to damage, etc., connections using UL listed connectors shall be permitted. Exothermic welding shall be used for the permanent bonding of copper conductors to steel. Where the combustion products of a standard exothermic weld present problems, a smokeless exothermic process is commercially available and shall be used. All residual fluxes shall be removed or neutralized to prevent corrosion.

4.1.1.2.2 Welded Assemblies

Individual components of a welded assembly shall not require additional bonds between components if the DC resistance between individual components is less than 1 milliohm.

4.1.1.2.3 Dissimilar Metals

Mechanical bonds shall comply with Table I unless specifically approved by the OPR.

The legend shown below is for Table I and represents the four basic categories of possible metal interfaces.

no	Not suitable. This interface is highly likely to result in significant corrosion.
•	Suitable for indoor environments where temperature and humidity are controlled (non-condensing environment).
••	Suitable for all indoor environment.
•••	Suitable for all environments.

Table I. Mechanical Bonds Between Dissimilar Metals

METAL	Copper, solid or plate	Brass and bronze	Stainless Steel	Tin-plate; tin-lead solder	Aluminum, wrought alloys of the 2000 Series	Iron, wrought, gray or malleable, plain carbon and low alloy steels	Aluminum, wrought alloys other than 2000 Series aluminum, cast alloys of the silicon type	Aluminum, cast alloys other than silicon type, plated and chromate	Galvanized steel	Zinc, wrought; zinc-base die-casting alloys; zinc plated
Copper, solid or plate	•••	•••	••	•	•	•	no	no	no	no
Brass and bronze	•••	•••	••	••	•	•	•	no	no	no
Stainless Steel	••	••	•••	•••	•••	••	•	•	no	no
Tin-plate; tin-lead solder	•	••	•••	•••	•••	••	••	•	no	no
Aluminum, wrought alloys of the 2000 Series	•	•	•••	•••	•••	•••	•••	••	•	•
Iron, wrought, gray or malleable, plain carbon and low alloy steels	•	•	••	••	•••	•••	•••	•••	•	•
Aluminum, wrought alloys other than 2000 Series aluminum, cast alloys of the silicon type	no	•	•	••	•••	•••	•••	•••	•	•
Aluminum, cast alloys other than silicon type, plated and chromate	no	no	•	•	••	•••	•••	•••	••	•
Galvanized steel	no	no	no	no	•	•	•	••	•••	•••
Zinc, wrought; zinc-based die-casting alloys; zinc plated	no	no	no	no	•	•	•	•	•••	•••

4.1.1.2.4 Mechanical Connections

4.1.1.2.4.1 Coupling of Dissimilar Metals

Compression bonding with bolts and clamps should be used between metals having acceptable couples depending on the location as shown in

Table I. When the base metals form couples that are not allowed, the metals shall be coated, plated, or otherwise protected with a conductive finish. MIL-STD-889 provides specific information in this area.

4.1.1.2.4.2 Bolted Connections for Electrical Bonding

Bolts shall be used primarily as mechanical fasteners for holding the component members of the bond in place. Bolts shall be tightened sufficiently to maintain the contact pressures required for effective bonding but shall not be over-tightened to the extent that deformation of bond members occurs. Disc springs (Belleville spring washers) shall be installed on all bolted connections $\frac{1}{4}$ inches diameter and greater to prevent loosening. Bolted joints other than those intentionally used to attach bonding straps or conductors, shall not be used in lieu of dedicated bonding jumpers.

- a) All bolted connections $\frac{1}{4}$ inches diameter and greater shall conform to the torque requirements in Table II.
- b) All bolted connections in corrosive, damp, or wet locations, $\frac{1}{4}$ inches diameter and greater shall utilize stainless steel bolts, nuts, and load distribution washers to meet the strength requirements of same size SAE Standard J429 Grade 5. All other locations shall use corrosion inhibited SAE Standard J429 Grade 5 nuts and bolts. Load distribution washers shall comply with ANSI B18.22.1 for stainless steel washers, Wide Series, Type B.
- c) Bolted connections $\frac{1}{4}$ inches diameter and greater shall be assembled in the order shown in Figure I. Additional load distribution washers, if used, shall be positioned directly underneath the bolt head. Disc springs shall be between the nut and the load distribution washer. Washers shall not be placed between bonded members. Load distribution washers be wide Series, Type B.

Table II. Torque Requirements for Bolted Bonds

Bolt Size	Torque (ft-lbs)	Bolt Load (lbs)	Washers Required	Solon Part Number*
1/4 in.	10	2500	3	4-EH-70-301
5/16 in.	21	4000	3	5-EH-80-301
3/8 in.	34	5500	3	6-EH-89-301
7/16 in.	55	7500	6	7-L-70-301
1/2 in.	83	10,000	2	8-18-125-301
9/16 in.	117	12,500	N/A	N/A
5/8 in.	167	16,000	3	10-EH-150-177
3/4 in.	288	23,000	3	12-EH-168-177
7/8 in.	452	31,000	3	14-EH-168-177
1 in.	567	40,000	3	15-H-187-177

*Other manufacturers of disc spring washers are equally suitable

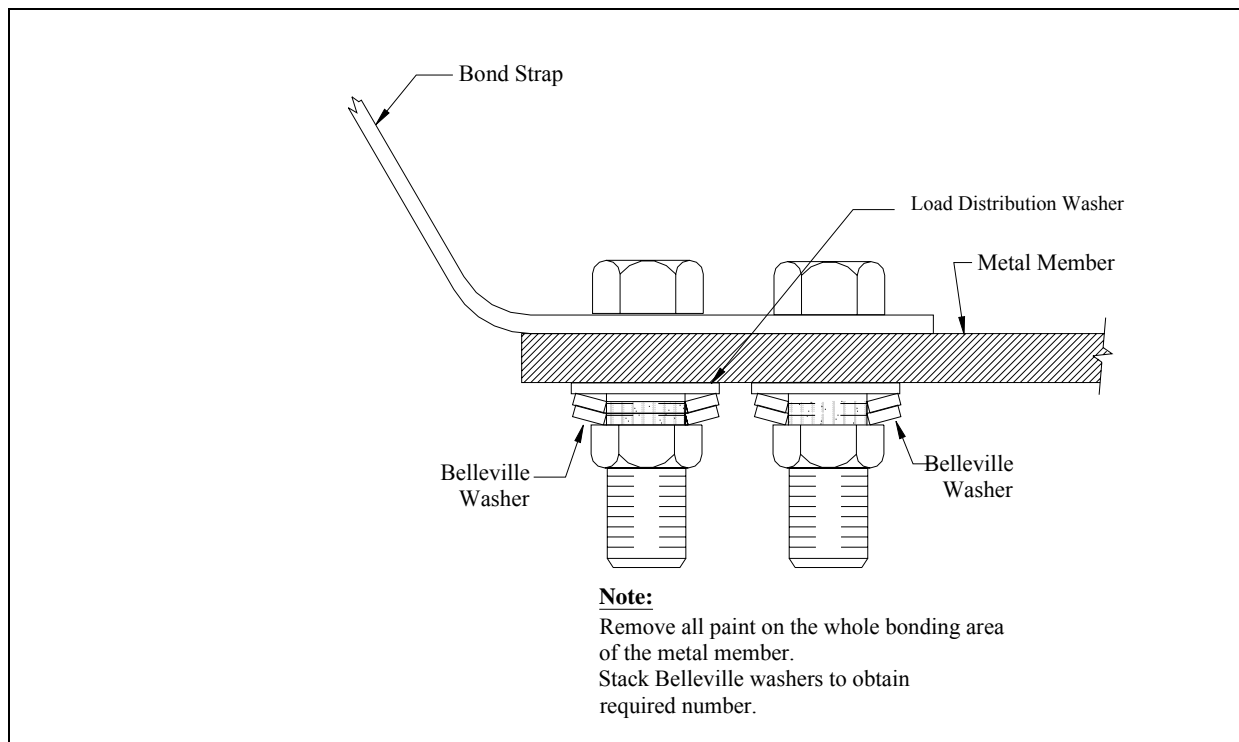


Figure I. Order of Assembly for Bolted Connections

4.1.1.2.4.3 Sheet Metal Screws

Sheet metal screws shall not be used to provide an electrical bond.

4.1.1.2.4.4 Hydraulically Crimped Terminations

Where crimped connectors are used for conductors 6 AWG or larger, the connectors shall be accomplished hydraulically using a minimum force of 12 tons concentrically applied.

4.1.1.2.4.5 Soldering

The use of silver solder to improve mechanical bonds by excluding contaminants from the mating surfaces shall be allowed. Mechanical bonds shall be mechanically secured prior to applying solder to prevent cold solder joints. Soldered mechanical connections shall not be used for any part of the power grounding system or the lightning protection system. See FAA Order 6950.20, Chapter 5, paragraph 99 for additional information.

4.1.1.2.4.6 Riveting

Rivets shall be employed solely as mechanical fasteners to hold multiple smooth, clean metal surfaces together or to provide a mechanical load bearing capability to a soldered bond.

4.1.1.3 Bonding Straps and Jumpers

Bonding straps, including jumpers, shall conform to the following:

- (a) Bonding jumpers shall be insulated except those used under a raised floor which shall be bare. Bonding jumpers for structural steel, rebar, connected to the EES, the lightning protection system, and any plenum or environmental airspace shall be bare also. Short bonding straps may be bare. (This requirement is to maintain compliance with the requirements of the NEC)
- (b) Bonding straps shall be attached to the basic component rather than through any adjacent parts.
- (c) Bonding straps shall be installed so that the electrical bond is not affected by motion or vibration.
- (d) Braided bonding straps shall not be used for bonding transmitters or other sources of radio frequency (RF) fields.
- (e) Bonding straps shall be installed whenever possible in areas accessible for maintenance and inspection.
- (f) Bonding straps shall be installed so they will not restrict movement of the components being bonded or other components nearby which must be able to move as part of normal functional operation.
- (g) Two or more bonding straps shall not be connected in series to provide a single bonding path.
- (h) The method of installation and point of attachment of bonding straps shall not weaken the components to which they are attached.
- (i) Bonding straps shall not be compression-fastened through non-metallic material.
- (j) Bonding straps shall be designed not to have resonant impedances at equipment operating frequencies. Two short, low-impedance grounding straps between the signal reference structure and two corners of the equipment should be used. These straps shall be connected as far apart as possible on the equipment (ideally on opposite corners) in order to reduce mutual inductance and they shall have few bends or sags. Two straps with a 20% to 30% difference in length should be used so that if one strap experiences resonance, limiting current flow, the other strap will not.
- (k) The length of the equipment bonding conductor connections shall be as short as possible and ideally be limited to 1/20th of a wavelength of the signal frequency, e.g., about six inches at 100 MHz.
- (l) Broad flat conductors, with a large surface area (at least one inch wide) shall be used for bonding straps since they have a lower inductance than round conductors. All bonding straps shall be fabricated with integral terminations that approximate the width of the strap, permitting proper terminations. Lower impedance can be achieved by multiple bonds.

4.1.1.4 Fasteners

Fastener materials for bonding aluminum and copper jumpers to structures shall conform to the materials listed in Table I.

4.1.1.5 Temporary Bonds

Alligator clips and other spring loaded clamps shall be employed only as temporary bonds while performing repair work on equipment or facility wiring.

4.1.1.6 Inaccessible Locations

All bonds in permanently concealed or inaccessible locations shall be exothermically welded.

4.1.1.7 Surface Preparation

All surfaces to be bonded shall be thoroughly cleaned to remove all dirt, grease, oxides, nonconductive films, or other foreign material. Paints and other coatings shall be removed to expose the base metal.

4.1.1.7.1 Area to Be Cleaned

Clean all surfaces at least $\frac{1}{4}$ inches (6.4 mm) beyond all sides of the larger bonded area on all mating surfaces.

4.1.1.7.2 Final Cleaning

Clean surfaces with a solvent suitable for electrical work immediately prior to assembly.

4.1.1.7.2.1 Clad Metals

Clean clad metal to a bright, shiny, smooth surface without penetrating the cladding. Wipe the cleaned area with solvent and allow to air dry before completing the bond.

4.1.1.7.2.2 Aluminum Alloys

A conductive finish shall be applied to aluminum mating surfaces after cleaning to a bright finish.

4.1.1.7.3 Completion of the Bond

Mating surfaces shall be joined within 2 hours after cleaning if an intentional protective coating has been removed from the metal surface. If delays beyond two hours are necessary in corrosive environments, the cleaned surfaces must be protected with an appropriate coating that must be removed before completion of the bond.

4.1.1.7.4 Refinishing of Bond

Where practicable restore areas around bonds so as to match the original finish.

4.1.1.7.5 Surface Plating or Treatments

Surface treatments that include plating provided for added abrasion resistance or corrosion protection shall offer high conductivity. Unless suitably protected from the atmosphere, silver and other easily tarnished metals shall not be used to plate bond surfaces, except where an increase in surface contact resistance cannot be tolerated.

4.1.1.8 Bond Protection

All bonds shall be protected against weather, corrosive atmospheres, vibration, and mechanical damage. Under dry conditions, apply a compatible corrosion preventive or sealant, within 24 hours of assembly of the bond materials. Under conditions exceeding 60% humidity, seal the bond with a compatible corrosion preventive or sealant within 1 hour of joining.

4.1.1.8.1 Paint

If a paint finish is required on the final assembly, the bond shall be sealed with the recommended finish. Care shall be taken to assure that all means by which moisture or other contaminants

enter the bond are sealed. A waterproof type of paint or primer shall be used if the recommended finish is not waterproof.

4.1.1.8.2 Compression Bonds in Protected Areas

Sealing is not required for compression bonds between copper conductors or between compatible aluminum alloys located in readily accessible areas that are not exposed to moisture, corrosive fumes, or excessive dust.

4.1.1.8.3 Corrosion Protection

All exterior and interior bonds exposed to moisture or high humidity shall be protected against corrosion. All interior bonds made between dissimilar metals shall be protected against corrosion in accordance with paragraph 4.1.1.2.3 and paragraph 4.1.1.2.4.1. All exothermic welds shall be cleaned of all residual slag. Protection shall be provided by a moisture proof paint conforming to the requirements of FAA-STD-012 or shall be sealed with a silicone or petroleum-based sealant to prevent moisture from reaching the bond area. Bonds protected by conductive finishes (alodine, iridite, et. al.) shall not require painting to meet the requirements of this standard.

4.1.1.9 Bonding across Shock Mounts

Bonding straps installed across shock mounts or other suspension or support devices shall not impede the performance of the mounting device. They shall be capable of withstanding the anticipated motion and vibration requirements without suffering metal fatigue or other failures.

4.1.1.10 Enclosure Bonding

Directly bond subassemblies and equipment at the areas of physical contact with the mounting surface.

4.1.1.11 Subassemblies

Utilize the maximum possible contact area when bonding subassemblies to the chassis. All feed throughs, filters, and connectors shall be bonded around the periphery to the subassembly enclosure to maintain shield effectiveness. Covers shall exhibit intimate contact around their periphery, and contact shall be achieved and maintained through the use of closely spaced screws or bolts, or the use of resilient conductive gaskets, or both. Note: COTS equipment should be treated as a sealed unit for the purposes of this requirement.

4.1.1.12 Equipment

The chassis or case of equipment shall be directly bonded to the rack, frame, or cabinet in which it is mounted. Clean all flange surfaces and the contact surface on the supporting element of all paint or other insulating substances in accordance with the requirements of paragraph 4.1.1.7. Fasteners shall maintain sufficient pressure to assure adequate surface contact to meet the bond resistance requirements in paragraph 4.1.1.1. Captive nuts and sheet metal screws shall not be used for fasteners. If equipment must remain operational when partially or completely withdrawn from its mounted position, the bond shall be maintained by a moving area of contact or by the use of a flexible bonding strap. Mechanical designs shall employ direct bonding, without straps, whenever feasible.

4.1.1.13 Connector Mounting

All metal or metallized connectors shall be mounted so that electrical contact is maintained between the connector body and the panel to which it is mounted. Bonding shall be accomplished completely around the periphery of the flange of the connector. Both the flange surface and the mating area on the panel shall be cleaned in accordance with paragraph 4.1.1.7. All nonconductive material shall be removed from the panel as illustrated in Figure II. After mounting of the connector, the exposed area of the panel shall be repainted or otherwise protected from corrosion in accordance with paragraph 4.1.1.8.

4.1.1.14 Shield Terminations

Cable shields shall be terminated in the manner specified by paragraphs 4.1.2.3.2 and 4.1.2.3.3. Shields of axial cables shall be fastened tightly to the cable connector shell with a compression fitting or soldered connection. The cable shall be able to withstand the anticipated use without becoming noisy or suffering a degradation in shielding efficiency. Axial connectors shall be of a material that is corrosion resistant in keeping with requirements of FAA-G-2100. Low frequency shields shall be soldered in place or, if solderless terminals are used, the compressed fitting shall afford maximum contact between the shield and the terminal sleeve. Shield pigtails shall extend less than 1 inch from the point of breakaway from the center conductors of the cable.

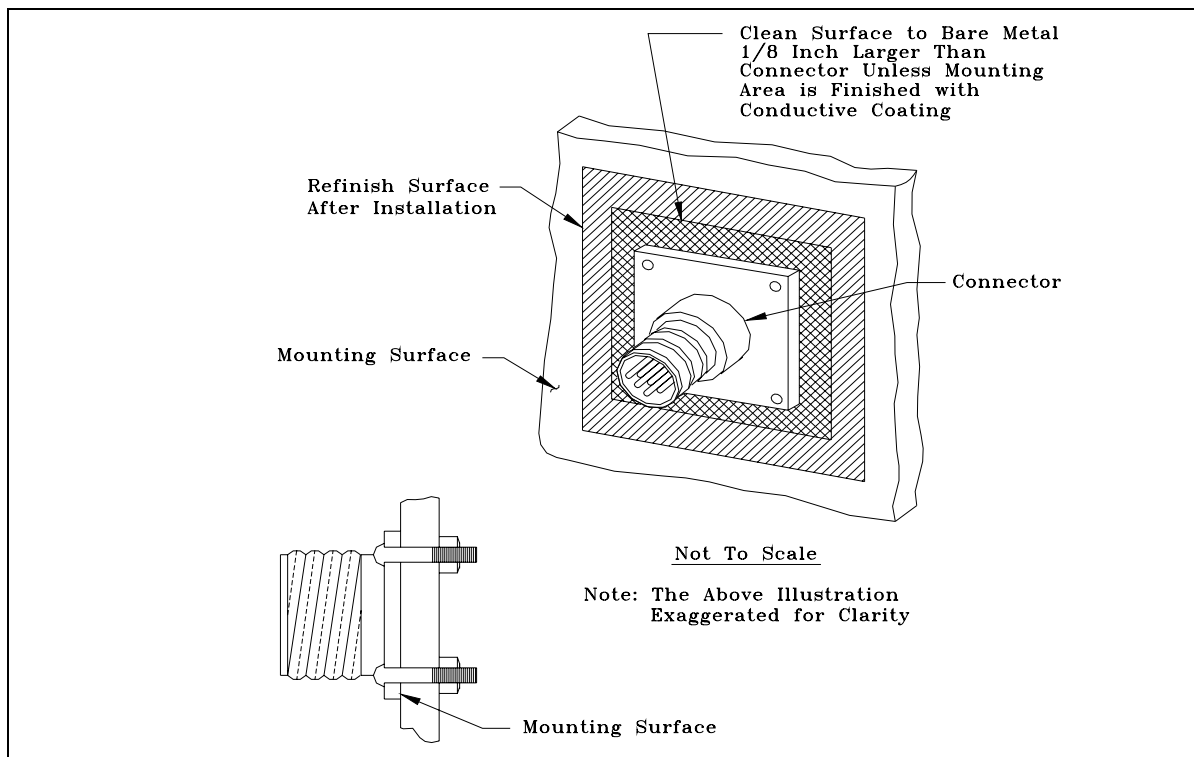


Figure II. Bonding of Connectors to Mounting Surface

4.1.1.15 RF Gaskets

Conductive gaskets shall be made of corrosion resistant material, shall offer sufficient conductivity to meet the resistance requirements of paragraph 4.1.1.1, and shall possess adequate

strength, resiliency, and hardness to maintain the shielding effectiveness of the bond. The surfaces of contact with the gasket shall be smooth and free of insulating films, corrosion, moisture, and paint. The gasket shall be firmly affixed to one of the bond surfaces by screws, conductive cement, or other means that do not interfere with the effectiveness of the gasket; or a milled slot shall be provided that prevents lateral movement or dislodging of the gasket when the bond is disassembled. Gaskets shall be a minimum of $\frac{1}{8}$ inch wide. The gasket as well as the contact surfaces shall be protected from corrosion.

4.1.2 Shielding Requirements

4.1.2.1 Design

The facility design and construction shall incorporate both protective shields to attenuate radiated signals, and separation of equipment and conductors to minimize the coupling of interference. The equipment design shall incorporate component compartments and overall shields as necessary to meet the electromagnetic susceptibility and emission requirements of MIL-STD-461 as required by NAS-SS-1000 and FAA-G-2100. In addition, the design shall provide the shields necessary to protect personnel.

4.1.2.2 Facility Shielding

Shielding of facility buildings, shelters or equipment spaces shall be provided when other facility or environmental sources of radiation are of sufficient magnitude to degrade the operation and performance of electronic equipment or system. Where rebar or a rudimentary Faraday cage exists, it shall be connected to the EES with a minimum 2 AWG copper conductor that is applied via an exothermic weld or a hydraulically crimped termination.

4.1.2.3 Conductor and Cable Shielding

Conductor and cable shielding shall comply with the following sub-paragraphs:

4.1.2.3.1 Signal Lines and Cables

Cables consisting of multiple twisted pairs shall have individual shields for each twisted pair.. The shields shall be isolated from each other. Cables with an overall shield shall have the shield insulated and isolated from the individual shields..

4.1.2.3.2 Termination of Individual Shields

Shields of pairs of conductors, line shields, and the shield of cables containing unshielded conductors shall be terminated in accordance with the following:

- (a) Shields shall be terminated to ensure correct equipment operation.
- (b) Shield terminations shall employ minimum length pigtails between the shield and the connection to the bonding halo or ferrule ring and between the halo or ferrule ring and the shield pin on the connector. The unshielded length of a signal line shall not exceed 1 inch (25 mm) with not more than $\frac{1}{2}$ inch (13 mm) of exposed length as the desired goal.
- (c) Shields, individually and collectively, shall be isolated from overall shields of cable bundles and from electronic equipment cases, racks, cabinets, junction boxes, conduit, cable trays, and elements of the electronic multipoint ground system. Except for one interconnection, individual shields shall be isolated from each other. This isolation shall be maintained in

junction boxes, patch panels and distribution boxes throughout the cable run. When a signal line is interrupted such as in a junction box, the shield shall be carried through. The length of unshielded conductors shall not exceed 1 inch (25 mm). To meet this requirement, the length of shield pigtail longer than 1 inch shall be allowed but shall be the minimum required.

- (d) Circuits and chassis shall be designed to minimize the distance from the connector or terminal strip to the point of attachment of the shield grounding conductor to the electronic signal reference. The size of the wire used to extend the shield to the circuit reference shall be as large as practical but shall not be less than 16 AWG or the maximum wire size that will fit the connector pin. A common shield ground wire for input and output signals, for both high level and low level signals, for signal lines and power conductors, or for electronic signal lines and control lines shall not be used.
- (e) Nothing in this requirement shall preclude the extension of the shields through the connector or past the terminal strip to individual circuits or chassis if required to minimize unwanted coupling inside the electronic equipment. Where extensions of this type are necessary, overall cable or bundle shields grounded in accordance with paragraph 4.1.2.3.3 shall be provided.

4.1.2.3.3 Termination of Overall Shields

Cables that have an overall shield over individually shielded pairs shall have the overall shield grounded at each end unless otherwise required by the equipment. Grounding through an SPD is permissible if grounding both ends of the conductors degrades system performance. The drain wire if present shall be grounded the same as the shield.

- (a) Cable shields terminated to connectors shall be bonded to the connector shell as shown in Figure IIIa or Figure IIIb. The shield shall be carefully cleaned to remove dirt, moisture, and corrosion products. The connector securing clamp shall be carefully tightened to assure that a low resistance bond to the connector shell is achieved completely around the circumference of the cable shield. The bond shall be protected against corrosion in accordance with paragraph 4.1.1.8. The panel-mounted part of the connector shall be bonded to the mounting surface in accordance with paragraph 4.1.1.13.
- (b) Where the cable continuity is interrupted, such as in a junction box, the shield shall be carried through and grounded at the box. The length of unshielded conductors shall not exceed 1 inch (25 mm). If necessary, the shield pigtail shall be allowed longer than 1 inch to reach ground but shall be as short as possible.
- (c) Cables which penetrate walls or panels of cases or enclosures without the use of connectors shall have their shields bonded to the penetrated surface in the manner shown in Figure IIIc. Overall shields shall be terminated to the outer surface of cases to the maximum extent possible.
- (d) Grounding of overall shields to terminal strips shall be as shown in Figure IV.

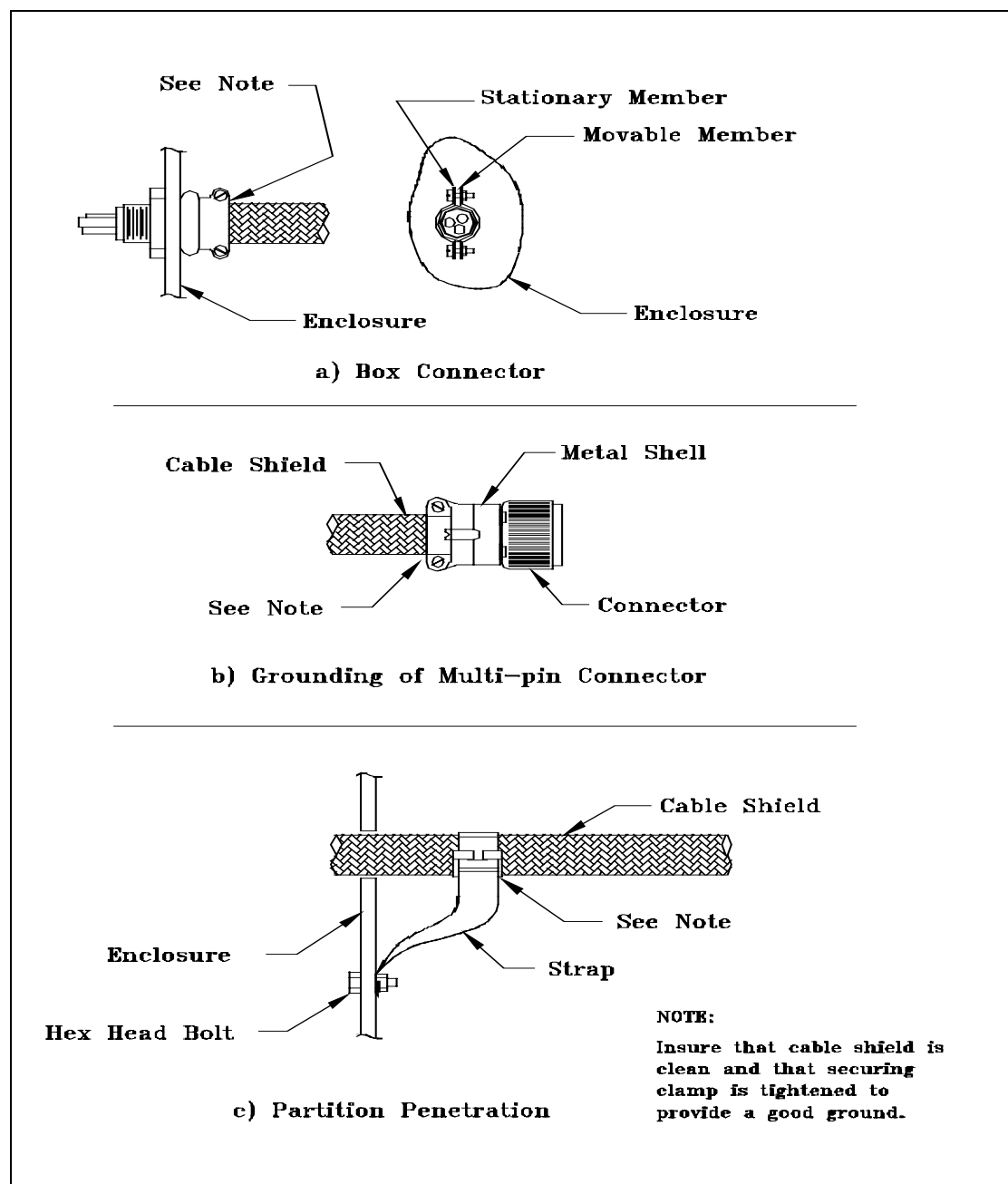


Figure III. Grounding of Overall Cable Shields to Connectors and Penetrating Walls

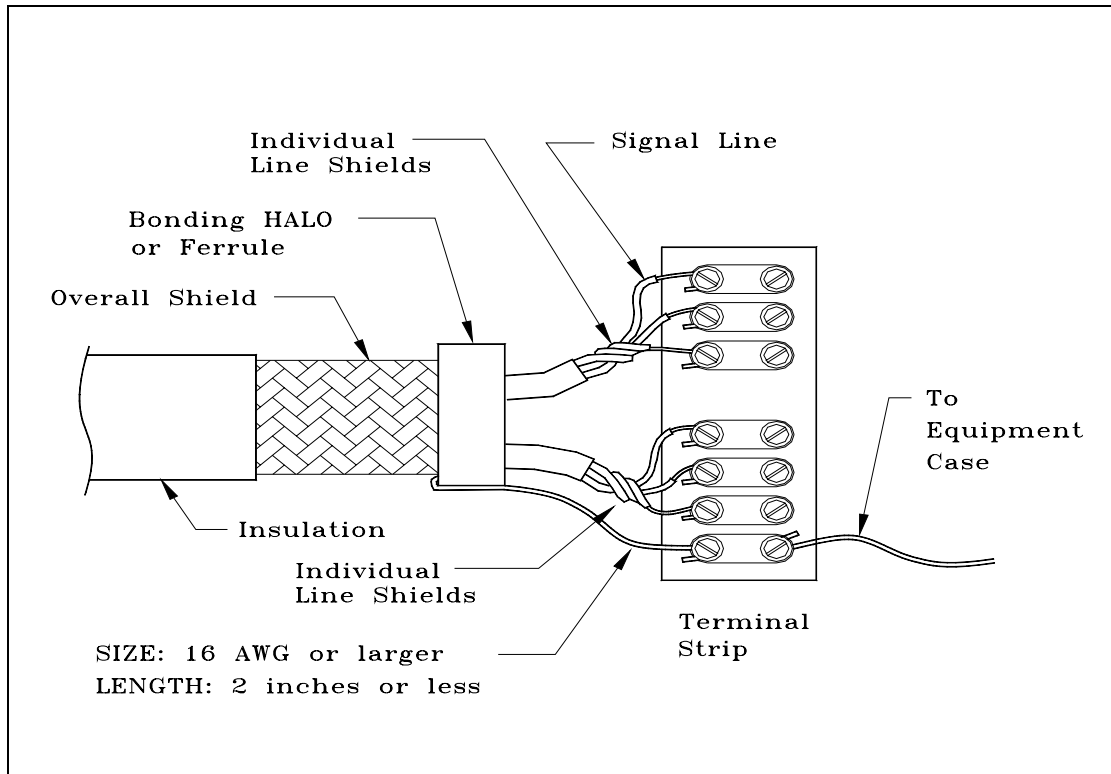


Figure IV. Grounding of Overall Cable Shield to Terminal Strip

4.1.2.4 Electromagnetic Environment Control

Shielding shall be integrated with other basic interference control measures such as filtering, wire routing, cable and circuit layout, signal processing, spectrum control, and frequency assignment to achieve the highest operational reliability of the equipment. Implementation procedures necessary to achieve the required filtering and shielding shall be detailed in the control plan described in paragraph 4.1.4.2 to include material requirements, shield configurations, placement and installation limitations, gasket utilization, filter integration, aperture control, bonding and grounding requirements, and wire routing and circuit layout constraints.

4.1.2.4.1 Space Separation

The design and layout of facilities shall physically separate electronic equipment and conductors that produce interference from equipment and conductors that are susceptible to interference. The minimum separation distance between power and signal cables shall be in accordance with Table III.

4.1.2.4.2 Wire and Cable Routing

The routing and layout of wires, conductors and cables shall be performed in a manner that does not jeopardize the integrity of the equipment shield. Signals with power level differences of greater than 20dB shall be routed as far apart as feasible. AC power conductors and control lines shall be routed away from sensitive digital or other susceptible circuits. Shielded cables shall be

used where needed to prevent emissions and/or to provide shielding. Cable shields shall be grounded in accordance with the requirements of paragraphs 4.1.2.3.2 and 4.1.2.3.3

Table III. Minimum Separation Distance Between Signal and Power Conductors.

Condition	Circuit Power Level		
	< 2 kVA	2-5 kVA	> 5 kVA
Unshielded power lines or electrical equipment in proximity to signal conductors in open cable tray or nonmetal raceway.	5 in. (127 mm)	12 in. (305 mm)	24 in. (610 mm)
Unshielded power lines or electrical equipment in proximity to signal conductors in a grounded metal raceway.	2.5 in. (64 mm)	6 in. (152 mm)	12 in. (305 mm)
Power lines enclosed in a metal raceway (or equivalent shielding) in proximity to signal conductors in a metal raceway.	-	3 in. (76 mm)	6 in. (152 mm)

4.1.2.4.3 Gaskets

Conductive gaskets conforming to paragraph 4.1.1.15 shall be utilized at joints, seams, access covers, removable partitions, and other shield discontinuities to the extent necessary to provide interference-free operation of the equipment under normal use and environmental conditions. Finger stock used on doors, covers, or other closures subject to frequent openings shall be installed in a manner that permits easy cleaning and repair.

4.1.2.4.4 Filter Integration

Filters on power, control, and signal lines shall be installed in a manner that maintains the integrity of the shield. AC power filters shall be completely shielded with the filter case grounded in accordance with paragraph 4.3.4.4. Filters for control and signal lines shall be placed as close as possible to the point of penetration of the case to avoid long, unprotected paths inside the equipment.

4.1.2.4.5 Bonding and Grounding of Compartment Shields

All shields shall be grounded. Bonding shall be accomplished in accordance with paragraph 4.1.1.

4.1.3 Electrostatic Discharge (ESD) Requirements

Modern electronic and electronically controlled electrical equipment is susceptible to damage from Electrostatic Discharge (ESD). The requirements of this section are designed to reduce the frequency and minimize the effects of ESD events. All electronic circuitry that contains miniaturized or solid-state components shall be considered ESD susceptible.

4.1.3.1 ESD Sensitivity Classification

Classification of items as ESD sensitive shall be in accordance with the Human Body Model testing procedures and requirements of ANSI/ESD STM5.1. Electronic parts, components, and assemblies shall be classified as either sensitive or supersensitive. Items that will fail from ESD at 1000 to 16000 Volts shall be classified as ESD sensitive. Those items that will fail below 1000 Volts shall be classified as supersensitive. Any exceptions to this guidance shall be through the OPR of this document. Devices with a sensitivity of less than +/- 200 Volts require additional ESD protection measures than those specified in this standard. ESD susceptible items shall not be exposed to an electrostatic field (E-field) greater than 100 Volts/meter or brought closer than 24" to known static generators or non-essential insulative materials.

4.1.3.2 ESD Protection Requirements

All NAS electrical and electronic equipment, subassemblies, and components subject to damage from exposure to electrostatic fields or electrostatic discharge (ESD) shall be protected in accordance with the protection requirements herein. ESD controlled areas shall be provided for all operations, storage, repair, and maintenance spaces used for electrical and electronic equipment or subassemblies that are subject to damage from static electricity or ESD.

4.1.3.3 Classification of Materials

4.1.3.3.1 General

Most materials and products that are used to control and prevent ESD are classified by their resistive properties as conductive or static dissipative. Antistatic materials are an exception to this and are classified by their propensity to not generate static electricity from triboelectric charging. Any material used for construction of ESD protected areas (with the exception of antistatic materials) shall meet the resistive properties specified for type and use of the material. Materials that will tribocharge to greater than +/- 200 Volts (EIA-625), if the material were to contact and separate from itself or from other materials, shall not be used in ESD controlled areas.

4.1.3.3.2 Static Conductive Materials

Those materials with a surface resistivity less than 1.0×10^5 ohms/square when tested per ANSI/ESD S11.11 shall be considered conductive. Conductive ESD control materials shall not be used for ESD control work surfaces, tabletop mats, floor mats, flooring, or carpeting where the threat of personnel contact with energized electrical or electronic equipment exists. Conductive ESD control materials are not to be used in any other application where their use could result in electromagnetic interference (EMI) or radio frequency interference (RFI) that would be created by rapid, high voltage ESD spark discharges. Any exceptions to this guidance shall be through the OPR of this document.

4.1.3.3.3 Electrostatic Shielding Materials

Electrostatic shielding materials are a subset of conductive materials with a surface resistance equal to or less than 1.0×10^3 ohms when tested per ANSI/ESD S11.11. Electrostatic shielding materials shall be allowed as barriers for protection of ESD sensitive items from electrostatic fields where required.

4.1.3.3.4 Electromagnetic Shielding Materials

Electromagnetic shielding materials with highly conductive surfaces (< 10 ohms) or specifically designed composite materials that absorb and reflect electromagnetic radiation over a broad range of frequencies shall also be allowed as barriers where required to protect ESD sensitive items from electromagnetic fields.

4.1.3.3.5 Static Dissipative Materials

Those materials with a surface resistivity greater than 1.0×10^5 ohms/square but less than or equal to 1.0×10^{12} ohms/square when tested per ANSI/ESD S11.11 are classified as static dissipative materials. Static dissipative materials with a surface resistance less than or equal to 1.0×10^9 ohms shall be used to provide controlled bleed-off of accumulated static charges in ESD controlled areas. Static dissipative materials with a surface resistance of greater than 1.0×10^9 ohms shall not be used for applications where controlled bleed-off of accumulated static charges is essential. Any exception to this guidance shall be through the OPR of this document.

4.1.3.3.6 Antistatic Materials

Any material that inhibits or has a low propensity to generate static electricity from triboelectric charging shall be considered antistatic. Antistatic ESD control items and materials used for construction of ESD controlled areas in new or renovated facilities shall not tribocharge to greater than ± 200 Volts when being used for their intended application. Antistatic materials with a surface resistance greater than 1×10^9 ohms shall not be used for ESD protective work surfaces, tabletop mats, floor mats, flooring, and carpeting when charge dissipation is the primary consideration. If the surface resistance (R_{tt}) of an antistatic material is greater than 10^{12} ohms it shall normally be considered to be too resistive for use in ESD controlled areas. Use of antistatic items and materials that utilize hygroscopic surfactants that depend on ambient humidity to promote absorption of water shall be limited. Only antistatic materials that are intrinsically antistatic and will retain their antistatic properties shall be used in ESD controlled areas. Exceptions to this guidance shall be through the OPR of this document.

4.1.3.3.7 Static-Generative Materials, Non-Conductors, and Insulators

Materials having a surface resistance greater than 1.0×10^{12} ohms (ANSI/ESD S11.11) shall be considered to be insulators and a possible source of triboelectric charging. These include common plastics, Plexiglas, Styrofoam, Teflon, nylon, rubber, untreated polyethylene, and polyurethane. Their use shall be minimized where ESD sensitive items are located.

4.1.3.4 Protection of ESD Susceptible and Sensitive Items

4.1.3.4.1 Static Protected Zone

A static protected zone shall be a volume or area where unprotected ESD sensitive items will be safe from direct contact with electrostatic potentials greater than ± 200 volts, electrostatic fields greater than 100 volts/meter, or radiated electromagnetic interference and radio frequency interference produced by rapid, high voltage ESD spark discharges. Static protected zones shall be incorporated into the construction of ESD special protection areas, ESD protected workstations, and ESD protected storage areas.

4.1.3.4.2 ESD Special Protection Areas

Special protection areas shall be designated areas that require extraordinary ESD control measures to accomplish the following:

- (a) Minimize triboelectric charging.
- (b) Control bleed-off and dissipation of accumulated static charges.
- (c) Neutralize charges.
- (d) Minimize the effects of E-Fields, H-Fields, and EMI and RFI from ESD spark discharges.

Areas within a facility that shall be designated as ESD special protection areas are:

- (a) Air traffic operations areas (e.g., tower cab, TRACON, ARTCC control rooms, AFSS, etc.).
- (b) Electronic equipment rooms.
- (c) Storage areas for ESD susceptible components, subassemblies, circuit cards, etc.
- (d) Areas that contain personal computers and Local Area Networks (LANs) that are connected to or interface directly with NAS electronic equipment.
- (e) All other locations where jacks, plug in connectors or interfaces of ESD sensitive electronic equipment are exposed and vulnerable to damage from ESD by direct human contact shall also be designated as ESD special protection areas.

4.1.3.4.3 ESD Controls Required for ESD Special Protection Areas

The following minimum ESD control measures shall be implemented in all areas designated as ESD special protection areas:

4.1.3.4.3.1 ESD Groundable Point (GP)

Each ESD control material, surface, or item used in an ESD controlled area shall have a designated groundable point (GP) to provide ease of connection to the nearest Signal Reference Structure (SRS).

4.1.3.4.3.2 Grounded Static Dissipative Surfaces

All work surfaces which include work surface laminates, paints and sealers, writing surfaces, table tops, consoles, workbenches, and table top mats shall be static dissipative and connected to any SRS in the area served – except to a single point ground system. The point-to-point resistance and surface to ground resistance of static dissipative work surfaces shall be greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ANSI/ESD S4.1).

4.1.3.4.3.3 Limiting the Use of Non-ESD Control Materials

Materials that will tribocharge (e.g., generate electrostatic potentials by contact and separation with themselves or other materials) shall not be used for construction in ESD special protection areas. Insulative materials and any other non-essential triboelectric charge generators that generate potentials in excess of +/- 200 Volts shall not be permitted within 24 inches of ESD special protection areas.

4.1.3.4.3.4 Static Dissipative Chairs

Chairs (e.g., seating) provided for ESD special protection areas shall incorporate a continuous path between all chair elements (e.g., cushion and arm rests) to the ground points of greater than

1.0×10^5 ohms to less than 1.0×10^9 ohms. The ground points for ESD chairs are static dissipative or conductive casters that provide electrical continuity from all elements of the chair to ESD control carpeting, tile, or floor mats that are properly bonded to any SRS – except to a single point ground system. ESD control chairs must be tested and meet the requirements of ANSI/ESD STM12.1.

4.1.3.4.3.5 Static Dissipative ESD Control Floor Coverings

Static dissipative ESD control floor coverings shall include static dissipative tile, carpeting, static limiting floor finishes, and floor mats. Floor coverings in ESD special protection areas shall have a point-to-point resistance and surface-to-ground resistance of greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ANSI/ESD S7.1). These floor coverings shall be bonded to any SRS in the area served in accordance with paragraphs 4.1.3.4.3.1 and 4.1.3.4.8 – except to a single point ground system. In circumstances involving extremely static sensitive equipment a static conductive floor covering with a lower resistance limit of 2.5×10^4 ohms (UL779) shall be implemented when it is part of a designed approach for ESD control for the equipment approved by the OPR of this document. This designed approach shall include all steps required to produce an electrically safe working environment.

4.1.3.4.3.6 Relative Humidity Control

Relative humidity in ESD special protection areas shall be maintained within the range of 40 to 60%.

4.1.3.4.4 ESD Signs, Labels, Cautions, and Warnings

ESD warning signs that include ESD sensitive device warning symbols with appropriate cautions and warnings shall be posted in ESD special protection areas and all other ESD controlled areas. Exterior cabinets of ESD sensitive electronic equipment shall also be marked or labeled with an ESD sensitive device symbol with a warning that is visible from at least 3 feet. Any signs or labels shall be consistent with the requirements of ANSI/ESD S8.1.

4.1.3.4.5 ESD Protected Workstations

These workstations are for the maintenance and repair of ESD sensitive equipment.

4.1.3.4.5.1 ESD Protected Workstation Minimum Requirements

All ESD control items at an ESD protected workstation shall be connected to a common groundable point, i.e., ESD ground, that is connected to any SRS in the area served – except to a single point ground system. ESD protected workstations shall be free of all non-essential static charge generators; and provide a means of personnel grounding. They shall have a grounded static dissipative work surface, and grounded static dissipative ESD control floor or mat. Storage containers provided at ESD protected workstations shall provide ESD protection and shall also be connected to the ESD ground. All outlets at ESD protected workstations shall be protected with ground fault circuit interruption (GFCI) capability to minimize danger to grounded personnel from electrical shock.

4.1.3.4.5.2 Use of Ionization

Selective use of bench top or area ionizers shall be allowed at ESD protected workstations if static generative items (e.g., insulators) are deemed essential and cannot be removed from ESD

protected workstation areas or if grounding of mobile personnel would be cumbersome or create a safety hazard.

4.1.3.4.5.3 Identification of ESD Protected Workstations

The boundaries of all ESD protected workstations shall be clearly defined. The boundaries of ESD protected workstations shall extend a minimum of 24 inches beyond where ESD sensitive items will be located and will be marked with yellow tape. ESD warning signs that are yellow with black markings and lettering shall be posted that will be visible to anyone entering these areas. Signs shall include an ESD sensitive electronic device warning symbol and appropriate warnings and cautions.

4.1.3.4.6 ESD Protective Storage Areas

4.1.3.4.6.1 Shelves, Bins, and Drawers

Shelves, bins, and drawers shall be static dissipative and electrically continuous with the support structure of the storage shelves, bins, or container.

4.1.3.4.6.2 Grounding

The storage container metal support structure shall have a groundable point (GP) that shall be connected to the nearest SRS – except to a single point ground system. The resistance from the ground point of storage containers, shelving, cabinets, and bins used to store ESD sensitive items to the nearest SRS shall be less than one ohm.

4.1.3.4.6.3 Personnel Grounding

Wrist straps shall be equipped with one megohm or greater series resistance to protect personnel. Standard 0.157 inch banana jacks for personnel grounding wrist straps shall be connected to the ESD ground or directly to any SRS in the area served – except to a single point ground system. The resistance from a banana jack to a ground point and/or to the nearest SRS – except to a single point ground system shall be less than one ohm.

4.1.3.4.6.4 Materials Prohibited in ESD Protective Storage Areas

Static generative (e.g., insulative) materials shall not be used for construction in any areas where ESD sensitive items will be stored. All materials that can generate potentials greater than +/- 200 Volts shall be a minimum of 24 inches from ESD protected storage areas.

4.1.3.4.6.5 Resistance to ESD Ground for Shelves, Drawers, and Bins

All surfaces and drawers of the storage media provided shall be made with static dissipative materials and meet the requirements and be tested the same as work surfaces (ANSI/ESD S4.1). The surface-to-surface resistance (R_{ts}) and surface-to-ground resistance (R_{tg}) from the shelves, bins, and drawers of storage containers that will be used to store unprotected ESD sensitive items shall be greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ESD ADV53.1).

4.1.3.4.6.6 Identification of ESD Protective Storage Areas

The boundaries of all ESD protective storage areas shall be clearly defined. Boundaries of ESD protective storage areas shall extend a minimum of 24 inches beyond where ESD sensitive items will be located and will be marked with yellow tape. ESD warning signs that are yellow with

black markings and lettering shall be posted that will be visible to anyone entering these areas. Signs shall include an ESD sensitive electronic device warning symbol and appropriate warnings and cautions.

4.1.3.4.7 Hard and Soft Grounds

4.1.3.4.7.1 Hard Grounds

Any item, material, or product that is a part of the ESD control system that is intentionally or unintentionally connected to an ESD ground, or directly to any SRS in the area served – except to a single point ground system – shall be considered to be hard grounded. Unless specified otherwise or justified by the OPR for this document, ESD control worksurfaces, cabinets, flooring, carpeting, test equipment, and any other items used for ESD control shall be hard grounded.

4.1.3.4.7.2 Soft Grounds

A soft ground is an intentional connection to ground through a series current limiting resistor. Soft grounding shall only be used in personnel grounding skin contact devices such as wrist straps, leg or ankle straps, conductive shoes, and heel or toe grounders. The nominal resistance of the resistor used for soft grounding of personnel shall be greater than 1.0×10^6 ohms unless otherwise specified by the OPR for this document. All other elements of the ESD control system shall be hard grounded.

4.1.3.4.8 ESD Control Flooring and Floor Coverings

All ESD control floors and floor coverings shall have a point to point resistance and a surface to ground resistance of greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ESD STM7.1). ESD control flooring and floor coverings include vinyl tile, vinyl sheet, carpet, carpet tile, carpet tile with positioning buttons and others but not to include applied coatings.

These control floors and floor coverings shall be installed, grounded, and initially tested only by trained installers. A representative ten-feet-square section of the floor system shall be tested and the results approved and accepted by FAA personnel, prior to installation of the full floor system.

ESD control floors and floor coverings shall be bonded to the nearest SRS at a minimum of four locations. The connections and method shall be recommended by the floor manufacturer and approved by the OPR. These connections shall utilize copper: strip, foil, conductive fabric ribbon, or stranded wire. Electrical contact shall be made with the underside of the floor material or connections may be embedded in the conductive permanent or releasable adhesive used to lay the floor. The ESD control flooring shall not be bonded to any single point ground system.

4.1.3.4.8.1 Surface Resistance (R_{tt})

Surface resistance (R_{tt} - Resistance top-to-top or surface-to-surface) of ESD control floors, carpets or floor mats shall be greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ANSI/ESD S7.1). A minimum of five readings shall be taken at different locations on the floor surface and averaged together for each 500 square feet (or fraction thereof) of floor surface. These readings shall be recorded in the FRDF.

4.1.3.4.8.2 Resistance Surface-to-Ground (R_{tg})

Resistance from the floor surface to ground (R_{tg} - Resistance top-to-ground) of ESD control floors, carpets or floor mats shall be greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ANSI/ESD S7.1). A minimum of five readings shall be taken at different locations on the floor surface and averaged together for each 500 square feet (or fraction thereof) of floor surface. These readings shall be recorded in the FRDF.

4.1.3.4.8.3 Triboelectric Charging Limitation

ESD control floors, carpets, or floor mats shall limit and control generation and accumulation of static charges to less than +/- 200 Volts in ESD controlled area.

4.1.3.4.9 ESD Requirements for Raised Floors

4.1.3.4.9.1 Resistance from Carpet Surface to Pedestal Understructure

Carpet tiles shall have a resistance from the carpeted surface of the raised floor to the pedestal greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms.

4.1.3.4.9.2 Panel to Floor Understructure Resistance

Panel-to-understructure (metal-to-metal) contact resistances between individual raised floor panels and the floor understructure shall be 10 ohms or less.

4.1.3.4.9.3 Carpet Tile Installation on Raised Floor Panels

Install individual carpet tiles on raised floor panels with either permanent or releasable conductive adhesive depending on the application.

4.1.3.4.9.4 Grounding

There shall be a minimum of four connections per 1,000 square feet of installed ESD control carpeting from the carpeting undersurface and conductive adhesive to the raised floor panel understructure. The Connections and method shall be in accordance with paragraph 4.1.3.4.8.

4.1.3.4.10 ESD Protective Worksurfaces

Static dissipative materials or electrostatic dissipative laminates shall be used to cover all worksurfaces, consoles, workbenches, and writing surfaces in areas that contain ESD sensitive equipment and in all areas designated as ESD special protection areas, static-safe zones, and ESD protected areas.

4.1.3.4.10.1 Requirements for ESD Protective Worksurfaces

Static dissipative worksurfaces shall be provided for new or upgrade facilities unless otherwise specified. Permanent static dissipative worksurfaces shall be connected to any SRS in the area served – except to a single point ground system. Permanent ESD protective static dissipative worksurfaces shall have a resistance greater than 1.0×10^6 ohms point-to-point (R_{tt}) and less than 1.0×10^9 ohms (ANSI/ESD S4.1). Permanent ESD protective worksurfaces shall have a resistance from their surface to the groundable point (R_{tg}) greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ANSI/ESD S4.1).

4.1.3.4.10.1.1 Worksurface Types

ESD protective worksurfaces used for FAA workstations shall meet the requirements of MIL-PRF-87893 Performance Specification, Workstation, Electrostatic Discharge Control and MIL-W-87893 Military Specification, Workstation, Electrostatic Discharge (ESD) Control.

4.1.3.4.10.1.2 Type I Worksurface - Hard

Type I worksurfaces shall be constructed of rigid static dissipative materials of any color having an average Shore D hardness in excess of 90. Two male or female 0.395 inch ground snap (female) or stud (male) fasteners shall be installed on both corners on one of the longest sides of the worksurface to accommodate the male or female snap or stud fastener of the common point grounding cord. The locations of the two snaps or studs shall be 2 inches from each corner.

4.1.3.4.10.1.3 Type II Worksurface - Soft

Type II worksurfaces shall be constructed of cushioned static dissipative materials of any color having an average Shore A (ATSM D2240) hardness in excess of 45 and less than 85. Two male or female 0.395 inch ground snap (female) or stud (male) fasteners shall be installed on both corners on one of the longest sides of the worksurface to accommodate the male or female snap or stud fastener of the common point grounding cord. The locations of the two male or female snaps or studs shall be 2 inches from each corner. No low-density open-cell materials shall be used for Type II worksurfaces.

4.1.3.4.10.2 Static Dissipative Laminates

High pressure, multi-layer static dissipative laminates shall be used to cover surfaces such as plywood, fiber board, particle board, bench tops, counter tops, and consoles in ESD controlled areas and special protection areas. Laminates shall include a buried conductive layer to provide for ease of grounding using a through bolted pressure type ESD grounding terminal.

4.1.3.4.10.3 Grounding of Laminated Surfaces

The resistance across the surface (R_{ts}) of the static dissipative laminate shall be greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms. The resistance from the surface of the laminate to ground (R_{tg}) shall be greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ANSI/ESD S4.1). A minimum of five readings of each shall be taken and averaged together. These readings and averages shall be recorded in the FRDF.

4.1.3.4.11 Static Dissipative Coatings

Permanent clear or colored static dissipative coatings used in ESD controlled areas, including all painted surfaces, shall have a point to point resistance greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms.

4.1.4 Electromagnetic Compatibility Requirements

4.1.4.1 General

A comprehensive plan for the application of various sections of this document is required to assure the compatible operation of equipment in complex systems. Additional considerations of this section shall be implemented to reduce susceptibility and emissions of equipment.

4.1.4.2 Requirements

The emission and susceptibility limits contained in MIL-STD-461 shall be applied unless otherwise specified. An EMI Control and Test Plan shall be developed in accordance with MIL-HDBK-237 to assure compliance with the applicable requirements. The plan shall include a verification matrix to track the satisfaction of requirement by test, analysis or inspection. .

4.1.4.3 Approval

Control Plans and Test Plans shall be submitted to the OPR of this document for approval.

4.2 Facility Requirements

4.2.1 Passive Transient Protection Requirements

All metallic conduit, conductors and cables in NAS operational facilities are subject to currents induced by nearby lightning strikes. These induced effects can adversely affect the operation of sensitive electronic equipment.

4.2.1.1 Existing Metallic Conduit, Conductors and Cables

Unless the facility manager disapproves the removal, all unused conduits, conductors and cables shall be removed. The facility manager shall be consulted to validate the decision to remove any metallic conduit, conductors or cables prior to acting. If they are to remain, the following actions shall be accomplished to minimize the voltage differential between ends:

- (a) Metallic conduits shall be bonded to adjacent grounded metalwork at both ends.
- (b) Unused conductors bonded to adjacent grounded metalwork at both ends.
- (c) Unused cables shall have conductors and shields bonded to adjacent grounded metalwork at both ends.

If not direct connected the above bonding shall utilize a 6AWG minimum pigtail no longer than 18 inches. Multiple conductors shall be grouped together and bonded to the adjacent metalwork directly or via a single pigtail.

Unused conductors of a structured cable system installed for spares purposes with vertical risers of no more than fifty feet and of circuit length totaling no more than three hundred feet are exempted from this requirement if they do not pass between facilities. Where circulating currents are present, installation of a SPD at one end of the cable shall be allowed for this requirement..

The OPR of this document should be contacted for additional information.

4.2.1.2 Electromagnetic Shielding for Lines, Conductors and Cables

4.2.1.2.1 Facility Entrance Conduit

All lines, conductors and cables, both overhead and buried, shall enter the facility through a minimum of 10 feet of ferrous conduit (RGS). Conduit routed by other than a direct route shall be allowed to achieve this 10-foot requirement. All entrance conduits shall be bonded to the EES with a bare copper stranded conductor, 2 AWG minimum. This entrance conduit, if buried, shall extend 5 feet beyond the earth electrode system.

4.2.1.2.2 Buried External Power Cables and Conductors

Buried external power cables and conductors shall have magnetic shielding to prevent coupling of damaging transient currents, from man made and lightning sources. This shielding can only be provided by a ferrous metal. This may be in the form of a sheath, ferrous armor or ferrous conduit (RGS). Specification details of this type of cable and potential sources are available from the OPR and the LPGBS web page. Ferrous armor cable has been shown to be extremely cost effective when compared to ferrous conduit and presents a marginal increase in cost over unarmored cable. Cables may be installed in metallic or nonmetallic conduit where permitted by the NEC. When a conduit is not used cables shall be identified for direct earth burial (DEB).

For portions of buried external power cables and conductors greater than 300 feet cable length from the facility ferrous shielding is recommended but not required. Facility entrance surge protection shall be provided that fully complies with paragraph 4.2.2 and all sub paragraphs.

4.2.1.2.3 Buried Landlines

The preferred type of buried landline that represents best engineering practice is fiber optic type. Fiber optic cable does not require electromagnetic shielding and is exempt from these requirements. Metallic buried landlines that carry NAS Critical, Essential or Mission Support Services to a facility shall have a ferrous shield or be enclosed in ferrous conduit (RGS).

For portions of these buried landlines located greater than 300 feet cable length from the facility, ferrous shielding is recommended but not required. For these landlines facility entrance surge protection shall be provided that fully complies with paragraph 4.2.2 and all sub paragraphs.

4.2.1.2.4 Conduit Joints and Fittings

Conduit joints and fittings shall be electrically continuous with bonding resistance of 5 milliohms or less between joined parts. Conduit enclosing signal, control, status, power, or other conductors to electronic equipment shall be terminated using conductive fittings to their respective junction boxes, equipment cabinets, enclosures, or other grounded metal structures.

4.2.1.3 Above Ground Ferrous Conduit Penetration of Facility

At each location, where above ground conduits first penetrate a shelter or building a bonding connection shall be made. The conduit shall be bonded directly to the EES, or to a bulkhead connector plate that is bonded to the EES in accordance with paragraph 4.2.1.6. If neither of these bonds is feasible, the bond shall be made to the main or supplemental ground plate. The bond to the EES, or the bulkhead connector plate, or to the multipoint ground plate shall be a 2 AWG stranded copper conductor using exothermic welds or UL listed pressure connectors.

4.2.1.4 Armored Direct Earth Burial (DEB) Cables

The DEB cable armor shall be bonded to the EES with a 2 AWG conductor prior to entry into the conduit. The DEB cable armor shall also be bonded to the main or supplemental ground plate. If bonding to the main or supplemental ground plates is not feasible the armor shall be bonded to the ground bus at the service disconnecting means (SDM). If armor is continued to the electronic equipment, bond it to any SRS – except to a single point ground system – of the electronic equipment unless the equipment is required to be isolated. All bonds shall be less than 5 milliohms between joined parts. Apply this requirement during initial cable installation. Complete cable replacement is not required if only a short length requires repair.

4.2.1.5 Guard Wires

A 1/0 AWG bare copper stranded guard wire shall be provided for all buried cables and conductors not routed in ferrous conduit. The guard wire shall be embedded in the soil, a minimum of 10 inches (25 cm) above the cable to be protected and located directly above and parallel to the lines or cables being protected. When the width of the cable run or duct does not exceed 3 ft (90 cm), one guard wire, centered over the cable run or duct, shall be installed. When the cable run or duct is more than 3 feet (90 cm) in width, two guard wires shall be installed. The guard wires shall be spaced at least 12 inches (30 cm) apart and be not less than 12 inches (30 cm) nor more than 18 inches (45 cm) inside the outermost wires or the edges of the duct. The guard wire shall be bonded to the EES at each end and to ground rods at approximately 90-foot intervals using exothermic welds. The spacing between ground rods must vary by 10% to 20% to prevent resonance. Install the ground rods at approximately 6 feet (2 m) on either side of the trench. Where cables run parallel to the edge of a runway, they shall be located 10 feet from the edge lights on the outside of the lights.

4.2.1.6 Metal Bulkhead Connector Plates

A metal bulkhead connector plate shall be provided where overhead axial-type cables, waveguides, etc., first enter a facility. The bulkhead connector plate shall be mounted on the outside surface of the facility, a minimum of 1/4 inch thick, and shall be constructed of tin-plated copper. The plate or plates shall have the required number and types of feed-through connectors to terminate all axial cables and shall provide adequate surface area for bonding waveguides, cable shields, conduits etc. Cable shields shall be bonded and grounded, except when the shield must be isolated for proper equipment operation. If external and internal cables are of different sizes, the changeover in cable size shall be allowed by the feed-through connectors at the plate.

Axial type cables, Waveguides, etc.(and conduits where not bonded directly to the EES) shall be bonded to the bulkhead plates with a minimum 4 AWG bonding jumper. The 4 AWG bonding cable for a waveguide can be connected to the waveguide flange with an appropriately sized ring terminal. Conduits shall be bonded with a UL listed U-Bolt bonding connector. Axial cable shields shall be bonded with bonding kits sized for the specific cable type. Bonding jumpers shall be connected to the plate with either an exothermic weld or a double-bolted lug and shall be no longer than 12 inches.

The bulkhead plate shall be bonded to the EES with a minimum 4/0 AWG copper cable color-coded green with a red tracer. When the bulkhead connector plate is located within 6 feet of

building steel, the bulkhead plate shall be connected to building steel with a 4/0 AWG copper conductor color coded green with a red tracer. The building structural steel is required to be bonded to the EES. Exothermic welds shall be used for these connections.

4.2.1.7 Balanced Pair Lines

When possible, signal and control circuits routed external to equipment shall be balanced, two conductor, shielded circuits.

4.2.1.8 Fiber Optic Cable

Fiber optic cables are not inherently susceptible to electromagnetic interference or the induction fields produced by lightning. Fiber optic cables should replace metallic cables when economically and technically feasible. Ferrous conduit shielding is not required for fiber optic lines. Suppression components are not required for fiber optic cables. Where metallic or electrically conductive sheaths or strength members are present, they shall be grounded to any SRS – except to a single point ground system at each end. To prevent circulating ground currents, a SPD shall be allowed at one end for grounding. The fiber optic transmitter and receiver modules shall have 90 dB of attenuation against all sources of electromagnetic interference (EMI).

Where an external fiber optic cable uses conductive armor, the armor shall be bonded directly or via a SPD to the EES at the facility entrance using a 2 AWG bare copper conductor. If the cable is internal to the facility, conductive armor shall be bonded to any SRS – except to a single point ground system – at the equipment entrance. The bonding conductor shall be a 4 AWG stranded copper conductor insulated green with an orange tracer. The use of fiber optic cables without a conductive shield or armor is permitted. The fiber optic transmitter and receiver modules shall be contained in ferrous enclosures bonded to the nearest SRS – except to a single point ground system. Penetrations of the enclosures shall be gasketed or constructed to limit RF coupling. SPD's for the metallic signal circuits and power circuits shall be installed as equipment level protection at the fiber optic receiver or transmitter equipment entrance and bonded to the chassis.

4.2.1.9 Interior Lines, Conductors and Cables

All permanently installed single conductors, cables and wiring shall be in ferrous conduit (RGS), ferrous intermediate metal conduit (IMC), ferrous electrical metallic tubing (EMT), ferrous cable trays, or ferrous wireways (except as prohibited by the NEC). These shall be connected to any SRS – except to a single point ground system – as specified in paragraphs 4.2.6.4.1 and 4.2.6.4.2.

When routing between floors the vertical section of the runs shall be in ferrous conduit (RGS), ferrous IMC, ferrous EMT, enclosed ferrous cable trays, or ferrous wireways that are connected to any SRS – except to a single point ground system – as specified in paragraphs 4.2.6.4.1 and 4.2.6.4.2.

Cable tray systems employing single rail or wire construction are prohibited at any location.

4.2.2 Active Transient Protection Requirements

4.2.2.1 Conducted Power Line Surges

Surge protective devices (SPDs) shall be provided at the service disconnecting means (SDM), at all facility penetrations (entrances), and at feeder and branch panelboards as specified in paragraph 4.2.2.3. Additional SPDs shall be provided at the power line entrances to operational electronic equipment. SPDs at the service disconnecting means, facility penetrations (entrances), feeder and branch panelboards as well as transient suppression provided at electronic equipment power line entrances shall be coordinated in accordance with the guidance provided in paragraphs 4.2.2.2 and 4.2.2.3.

4.2.2.2 Facility Entrance Surge Protective Devices

A facility power SPD shall be installed on the load side of the facility service disconnecting means, at any facility penetration (entrance) and between the load side of a Engine Generator transfer switch and the first feeder panel.

The SPD shall be a combination of solid-state circuits, varistors, or other devices and shall meet the requirements provided in this paragraph and its subparagraphs. Protection will be provided between all lines, including neutral where provided, and ground. A surge arrestor shall also be installed on the primary side of FAA owned distribution transformers. These arresters and SPDs shall be approved by the OPR of this document.

The SPD shall be installed as close as possible (within 12 inches) to the facility SDM and with the shortest and most direct conductor connection to the SDM. Connections shall be made with UL listed connectors identified for the wire size and type used.

- (a) Connections. SPD terminals shall be connected to corresponding terminals of the service disconnecting means with insulated 2 AWG (minimum) copper conductors. The conductors shall be as short and direct as possible without loops, sharp bends or kinks, be all the same size, and be color-coded in accordance with FAA-C-1217. The ground bus in the service entrance enclosure shall be bonded directly to the SPD terminal marked G or ground. The SPD enclosure shall be bonded to the SPD ground terminal.
- (b) Conduit sealing. The conduit connecting the SPD enclosure to the SDM enclosure shall be sealed with duct seal or other UL listed nonflammable medium to prevent soot from entering the SDM enclosure in the event of SPD failure.

4.2.2.3 Surge Protective Devices for Feeder and Branch Panels

SPDs shall be installed on all panels providing service to NAS operational equipment or supplying exterior circuits. Examples of exterior circuits include obstruction lights, convenience outlets, guard shacks, security systems, electric gates and feeds to other facilities. Exterior circuits shall be protected in accordance with the requirements of paragraph 4.2.2.2. Where feeder and branch panels are located close together and the panels do not serve exterior circuits, the OPR of this document shall be allowed to grant relief from providing separate protection on each panel. SPD's for panels that provide service to any exterior circuits shall meet the requirements given by paragraphs 4.2.2.4.2, 4.2.2.4.3, and 4.2.2.4.4 for facility entrance SPD's. The SPD's shall be installed as close as possible to the panel they serve and in accordance with the manufacturer's instructions. The conduit connecting the SPD enclosure to the panel enclosure shall be sealed with duct seal or other UL listed nonflammable medium to prevent soot

from entering the enclosure in the event of SPD failure. A feeder or branch panel SPD shall be provided with an overcurrent device. Examples of this overcurrent device include a fuse or circuit breaker fitted internally to the SPD or fitted to the panelboard for the sole use of the SPD. The overcurrent device shall not increase the clamp voltage of the SPD by greater than 5% and shall pass the surge current levels listed in Table IV up to the 40kA level without opening. Overcurrent devices for any exterior circuits shall pass all values shown in Table IV. All overcurrent devices, both internal and external to the SPD, and SPD short circuit current ratings shall be properly sized and coordinated in accordance with the NEC and be field resettable or replaceable.

4.2.2.4 SPD General Requirements

SPDs shall be listed in accordance with UL 1449 Second Edition. All components comprising a SPD shall be packaged in a single National Electrical Manufacturers Association (NEMA) type 12 steel enclosure for indoor use only, or a NEMA type 4 steel enclosure for indoor or outdoor use. SPDs enclosed within panelboards or switchgear enclosures shall be allowed, provided the integrated SPD and panelboard or switchgear is UL listed/recognized as components and as an assembly. The use of potting material in SPDs is strictly prohibited. All SPD components must be accessible for inspection by qualified FAA personnel. Heavy duty, screw-type studs shall be provided for all input and output connections. The SPD phase and neutral terminals, when not connected, shall be electrically isolated from the enclosure by a minimum of 10 megohms resistance measured at 100V DC. The enclosure door shall be hinged and electrically bonded with a bonding jumper to the enclosure. Fuses, lights, fuse wires, and arrester elements or components shall be readily accessible for inspection and replacement. Manufacturers shall supply clear installation instructions with each unit.

4.2.2.4.1 SPD Operational Characteristics

Minimum functional and operational characteristics of SPDs are given in Table IV, Table V, and Table VI. Other characteristics will also include the following:

- (a) Maximum continuous operating voltage (MCOV). The maximum continuous operating voltage is the maximum RMS voltage an SPD will withstand at its maximum operating temperature continuously without degradation or change to any of its parameters greater than +/- 10%. The MCOV shall not be less than 10 percent above the nominal system voltage. Leakage current as defined below shall not be exceeded.
- (b) Leakage current. The DC leakage current shall be less than 1mA for voltages at or below $1.414 \times \text{MCOV VDC}$.
- (c) Clamp (discharge) voltage. Clamp (discharge) voltage is the maximum voltage that appears across an SPD output terminal while conducting surge currents. This voltage, measured at 3kA (to ensure performance in the linear region without impacting the device lifetime performance) with an 8/20 microsecond waveform, shall not change more than 10 percent over the operating life (as defined in Table IV. Surge Current Lifetime Requirements) of the SPD.
- (d) Overshoot voltage. Overshoot voltage shall not exceed twice the SPD clamp voltage for more than 10 nanoseconds. Overshoot voltage is the surge voltage level that appears across the SPD terminals before the device turns on and clamps the surge to the specified voltage level.

- (e) Self-restoring capability. The SPD shall automatically return to an off state after surge dissipation when line voltage returns to normal.
- (f) Operating lifetime. The SPD shall safely dissipate the number and amplitude of surges listed in Table IV. Surge Current Lifetime Requirements.
- (g) In-line inductors. In-line inductance, other than that normally caused by routing conductors, is not permitted.
- (h) Fusing. Any fuses part of a SPD installation shall be able to pass all surge currents specified in Table IV without opening.

4.2.2.4.2 Surge Levels

Table IV defines line-to-ground, line-to-neutral, neutral to ground, and line-to-line surge currents, and number of occurrences for AC services in FAA facilities below 600V. In this table, the 8/20 μ s wave form defines a transient reaching peak value in 8 μ s and decays to 50 percent of peak value 20 μ s after inception. These devices shall be able to tolerate surges of shorter duration without malfunction.

Table IV. Surge Current Lifetime Requirements

Surge Current Amplitude 8/20μs Waveform	Surge Number Lifetime Any Facility Entrance	Surge Number Lifetime Feeder and Branch Panels
10kA	1500	1000
20kA	700	500
30kA	375	250
40kA	50	25
50kA	8	1
60kA	6	
70kA	4	
100kA	2	
200kA	1	

Each level of surge current and the number required represents a single lifetime of an SPD.

- (a) Any change greater than 10% in the 8/20 μ s clamping voltage at 3kA during service or when the pre life/service test and the post life or in-service test results are compared is a device failure. The pre life test value shall be taken as the 100% value.
- (b) Any change greater than 10% in the RMS voltage required to drive 1mA RMS through the device when the pre life/service test and the post life or in-service test results are compared is a device failure. The pre life test value will be taken as the 100% value.
- (c) Any change greater than 10% in the DC voltage required to drive 1mA DC through the device when the pre life/service test and the post life or in-service test results are compared is a device failure. The pre life test value will be taken as the 100% value.
- (d) Clamping voltages for each of the devices/assemblies/system voltages will be measured at 1kA and 10kA 8/20 μ s.

4.2.2.4.3 Slope Resistance

It is the purpose of this parameter to specify a region on the SPD characteristic where it is possible to ensure device coordination. A slope resistance (the slope of the voltage/current characteristic of an SPD in its linear region) shall be calculated from the formula below:

$$R_{\text{slope}} = (V_{10} - V_1) / 9000$$

Where V_{10} = the clamping voltage measured at 10kA 8/20 μ s
and

Where V_1 = the clamping voltage measured at 1kA 8/20 μ s

The values of V_{10} and V_1 used will be the absolute values as measured and not as a calculated value. The slope values shall conform to Table V.

Table V. Entrance, Feeder, and Branch Panels Slope Resistance Requirements

Location	Slope Resistance
Any Facility Entrance	8 m Ω Maximum
Feeder and Branch Panels	30 m Ω +/- 15 m Ω

4.2.2.4.4 3kA Voltages V_3

The voltages that must be achieved during testing at 3kA with an 8/20 μ s current impulse is shown in Table VI. All voltages shall be measured at the device terminals. The 8/20 μ s current impulse wave shape shall not lead or lag the voltage wave shape by more than 30 degrees.

Table VI. Protection Voltages at 3kA

Location	System	V_3	Limit
Any Facility Entrance	120/208V 120/240V	400 L-N, L-G 700 L-L	Maximum
Any Facility Entrance	277/480V	700 L-L, L-G	Maximum
Any Facility Entrance	380V Delta	1200 L-L, L-G	Maximum
Any Facility Entrance	480V Delta	1200 L-L, L-G	Maximum
Feeder and Branch panels	120/208V 120/240V	475 L-N, L-G 775 L-L	+/- 45V
Feeder and Branch panels	277/480V	775 L-N, L-G 1275 L-L	+/- 45V
Feeder and Branch panels	380V Delta	1275 L-L, L-G	+/- 45V
Feeder and Branch panels	480V Delta	1275 L-L, L-G	+/- 45V

4.2.2.4.5 Indicator Lamps

Indicator lamps shall be provided for each phase on the SPD enclosure cover. They shall visually indicate normal condition (power applied to the SPD with any component fuses intact).

If indicator lamps are used that have a service life of less than 50,000 hours then two lamps per phase shall be provided.

4.2.2.4.6 Accessibility

All SPD installations shall be safely accessible for visual inspection and evaluation. The use of potting material or other encapsulating materials that prevent component inspection in SPDs shall be limited to inorganic particulates. All SPD components shall be accessible for maintenance and replacement by qualified FAA personnel. Determination of the acceptability of potting material or other encapsulating materials in a given design resides with the OPR of this document.

4.2.2.5 Signal, Control, and Data Line Protection Design

Transient protection shall be provided for all signal, data and control lines; both at facility entrances and at entrances to all electronic equipment used in direct support of the NAS including those provided or installed by a telecommunications service provider.

The suppression components at the facility and electronic equipment entrances shall be coordinated to function together and limit the transient voltage and energy safely below circuit susceptibility levels. Coordination of suppression components is dependant on several factors including separation distance, equipment system bandwidth, etc. In principle facility entrance devices and electronic equipment entrance devices shall not affect each others operation. The coordination of these protectors is achieved at the system design stage – not intended to be accomplished by field personnel (see paragraph 4.3.2).

Detailed analyses of suppression component and electronic equipment circuit characteristics are required to select components compatible with the requirements herein and to provide suppression circuits that will function without adversely affecting signals and information transmitted by individual landlines. Design requirements for selection of components are as follows:

- (a) Unipolar suppression components shall be selected and installed for signals and voltages that are always positive or always negative relative to reference ground. Bipolar suppression components shall be selected for signals and voltages that are both positive and negative relative to reference ground.
- (b) The total series impedance of the suppression circuits at both ends of a landline shall be designed so as not to significantly degrade electronic equipment performance.
- (c) The protection components at facility entrances and equipment shall be selected so that their operating levels are coordinated and transient levels to equipment are limited safely below electronic equipment susceptibility levels for individual lines.

Surge protective devices shall be placed on both ends of signal, data and control lines longer than 10 feet connecting pieces of equipment or facilities not located on and bonded to the same SRS, or when the SRGG, SRGP, and the multipoint ground system is located in different rooms or on different floors. This includes all signal, data, control, and status lines both internal and external. This also includes interfacility lines installed above and below grade between facility structures and to externally mounted electronic equipment and particularly vertically routed conductors and

cables such as those between an ATCT cab and base building or radar tower and base building. This requirement includes fire alarm and security wiring where it has direct impact on NAS equipment.

All unused conductors of a cable shall be grounded at each end. Grounding through an SPD is permissible if grounding both ends of the conductors degrades system performance.

4.2.2.6 SPD Requirements for Signal Data and Control Lines

Facility level SPDs for signal, data, and control lines shall be installed at the point where the lines transfer to FAA control and at any building/structure entrance under FAA control. Where a battery feeds signal, data or control lines, the suppression components shall be housed in a metal enclosure. For facility level SPD enclosures, a ground bus bar, electrically isolated from the enclosure, shall be provided to serve as the ground point. This ground bus bar shall be directly connected to the EES with an insulated 4 AWG or larger copper conductor of minimum length with no loops, sharp bends or kinks, and ensure a short direct path for connection to the SPD's. NOTE: When at the top of a tall ATCT (greater than 100 feet) the main ground plate on the lowest level containing NAS electronic equipment serves in lieu of the EES. The conductor insulation shall be color-coded green with a red tracer. A UL listed double bolted lug shall be used to bond the conductor to the ground bus bar. The bonding to the EES shall be an exothermic weld. The ground bus bar location shall ensure a short, direct path to ground for SPD's. The installation shall provide easy access to component terminals for visual inspection, test and replacement.

SPD's for landlines that combine the protection specified herein shall be located at the facility entrance, and have approval by the OPR of this document prior to implementation of vendor proposed protection. (Reference paragraph 4.2.2.5)

Field designed protection schemes shall be submitted to the OPR of this document for guidance and approval.

Transient suppression components for axial-type cables shall be packaged in a sealed metal enclosure with appropriate connectors at each end to permit in-line installation at the bulkhead connector plate required in paragraph 4.2.1.6.

4.2.2.6.1 Signal, Control, and Data Line Protection Requirements

The 10/1000 μ s waveform defines a transient with a 10 μ s rise time and decay to 50 percent of the peak voltage in 1000 μ s. SPDs must survive the transients listed in Table VII. Failure or end of life performance of a protector shall not normally disrupt the operation of the circuit being protected.

Table VII. SPD Lifetime Conducted Landline Transient Level Requirements

Lifetime Number of Transients	Transient Levels	
1,000	100V	50A
500	500V	100A
50	750V	375A
5	1000V	1000A

Each level of surge current and the number required represents a single lifetime of an SPD.

4.2.2.7 Axial Cable Protection Design

Special attention shall be given to the design of transient protection for axial-type cables. Design of transient protection is particularly critical at RF frequencies due to insertion losses. The following design requirements apply:

- (a) Analyses and tests shall be performed to assure that suppression components do not degrade signals to an unacceptable degree or cause marginal performance of electronic equipment.
- (b) Particular attention shall be given to the impedance, insertion loss, phase distortion, and voltage standing wave ratio for RF signals.
- (c) Transient protection for electronic equipment using coaxial, tri-axial, and twin-axial cables shall be provided both at facility entrances and at the electronic equipment.

Transient suppression shall be provided for each axial conductor and for shields that are not bonded directly to the electronic equipment case.

4.2.3 Lightning Protection System Requirements

4.2.3.1 General

The intended purpose of the lightning protection system is to provide preferred paths for lightning discharges to enter or leave the earth without causing facility damage or injury to personnel or equipment. The essential components of a lightning protection system are air terminals, roof and down conductors connecting to the EES, the EES and SPDs. These components act together as a system to dissipate lightning energy. The lightning protection system shall meet or exceed the requirements of all relevant FAA standards and orders; Standard for the Installation of Lightning Protection Systems, National Fire Protection Association (NFPA 780); Installation Requirements for Lightning Protection Systems, Underwriters Laboratories (UL 96A); and, as specified herein. The risk assessment guide in NFPA 780 indicates that many NAS facilities have a high risk index. Accordingly lightning protection that exceeds the minimum requirement of NFPA 780 is specified. The provision of a UL Master label is not sufficient to indicate compliance with this document.

4.2.3.2 Lightning Protection System Materials

All equipment shall be UL listed for lightning protection purposes and marked in accordance with UL requirements. All equipment shall be new and of a design and construction to suit the application in accordance with UL 96A requirements, except that aluminum shall only be used on aluminum roofs, aluminum siding or other aluminum surfaces. Bimetallic connectors shall be used for interconnecting copper and aluminum conductors. Dissimilar materials shall conform to the bonding requirements of paragraph 4.1.1.2.3.

4.2.3.2.1 Lightning Protection System Conductors

All conductors used in a lightning protection system (main and bonding) shall be class 2 main sized conductors as defined by NFPA 780 or larger.

4.2.3.2.2 Lightning Protection System Hardware

4.2.3.2.2.1 Fasteners

Roof and down conductors shall be fastened at intervals not exceeding 3 feet (0.9 m). Fasteners shall be of the same material as the conductor base material or bracket being fastened, or other equally corrosion resistant material. Plastic, galvanized or plated materials shall not be used. Where fasteners are used for bonding the surface shall be prepared and protected in accordance with paragraphs 4.1.1.7 and 4.1.1.8.

4.2.3.2.2.2 Fittings

Bonding devices, conductor splices, conductor attachments and connectors shall be suitable for use with the installed conductor and shall be stainless steel, copper, bronze, or aluminum with bolt pressure connections to the conductor. Crimp type fittings shall not be used anywhere for any purpose in the lightning protection system. Aluminum fittings shall only be used with aluminum conductors. Copper and bronze fittings shall only be used with copper conductors. Interconnection between copper and aluminum portions of the lightning protection system shall be accomplished with bimetallic connectors.

4.2.3.2.3 Guards

Guards shall be provided for down conductors located in or next to driveways, walkways or other areas where they are at risk of being displaced or damaged. Guards shall extend at least 6 feet (1.8 m) above and 1 foot (0.3 m) below grade level. Guards shall be schedule 40 polyvinyl chloride (PVC) conduit or better. When metal guards are used, the guard shall be bonded to the down conductor at both ends of the guard. Bonding jumpers shall be of the same size as the down conductor. PVC guards do not require bonding.

4.2.3.3 Lightning Protection System Bonds

4.2.3.3.1 Metallic Bodies Subject to Direct Lightning Strikes

Metallic bodies that protrude beyond the zone of protection provided by the installed air terminals, are subject to direct lightning strikes. This includes, but is not limited to, exhaust pipes, exhaust fans, metal cooling towers, HVAC units, ladders, railings, antennas, and large louvered structures, etc. When these metallic bodies have a metal thickness of $\frac{3}{16}$ inch or greater, they shall be bonded to the nearest main lightning protection system conductor. These

fittings shall provide bonding surfaces of not less than 3 square inches. If the metal parts of these units are less than $\frac{3}{16}$ inch thick, additional air terminals, main conductors and fittings shall be installed, providing two paths to ground from the air terminals.

4.2.3.3.2 Metallic Bodies Subject to Induced Charges

Metallic bodies that are subject to induced charges from lightning (including those in a zone of protection) shall be bonded to the lightning protection system in accordance with the guidance provided in NFPA 780. This includes, but is not limited to, roof drains, vents, coping, flashing, gutters, downspouts, doors, door and window frames, balcony railing, conduits, pipes, etc.

4.2.3.3.3 Exhaust Stack Grounding.

Bond all fossil fuel exhaust stacks to the nearest point in the lightning protection system or directly to the EES with a conductor of equal size as the main conductor. The bond to the exhaust stacks shall be made with an exothermic weld or a mechanical connector. Where exhaust stacks are not in close proximity (6 feet) to a main conductor, they shall be bonded directly to a ground rod in the EES.

4.2.3.3.4 Above Ground Fuel and Oil Storage Tanks.

Lightning protection shall be provided for all above-ground fuel and oil storage tanks. An air terminal shall be mounted to the top of non-pressurized fuel and oil tank vent pipes, high enough to provide the required zone of protection for the entire tank, and be connected directly to the EES using a main-sized down conductor.

Tanks shall be provided with at least two easily accessible, widely separated grounding points. Each of these grounding points shall be bonded directly to the EES. All other metallic components, e.g., stairs and skids, shall be bonded with 4/0 AWG copper conductors or if 4/0 AWG is not feasible then the largest feasible conductors. These conductors shall be exothermically welded to the EES.

Pressurized fuel tanks (propane, compressed natural gas, etc.) shall be bonded directly to the EES at one of the support legs.

4.2.3.4 Conductor Routing

Down conductors shall follow the most direct downward course. Main and bonding conductors must maintain a downward or horizontal course, and are permitted to rise at no greater than $\frac{1}{4}$ pitch.

No bend in a main and bonding conductor shall form an included angle of less than 90 degrees, nor shall it have a bend radius (sweep) of less than 8 inches. Connections between crossing conductors will use sweeps in all directions. T-connectors shall be allowed only for mechanical support.

Conductors shall be routed outside of any structure and not penetrate or invade that structure (except as indicated below in paragraph 4.2.3.6). Conductors shall be routed 6 feet or more from

power or signal conductors in air or through walls. If this clearance cannot be met, the power and signal conductors shall be routed in ferrous conduit (RGS) or enclosed ferrous cable tray.

Conductors shall be allowed to pass through a parapet, eave, walkway, wall, etc., where necessary to maintain horizontal or downward course of main conductors. Pass-throughs shall always be accomplished using main conductors, routed through Trade Size 2, Schedule 80, rigid PVC conduit. When a conductor penetrates a metallic structure of any thickness, the conductor shall be bonded to the metallic structure. Conductors passing through gratings or plates do not require conduit but do require bonding.

4.2.3.4.1 Down Conductors on Fiberglass Mounting Poles

Where a fiberglass pole is used to mount an air terminal, the air terminal shall extend two feet above the top of the pole and shall be securely fastened to the pole in accordance with the requirements of NFPA 780. The down conductor from the air terminal shall be run on the exterior of the fiberglass pole and shall be fastened to the pole at intervals not exceeding 3 feet. This down conductor shall be connected to the EES in accordance with paragraph 4.2.3.4.2.

4.2.3.4.2 Down Conductor Terminations

Down conductors shall be exothermically welded to a 4/0 AWG copper conductor prior to entering the ground at not less than 18 inches above the ground level. The 4/0 AWG copper conductor shall enter the ground and be welded to a ground rod that is exothermically welded to the EES.

4.2.3.5 Lightning Protection for Buildings and Structures

Lightning protection shall be provided for all buildings and structures, or parts thereof, not within a zone of protection provided by another building or higher part of a building, or by an antenna or tower. Zones of protection for all structures shall be as defined in NFPA 780.

4.2.3.5.1 Air Terminals

Air terminals shall be solid copper, bronze, or aluminum. In areas of high corrosion, air terminals shall be stainless steel. Copper air terminals shall be allowed to have nickel-plating. Air terminals shall be a minimum of 12 inches in height, at least $\frac{1}{2}$ inch in diameter for copper and at least $\frac{5}{8}$ inch in diameter for aluminum. Air terminals shall be located and installed in accordance with the requirements of NFPA 780 and UL 96A, and as required by this document. Closer spacing shall be allowed for unique geometries. Air terminals shall extend at least 10 inches above the object or area it is to protect. Air terminals shall be placed on the ridges of pitched roofs and around the perimeter of flat or gently sloping roofs at intervals not exceeding 20 feet except that air terminals 24 inches or higher shall be allowed at intervals not exceeding 25 feet.

SAFETY NOTE:

The tip of vertical air terminals shall not be less than 5 feet above adjacent walking or working surfaces to avoid the risk of personnel injury.

4.2.3.5.2 ATCT Potential Equalization

A continuous potential equalization loop (halo ring) shall be installed on the roof or roof parapet, within 24 inches of the periphery of the structure. All air terminals and down conductors shall be connected to this loop. Any parts of the structure below the roof level that extend outboard of the potential equalization loop shall be provided with additional air terminals at the extremities of the structure.

Potential equalization loops shall be installed at intermediate levels, evenly spaced no more than 60 feet apart, measured from the roof loop. Additional horizontal air terminals will be installed at each potential equalization loop.

All exterior catwalks and personnel access areas shall be provided with a potential equalization loop interconnected to the down conductors. Horizontal air terminals shall be installed at each corner.

4.2.3.5.3 Number of Down Conductors for Buildings

The number of down conductors shall be based on both the building height and perimeter. For the purpose of this paragraph, an ATCT with a base building shall be treated as two separate buildings.

Buildings and structures less than 50 feet high (measured to the highest point of the building or structure) shall have at least two down conductors. Buildings and structures more than 50 feet and less than 100 feet high shall have at least four down conductors. Buildings and structures more than 100 feet high, other than antenna towers, shall have one additional down conductor for each 50 feet of height or part thereof, e.g., a 150 foot building would have a minimum of five down conductors, a 300 foot building would have a minimum of eight down conductors, etc.

Buildings and structures with perimeters in excess of 250 feet shall have an additional down conductor for each 100 feet of perimeter distance or part thereof. Down conductors shall be as widely separated as possible, e.g., at diagonally opposite corners on square or rectangular buildings. The down conductors shall be equally spaced and without any sharp bends, or kinks. Building steel, metal supporting structures, and conduits shall not be used in place of down conductors.

4.2.3.5.4 Metal Parts of Buildings

Metal roofing, structural and reinforcing steel, siding, eave troughs, down spouts, ladders, duct, and similar metal parts shall not be used as substitutes for roof or down conductors. A lightning protection system shall be applied to the metal roof and to the metal siding of a metal clad building in the same manner as on a building without metal covering. Building metal parts shall be bonded in accordance with paragraph 4.2.3.3.

4.2.3.5.5 Roof Mounted Antenna Masts

Unless it is a radiating or receiving part of the antenna, a metallic mast of a roof-mounted antenna shall be bonded to the nearest roof or down conductor. If a roof or down conductor is not available then the antenna mast shall be bonded directly to the EES.

4.2.3.6 Lightning Protection for Antenna Towers

4.2.3.6.1 Number of Down Conductors for Towers

Towers that consist of multiple, parallel segments or legs that sit on a single pad or footing not over nine square feet in area are also considered pole type towers. All other towers shall have at least two down conductors. Large towers, such as radar towers, shall have one down conductor per leg. Down conductors on all towers shall be bonded to each tower section. Down conductors shall be routed down the inside of the legs wherever practical and secured at intervals not exceeding 3 feet.

4.2.3.6.2 Pole Type Towers

Pole type towers shall be protected by at least one air terminal and have at least one down conductor. This is to provide a zone of protection for all antennas located on the tower.

4.2.3.6.3 Towers without Radomes

Protection shall be provided for large radar antennas by extending structural members above the antenna and mounting the air terminal on top as shown in Figure V unless specifically disapproved by the Radar system OPR. Structural members shall be braced as necessary and shall not be used as part of the air terminal or down conductor. The air terminal shall be supported on the structural member and shall have a UL listed fitting on its base. The down conductor from the air terminal shall be connected to a perimeter conductor that forms a loop around the perimeter of the tower platform. Down conductors shall be run from the perimeter conductor to the EES. Each air terminal shall be provided with at least two paths to ground. All conductors shall be in accordance with NFPA 780 requirements for main conductors. All tower legs shall be bonded to the EES with a 4/0 AWG copper conductor exothermically welded at each end. This bonding conductor shall be either a separate conductor, or is permitted to be a part of the down conductor, as described in paragraph 4.2.3.4.2.

4.2.3.6.4 Radomes

Radomes shall be located within a zone of protection established according to the 100 foot radius “rolling sphere model” as described in NFPA 780. This protection can be either from air terminals mounted on the radome or air terminals or catenary wires mounted independently of the radome. When air terminals are mounted on the radome they must have two paths to the EES. A perimeter conductor shall be established at the radar antenna deck level.

Lightning protection systems for standalone radomes shall be designed and installed in consultation between the system OPR and the OPR of this document. The narrative in paragraph 4.2.3.6.5 shall be used as guidance in developing lightning protection systems for these radomes.

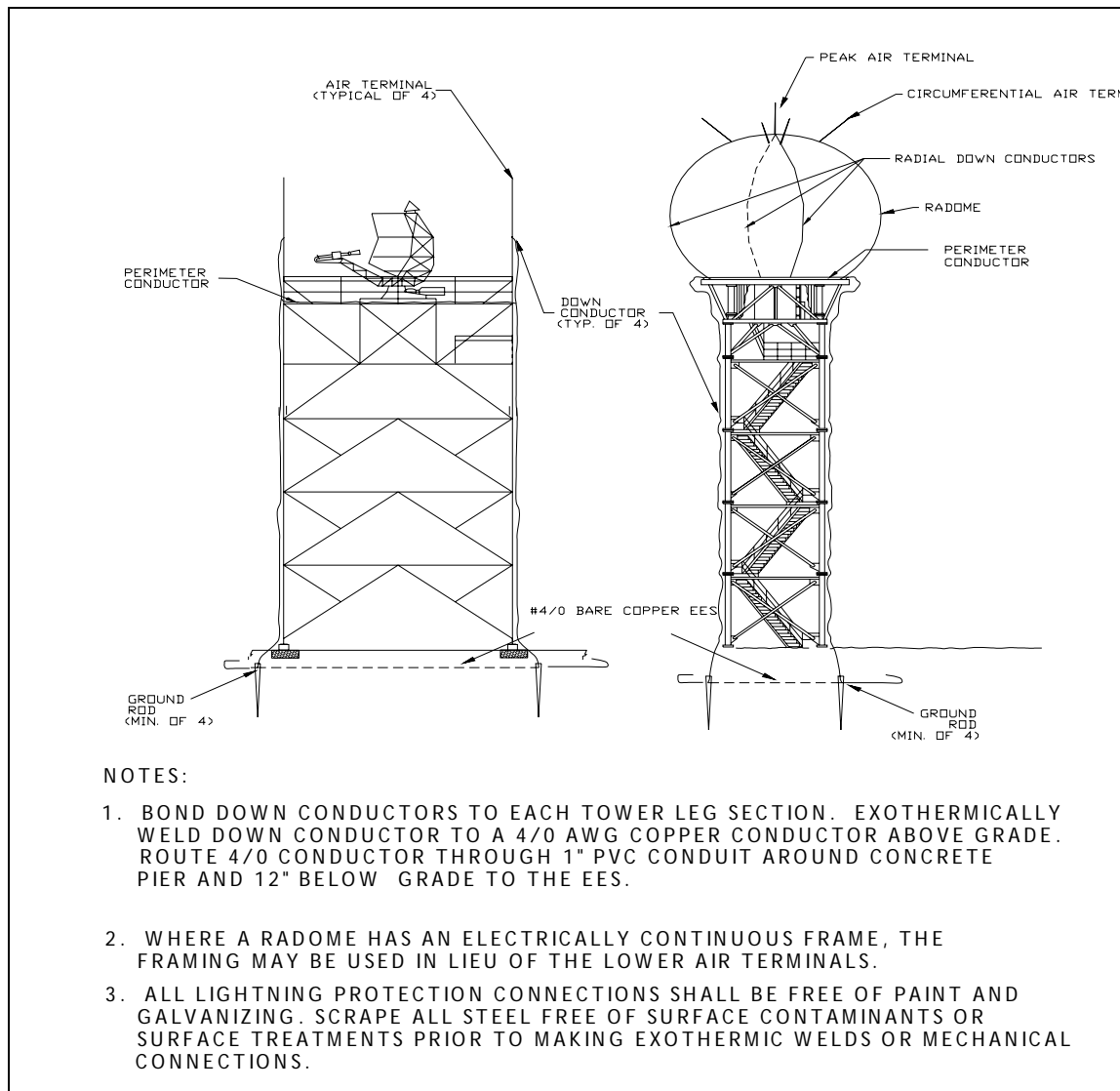


Figure V. Lightning Protection for Radomes and Radar Antenna Platforms

4.2.3.6.5 Towers with Radomes

Lightning protection systems for towers with radomes shall be designed and installed in consultation between the system OPR and the OPR of this document. The narrative below shall be used as guidance in developing lightning protection systems for these structures.

Towers with radomes shall be protected with a minimum 2 foot (0.62 m) air terminal at the peak and four or more air terminals equally spaced around the circumference of the radome and oriented perpendicular to the radome. The spacing and quantity of the circumferential air terminals shall be adjusted if the antenna pattern is affected, but their sizing, position and height shall establish a protection zone as specified in 4.2.3.6.4. The circumferential air terminals shall be interconnected with main sized conductors. The radial down conductors, as indicated in Figure V, shall be connected to the air terminal on the peak. The radial down conductors shall also be connected to the perimeter conductor that forms a loop around the base of the radome.

The radial down conductors on the radome shall be routed from the air terminal at the peak of the radome, in a path following the contour of the radome, to connection with the circumferential air terminals and then to connection with the perimeter conductor as shown in Figure V. Deviations from the shortest possible path shall be allowed where near field radar analyses determine that interference from the conductors will degrade the performance of the radar. Any bends in the radial down conductors on the radome shall maintain the largest possible radii and in no case be less than 12 inches. One down conductor per leg shall connect the perimeter conductor at the base of the radome to the EES. The down conductors shall be bonded to each leg section. All tower legs shall be bonded to the EES with a 4/0 AWG copper conductor exothermically welded at each end. This bonding conductor can be the same conductor required in paragraph 4.2.3.4.2.

4.2.3.6.6 Antenna Protection

Air terminals shall be placed to protect structural towers and buildings, and antennas mounted to towers and on buildings.

4.2.3.6.7 Tower Guying

All metallic guy wire systems without insulators shall be connected to the EES with a 4/0 AWG copper conductor.

4.2.3.6.7.1 Anchors

Where multiple guy wires terminate on a single anchor, one jumper shall be allowed to connect all guy wires to the EES. The jumper shall be exothermically welded to a ground rod that is exothermically welded to the EES. Mechanically bonded jumpers of the same material and size as the guy wire shall be placed across any intermediate turnbuckles in a guy wire. On guy wires terminating in low conductivity anchors (such as concrete), a jumper of the same material and size as the guy wire shall be mechanically bonded to each guy wire above its lowest turnbuckle and bonded to the EES. All jumper connections to the guy wires shall be made with appropriate compatible connectors.

4.2.3.6.8 Waveguide, Axial Cable, and Conduit Grounding

Waveguide, axial cable, and conduit located on the tower and feeding into the facility shall be separately bonded to a ground plate mounted on the tower or directly to the EES. This bond shall be above and no greater than 2 feet (0.6 m) from the transition bend (90 degree bend) near the tower's base. Bond the ground plate to the EES with a 4/0 AWG copper conductor in accordance with the requirement in paragraph 4.2.1.6. A separate bond shall be made from the point of origin within the tower structure of each waveguide, axial cable, or conduit to the metallic tower structure. These are in addition to the bulkhead connector plate required in paragraph 4.2.1.6.

4.2.3.6.9 Staircase/Ladder Protection

The metallic access to the tower, i.e., staircase, ladder, etc., shall be exothermically bonded near its base to the EES with a 4/0 AWG copper conductor installed in a location that avoids accidental tripping or striking that could result in personnel injury. Where staircase sections, platforms etc. are not welded together, bonding jumpers shall be installed between them.

4.2.3.7 Lightning Protection for Facilities without Buildings or Antennas

Facilities such as Runway Visual Ranges are commonly built without buildings or antennas. While these are small facilities their loss can have an impact on the NAS far out of proportion to their size. These small facilities must be included within a zone of protection established with either air terminals or overhead catenary wires to prevent damage from lightning strikes.

4.2.3.8 Lightning Protection for Fences and Gates

General airport fencing is not subject to the mandates of this document. Non-FAA owned fencing, that is adjacent to FAA facilities and meets the distance criteria set out in this and sub paragraphs, shall be protected as mandated after agreement with the owner of the fencing. Fences shall be constructed using electrically conducting materials e.g., chain link fabric, metal crossbar, stranded wire, etc., using metal posts that extend a minimum of 2 feet (0.6 m) below grade into a concrete base. Metallic fence fabric with non-conductive coatings shall not be used.

A ground rod shall be installed at spacings no greater than 100 feet, and bonded to a fence post with a 4/0 AWG stranded copper conductor, exothermically welded. Install a 1 inch by $\frac{1}{8}$ inch flexible tinned copper bond strap or an insulated 4/0 AWG flexible (welding) copper conductor from any gate to the adjacent post (exothermic welding is recommended). Install the bonding strap from the gate to the post so it will not limit full motion of the gate (whether swing or slide type). Exothermically weld a 4/0 AWG bare copper conductor from the posts at each side of the gate to ground rods installed at each side of the gate. Connect the conductor to the gateposts at a height no greater than one foot above grade. Interconnect the ground rods at either side of the gate with an exothermically welded 4/0 AWG bare copper conductor buried a minimum of 18 inches below grade.

Bond across any terminations in the security wire using a short piece of the security wire material and UL listed bonding connectors. Bond the security wires to the fence posts at intervals of approximately 40 feet using a 6 AWG stranded tinned copper conductor and UL listed bonding connectors. Attach the metallic fence fabric to the fence posts with wire ties of the same material. The method of bonding fences is illustrated in Figure VII.

For gates, a horizontal bare 6 AWG stranded tinned copper conductor shall be threaded continuously through the gate fabric and mechanically bonded to the vertical gate rails.

Portions of a fence that are within 22 feet of a facility EES shall be bonded to that EES with a 4/0 AWG bare copper conductor exothermically welded to a fence post ground rod. Connections shall be made at a maximum interval of 40 feet with a minimum of two connections.

The above requirements are designed to meet the minimum National Electrical Safety Code (NESC) ANSI C2, Rule 92E. and IEEE Std 80.

Long fences, of 100 feet or greater, shall be positioned so they do not approach any part of an FAA lightning protection system closer than 50 feet if at all feasible. Grounding for portions of long fences that approach closer than 50 feet to any part of a FAA lightning protection system shall be referred to the OPR of this document.

4.2.3.8.1 Fences in High Risk Locations

NFPA 780 identifies the ability of structures to attract lightning from a significant surrounding area increasing the lightning strike frequency. For NAS facilities, the calculated high risk indices and lightning strike frequency values identify an “increased risk of strike”, resultant damage, step potentials and touch potentials for adjacent areas. Consequently certain facilities require additional fence grounding for portions of the fence that fall within the combined area produced by drawing a boundary around each structure equal to 1.5 times the height of that structure in accordance with Figure VI Common Collective Area of Increased Risk. This additional fence grounding shall be in accordance with paragraph 4.2.3.8.2. This requirement applies to the following facilities.

- a) Radar sites such as ASR, ARSR, TDWR, PRM.
- b) ARTCC's
- c) ATCT's over 100 feet in height (tall towers)
- d) Large TRACON's

Grounding for fences for structures such as VOR, RTR, RCAG and lighted Navaids shall be in accordance with the site configuration design controlled by the program offices for those systems and have the approval of the OPR of this document.

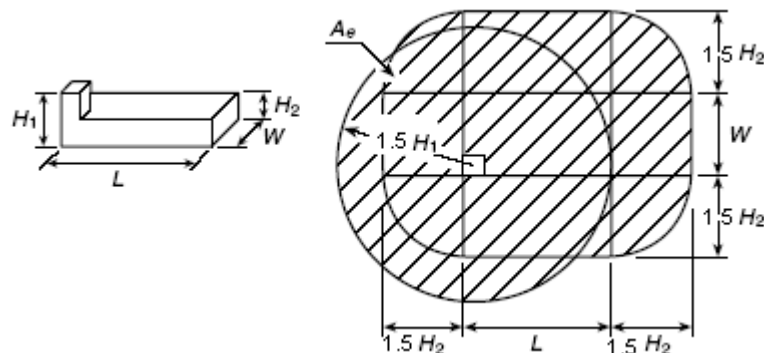


Figure VI Common Collective Area of Increased Risk

4.2.3.8.2 Fence Grounding for High Risk Locations

A buried bare 4/0 AWG stranded copper conductor (fence EES) shall be installed outside the fence where feasible (inside where not), within three feet of the fence, and two feet below grade. A horizontal bare 6 AWG stranded tinned copper conductor shall be threaded through the fencing fabric, approximately midpoint of the fence fabric, and shall be mechanically bonded to the fence posts at intervals not greater than 40 feet. A ground rod is required at these bonding locations and exothermically welded to the fence EES. The fence posts at these bonding locations shall be bonded to the fence EES with a bare 4/0 AWG stranded copper conductor,

exothermically welded to the fence posts and to the ground rod. The method of bonding a fence requiring an EES is illustrated in Figure VIII.

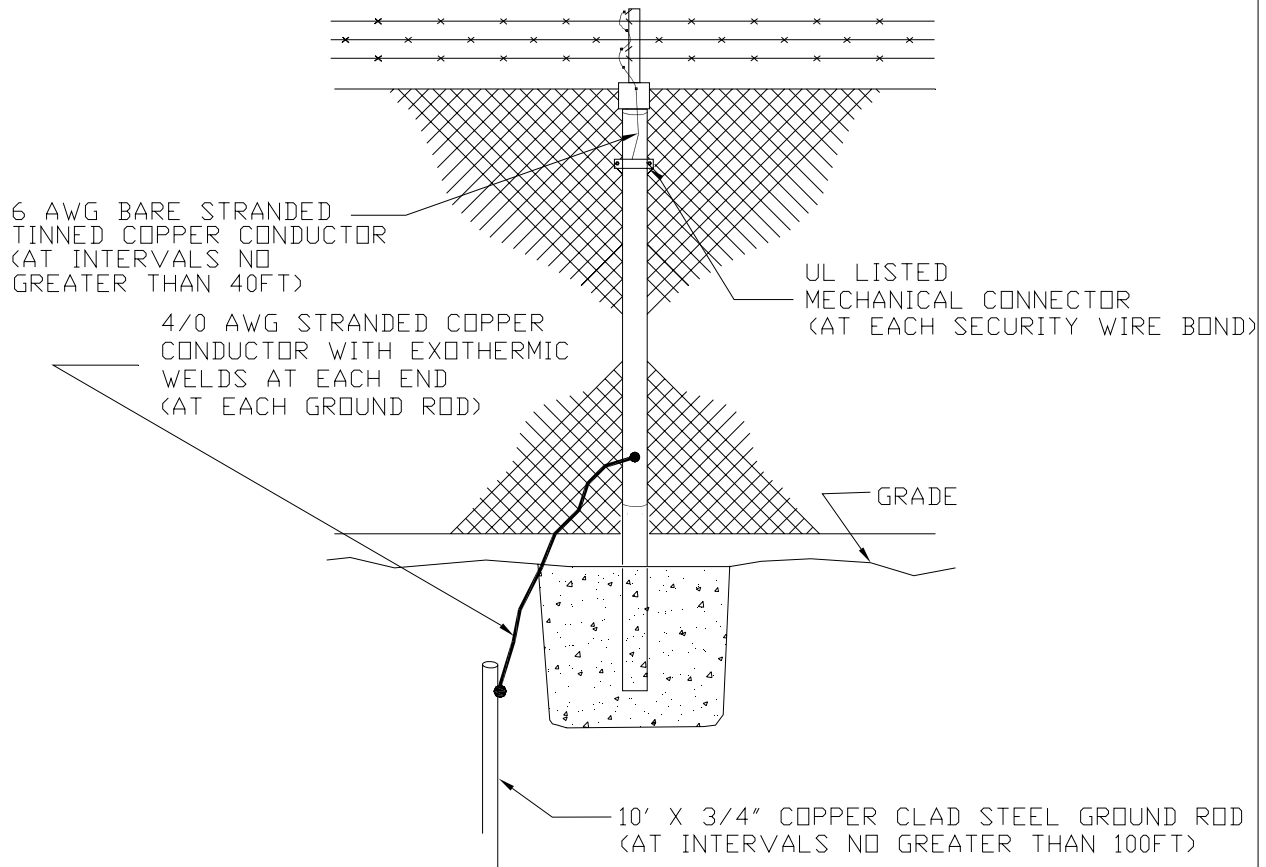


Figure VII. Fence Grounding

The fence EES shall be connected to other EES within the fence EES using buried bare 4/0 AWG stranded copper conductors. A minimum of four connections shall be installed between the fence EES and other EES for structures or buildings with an aggregate footprint of 5,000 square feet or less (preferably at the corners). A minimum of eight connections shall be installed between the fence EES and other EES for structures or buildings with an aggregate footprint greater than 5,000 square feet (preferably at the corners and at the midpoints). Aggregate footprint is defined as the sum of all building and structure footprints.

For swing gates, the horizontal bare 6 AWG stranded tinned copper conductor in the fence fabric shall continue to and be threaded through the gate fabric.

4.2.3.8.3 Fences Crossed by Overhead Power Lines

When overhead power lines cross a fence, bond a fence post on each side of the crossing to a ground rod with a bare 4/0 AWG copper conductor. These connections shall be on each side of and at least 20 feet from the overhead wire crossing. Bond the fence fabric at the top, middle and bottom of the fence and each strand of security wire placed above the fencing fabric to the grounded post with a bare 6 AWG tinned copper conductor. Where crossbars or stranded wire is used, each horizontal strand or cross bar shall be bonded to these posts. Figure VIII shows a typical fence post grounding and bonding.

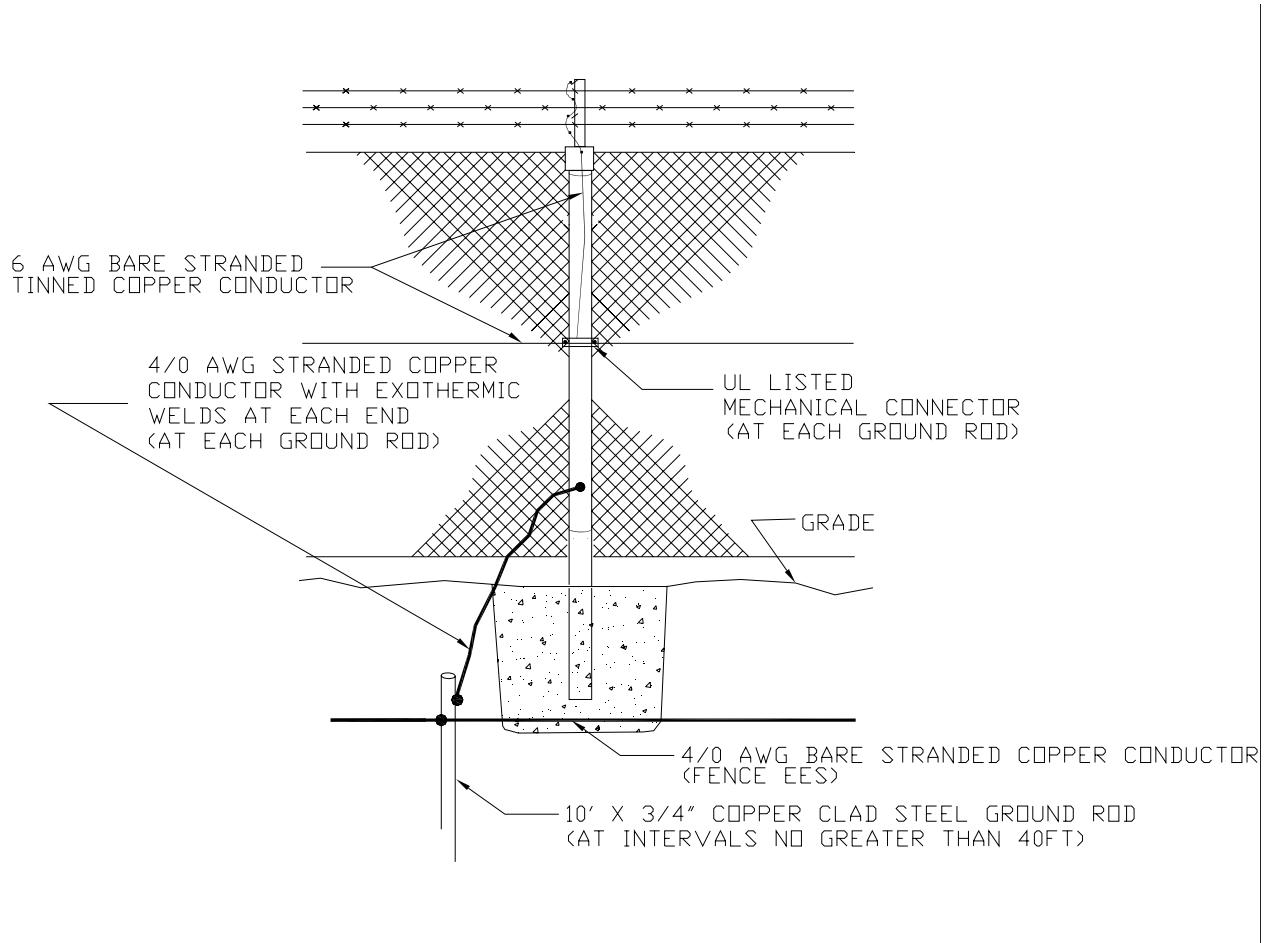


Figure VIII. Grounding Fences Requiring an EES

4.2.4 Earth Electrode System (EES) Requirements

4.2.4.1 General

An EES shall be installed at each facility. The purpose of the EES is to provide a low resistance to earth for lightning discharges, electrical and electronic equipment grounding and surge and transient protection. The EES shall be capable of dissipating within the earth the energy of direct

lightning strikes with no ensuing degradation to itself. The system shall dissipate DC, AC and RF currents from equipment and facility grounding conductors.

4.2.4.2 Site Survey

A site survey shall be conducted for all sites to determine the geological and other physical characteristics. Information to be collected shall include location of rock formations, gravel deposits, soil types etc. Perform a soil resistivity test at probe spacings of 10, 20, 30 and 40 feet (3, 6, 9 and 12m) in four directions from the proposed facility. All survey data, including soil resistivity measurements, shall be noted on a scaled drawing or sketch of the site and included in the Facility Reference Data File. Additional guidance can be found in FAA Orders 6950.19 and 6950.20.

4.2.4.3 Design

The EES shall normally consist of driven ground rods, buried interconnecting conductors and connections to underground metallic pipes (not including gas lines), and tanks. The site survey required in paragraph 4.2.4.2 shall be used as the basis for the design of the EES. The design goal for the resistance to earth of the EES shall be as low as practicable and not over 10 ohms. Where conditions are encountered such as rock near the surface, shallow soils, permafrost and soils with low moisture or mineral content, after evaluation, one of the ground enhancements listed in paragraphs 4.2.4.3.1 through 4.2.4.3.4 shall be used.

4.2.4.3.1 Chemical Enhancements.

Chemical enhancements (doping) with materials such as mineral salts, Epsom salts, sulfates, etc. should only be utilized as a last resort. Chemical enhancement is dependent on soil moisture content and requires periodic (usually yearly) re-treatment and continuous monitoring to be effective. The chemicals leach into the surrounding soil and can be deposited into the water table. Typical installation is in bored holes with ground rods and in trenches.

4.2.4.3.2 Chemical Rods.

Chemical rods also require re-treatment and monitoring to ensure continuous effectiveness. Many of these systems require a drip irrigation system in dry soil conditions. Inspections must be conducted frequently for timely detection of corrosion at connection points between conductors and the chemical rod attachment point. Normal installation is insertion into the soil in accordance with manufacturer's instructions.

4.2.4.3.3 Engineered Soil Materials

Engineered soil materials are cements, soils or clays treated with a variety of materials to enhance their conductive properties. These engineered soils can be a mixture of moisture absorbing materials such as Bentonite or homogenous clays in combination with native soils and/or chemicals. Some engineered soil enhancements utilize concrete-based materials. These materials should be avoided in areas with soil movement. The concrete can break the interconnecting conductor when combined with soil movement. Engineered soil requires the presence of moisture (> 14%) to be effective. Concrete type enhancements can be very expensive. Normal installation is installation in bored holes with ground rods and in trenches.

4.2.4.3.4 Coke Breeze

Coke breeze is a material that is produced as a by-product of coke production. Coke breeze is environmentally safe, stable, and conductive even when completely dry or frozen, non-moisture dependant, compactable and very economical to install. Normal installation is in a one-foot square trench in an EES configuration with a continuous 4/0 AWG stranded copper conductor in the center of the material (see Figure IX). Placement of the trench is based on the geometry of the facility and the physical site location. Radial trenches with a center conductor can be utilized to enhance Radio Frequency (RF) ground planes in communication facilities. The top of the coke breeze trench must be covered by a minimum of one foot of native soil. Coke breeze shall contain no more than 1% sulfur by weight. Charcoal and/or petroleum-based coke breeze shall not be substituted for coke breeze derived from coal in coke ovens. Charcoal and petroleum coke typically contain high levels of sulfur, which in the presence of moisture will accelerate corrosion of the EES.

4.2.4.3.5 Ground Dissipation Plates

In shallow soil locations with limited surface space, ground dissipation plates shall be allowed in place of ground rods in the earth electrode system. The plates shall be installed at the corners of the EES at the farthest accessible point from the facility to be protected. Plates shall be constructed of a minimum one quarter-inch thick copper and be a minimum of two feet square. These plates should be installed in a vertical plane to take advantage of seasonal moisture and temperature changes in the soil. Install the plates at the same depth or deeper than the interconnecting conductor, but maintain a minimum of one-foot of native soil above the upper edge of the plate. Attachment to the EES shall be with a 4/0 AWG bare stranded copper conductor, exothermically welded to the EES and the plate. For maximum performance, the attachment point at the plate shall be at the center of the plate, not near the edge or the corners. To further enhance the effectiveness of ground dissipation plates, they shall be configured as a Jordan Dissipation Plate Design or equal as shown in Figure X. This configuration provides 2/3 more surface area at the edge than a square plate and provides multiple sharp points for increased dissipation capability. In difficult soils/areas a combination of coke breeze trenches and ground dissipation plates is highly recommended (see Figure IX and Figure X).

4.2.4.3.6 Installation of Earth Electrode Systems in Corrosive Soils

Careful consideration must be given to the installation of any grounding system in soils with corrosive elements. Two geological areas of known concern are the volcanic soils in Hawaii and Alaska. It is recommended that supplemental cathodic protection be applied to the grounding system at these locations. A buried steel plate (acting as a sacrificial anode) is connected to the EES by a 4/0 AWG stranded bare copper conductor. The 4/0 AWG conductor shall be exothermically welded to the EES and to the sacrificial plate. The conductor shall be welded to the center of the plate, not near the edge or near the corners. Minimum sizing for the sacrificial plate is four feet square (4'x4') at ½ inch thickness. In shallow soils, this would be in addition to the standard copper ground plates. For enhanced performance, plates shall be a Jordan Dissipation Plate Design or equal (see Figure X).

4.2.4.3.7 Configuration

The EES shall consist of at least four ground rods whose configuration and depth shall be determined by a soil test included in the site survey. At facilities that have two or more structures, e.g. a building and antenna tower, separated by 15 feet or less, a single EES surrounding both structures shall be provided. Where structures are separated by more than 15 feet but less than 30 feet, an EES shall be provided for each structure, but the EES for each structure shall be allowed to share a common side. Where the structures are separated by more than 30 feet but less than 100 feet an EES shall surround each structure and the EESs shall be interconnected by at least two buried conductors. Guidance is provided in FAA Orders 6950.19 and 6950.20.

4.2.4.3.8 Ground rods

Ground rods and their installation shall meet the following requirements:

- (a) Material and Size. Ground rods shall be copper or copper clad steel, a minimum of 10 feet in length and $\frac{3}{4}$ inch in diameter. Rod cladding shall not be less than 1/100 inch thick.
- (b) Spacing. Ground rods shall be as widely spaced as possible, and in no case spaced less than one-rod length. Nominal spacing between ground rods is between two and three times the rod length.
- (c) Depth of Rods. Tops of ground rods shall be not less than 1 foot below grade level.
- (d) Location. Ground rods shall be located 2 to 6 feet outside the foundation or exterior footing of the structure. On buildings with overhangs or sidewalks in close proximity, ground rods shall be allowed at locations further out.

4.2.4.3.9 Interconnections

Ground rods shall be interconnected by a buried, bare, 4/0 AWG copper conductor. The conductor shall be buried at least 2 feet (0.6 m) below grade level. Connections to the ground rods shall be exothermically welded. The interconnecting conductor shall close on itself forming a complete loop with the ends exothermically welded. The structural steel columns of buildings shall be connected to the EES at approximately every other column at intervals not over 60 feet with a bare, 4/0 AWG stranded copper conductor. Connections shall be by exothermic welds. All underground metallic pipes, except where prohibited by the NEC (for example gas piping), and tanks (unless cathodically protected), and the telephone ground, if present, shall be connected to the EES by a copper conductor no smaller than 2 AWG. All underground, interconnecting conductors shall be bare. Exothermic welds shall not be used where hazards exist, i.e. near fuel tanks. In these cases, connections shall be accomplished with hydraulically-crimped terminations using a minimum force of 12 tons concentrically applied. The bonding resistance of all interconnections shall be one milliohm or less for each bond when measured with a 4-terminal milliohm meter.

4.2.4.3.10 Access Well

Access wells are permissible at facilities. The well should be located at a ground rod that is in an area with access to the open soil so that checks of the EES can be made once the facility is in use. The access well shall be made from clay pipe, poured concrete, or other approved wall material and shall have a removable cover. The access well shall be constructed to provide a minimum clearance (12 inches radius) from the center of the ground rod to the inside wall of the

access well. The access well shall have an opening of a minimum 12 inch radius. Connections shall be by exothermic welds.

4.2.5 Main and Supplemental Ground Plates

A main ground plate shall be established as a common point of connection for all Signal Reference Structures (SRSs) for the entire facility. This main ground plate shall be connected to the EES with one 500 kcmil conductor. The conductor from the main ground plate to the EES shall be exothermically welded at the EES and shall be exothermically welded or connected with a UL listed pressure connector to the main ground plate. The main ground plate location shall be chosen to minimize conductor length, but shall not be more than 50 feet from the EES. Ground plates shall be copper and at least 12 inches (305 mm) long, 6 inches (152 mm) wide and $\frac{1}{4}$ inch (6.4 mm) thick. The main ground plate shall have a clear plastic cover that bears the caption "MAIN GROUND PLATE" in black $\frac{3}{8}$ inch (10 mm) high letters and green slashes around the caption. The main ground plate conductor shall be color-coded green at each end.

A supplemental ground plate shall be established at the opposite side of the facility to the main ground plate and shall be color coded green/orange. This supplemental ground plate shall be used only for a second connection of the signal reference plane (SRP) and multipoint ground (MPG) systems to the EES. A large facility shall be allowed to employ more than one supplemental ground plate (contact the OPR when more than one supplemental ground plate is considered). Each supplemental ground plate or plates shall be connected to the EES with a 500 kcmil conductor. The conductor from each supplemental ground plate to the EES shall be exothermically welded at the EES and shall be exothermically welded or connected with UL listed pressure connector to the plate. The length of this conductor shall be 30% longer or shorter than the conductor between the main ground plate and the EES. Ground plates shall be copper and at least 12 inches long, 6 inches wide and $\frac{1}{4}$ inch thick. The supplemental ground plate shall have a clear plastic cover that bears the caption "SUPPLEMENTAL GROUND PLATE" in black $\frac{3}{8}$ inch high letters and green slashes around the caption. The supplemental ground plate conductor shall be color-coded green with red tracer.

A 4/0 AWG bonding conductor shall be provided internally between the main and each supplemental ground plate and shall be color-coded green with orange tracer.

4.2.6 General Grounding and Bonding Requirements

4.2.6.1 Secure Facilities

In all areas of facilities required to maintain communications security, equipment and power systems shall be grounded in accordance with NACSIM-5203 and MIL-HDBK-232A.

4.2.6.2 Electronic Signal Return Path

The electronic signal return path shall be routed with the circuit conductor. For axial circuits, the shield serves this purpose. The electronic equipment case and SRS shall not be used as a signal return conductor.

4.2.6.3 Interior Metal Piping Systems

The interior metal piping systems shall be bonded in accordance with the NEC. An additional bond shall be required in the tower cab between the power ground system and water supply systems. Where there is a separately derived power system for the tower cab, the interior metallic piping systems near the top of the ATCT shall also be bonded to the ground plate as required in paragraph 4.2.11.2.

4.2.6.4 Electrical Supporting Structures

All metallic electrical support structures shall be electrically continuous and shall be bonded to the signal reference plane (SRP) or multipoint ground (MPG) system and to the EES.

4.2.6.4.1 Conduit

All metal conduits shall be grounded as follows:

- (a) Conduit shall have a means to be bonded, prior to entering a structure, to a ground plate or bulkhead plate located outside the structure or directly to the EES. Plate(s) shall be bonded to the EES with an insulated 4/0 AWG stranded copper conductor color-coded green with a red tracer.
- (b) All joints between conduit sections and between conduit, couplings, and boxes shall be electrically continuous. Surfaces shall be prepared in accordance with paragraph 4.1.1.7. Joints that are not otherwise electrically continuous shall be bonded with short jumpers of 6 AWG or larger copper conductor. The jumpers shall be welded in place or shall be attached with clamps, grounding bushings, or other devices approved for this purpose. All bonds shall be protected against corrosion in accordance with paragraph 4.1.1.8.3.
- (c) Cover plates of conduit fittings, pull boxes, junction boxes, and outlet boxes shall be grounded by securely tightening all available screws.
- (d) Every component of metallic conduit runs such as individual sections, couplings, line fittings, pull boxes, junction boxes and outlet boxes shall be bonded, either directly or indirectly, to the SRP or MPG system or facility steel at intervals not exceeding 50 feet.
- (e) Conduit brackets and hangers shall be securely bonded to the conduit and to the metal structure to which they are attached.

4.2.6.4.2 Cable Trays and Wireways

The individual sections of all metallic support structures (cable tray systems) and wireways shall be bonded together with a minimum 6 AWG insulated copper conductor. All bonds shall be in accordance with procedures and requirements specified in paragraph 4.1.1. All cable trays shall be bonded to the SRP or MPG system within 2 feet (0.6 m) of each end of the run and at intervals not exceeding 50 feet (15 m). The resistance of each of these connections shall not exceed 5 milliohms. The minimum size bonding conductor for connection of a cable tray and wireway to the SRP or the MPG shall be 2 AWG copper conductor.

Table VIII. Grounding Conductor Color Codes

Color	Use
Solid green	NEC required grounds
Green with red and yellow tracers	Isolated grounds
Green with yellow tracer	Single point ground
Green with orange tracer	Multipoint ground
Green with red tracer	High-Energy ground

Note: Some commercial-off-the-shelf (COTS) equipment uses green with yellow tracer as a color code for equipment grounding conductors. These conductors shall be retained and grounded as required by the NEC.

4.2.6.5 Building Structural Steel Bonding Requirements

Major structural metal members internal to and about the periphery of NAS electronic equipment rooms shall be made electrically continuous by welding each joint. This shall be accomplished for all the joints of each major structural member, including welding of each roof truss to each column location. In addition, vertical columns on the periphery of the building that are bonded to the EES (paragraph 4.2.4.3.9) shall be welded as described above. Where rebar exists, it shall be connected to the EES with a minimum 2 AWG copper conductor that is applied via an exothermic weld or a hydraulically crimped termination.

In NAS electronic equipment rooms, where steel material is used in construction (including preformed decking, wall covering, etc), it shall be directly bonded (welded) to structural steel or to reinforcing bar. Where direct bonding is not practical, indirect bonds with copper conductor conforming to Table IX shall be used with a minimum of two 2 AWG conductors per 100 square feet of steel decking, wall covering etc. These connections shall be applied via an exothermic weld or a hydraulically crimped two-hole termination. All surface coatings shall be removed in accordance with paragraph 4.1.1.7. For additional installation guidance, contact the OPR of this document.

4.2.6.6 High RF Field Bonding Requirements

FAA facilities that are located in proximity to other facilities that generate high RF levels need additional shielding to protect personnel and sensitive equipment from these external RF sources. Where a determination has been made that the signal level is sufficient to cause concern the following shall be accomplished. Metal building components and attachments such as walls, roofs, floors, door and window frames, gratings and other metallic architectural features shall be directly bonded to structural steel or to reinforcing bar if structural steel is not present, in accordance with paragraph 4.1.1. Where direct bonding is not practical, indirect bonds with copper conductor conforming to Table IX shall be used. Removable or adjustable parts and objects shall be grounded with an appropriate type bond strap as specified in paragraph 4.1.1.3. All bonds shall conform to the requirements of paragraph 4.1.1. Metal building components with a maximum dimension of 3 feet (0.9 m) or less are exempt from the requirements of this paragraph as they are not efficient receiving antennas.

4.2.7 Signal Reference Structures Requirements

All FAA enclosed building facilities, used to house NAS equipment, shall be equipped with a Signal Reference Structure (SRS). Types of SRS include the following systems:

- (a) Multipoint Ground (MPG) systems
 - 1. Conductor and plate
- (b) Signal Reference Plane (SRP)
 - 1. Signal Reference Ground Plane (SRGP)
 - 2. Signal Reference Ground Grid (SRGG)
- (c) Single Point Ground (SPG) systems
- (d) Combination of engineered hybrid system as approved by the OPR of this document.

A SRS shall be constructed in the following areas:

- a) All facility operational areas (entire room area).
- b) All other areas containing electronic equipment supporting facility operations (entire room area).
- c) Any area containing electrical equipment installed to address power quality (e.g., isolation transformers, power conditioning equipment, etc.) not in the same area as the operational or electronic equipment (on different floors, etc.) shall be bonded to the SRS system described above.

The above referenced operational, electronic and electrical equipment shall be bonded to the SRS installations in the area. In turn, all installed SRS's - on the same floor and on different floors - shall be bonded together. Individual areas of the SRS on a single floor shall be bonded to adjacent areas via at least two separate paths. The grounding system on each floor with electrical, electromechanical, or electronic equipment shall be bonded to adjacent floors via at least two separate paths.

The specific SRS type shall be selected by the OPR. SRS systems will be designed for the site-specific requirements of the facilities and equipment. SRS applications require the analysis of equipment bandwidth, and equipment and SRS impedances. SRS analysis will consider, among other parameters, operating frequencies and impedances, transmission line communication models for bonding wires, noise levels in low frequency analog-based equipment, and the influence of high frequency digital signal and logic equipment. SRGGs and SRGPs will be considered when recommended by a vendor. MPGs, SRGGs, and SRGPs can be constructed on ceilings, walls, or floors.

Multiple components of the facility SRS – except any SPGs – shall be bonded together with a minimum of two 4/0 AWG conductors.

All signal-carrying conductors, axial lines, and waveguides and cabling and interconnections between equipments shall be routed in immediate proximity to the SRGG or SRGP when utilized.

A typical ground system is shown in Figure XI.

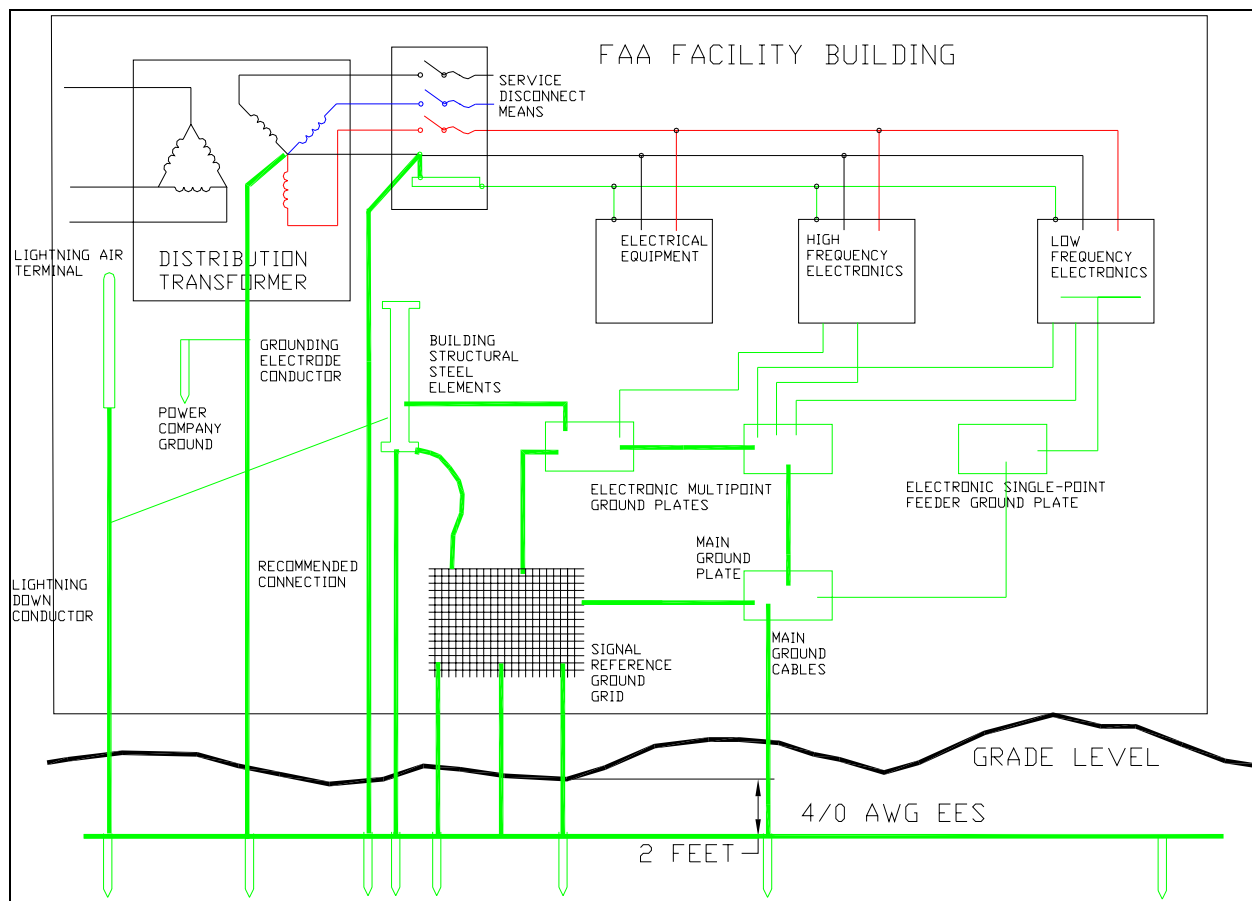


Figure XI. Facility Grounding System

Note figure colors are to distinguish systems and do not form part of a required color code

4.2.7.1 Multipoint Ground Systems

The protection of electronic equipment against potential differences and static charge buildup shall be provided by interconnecting all non-current-carrying metal objects to a multipoint ground system that is effectively connected to the EES. The multipoint ground system consists of installed network of plates and bonding jumpers, racks, frames, cabinets, conduits, wireways, cable trays enclosing electronic conductors, structural steel members, and conductors used for interconnections. The multipoint ground system shall provide multiple low impedance paths to the EES as well as between various parts of the facility, and the electronic equipment within the facility so that any point of the system has a low impedance path to the EES. This will minimize the effects of spurious currents present in the ground system due to equipment operation or malfunction, or from lightning discharges. The multipoint ground system shall not be used in lieu of the safety ground required by the NEC. The multipoint ground system is not to be used as a signal return path.

Exception: For buildings of 200 ft² or less, only the main ground plate is required which shall be connected to the EES with two 4/0 AWG stranded copper conductors. One of the conductors shall be 30% longer than the other. All signal grounding (single point or multipoint) shall terminate on this plate. No additional plates are required.

4.2.7.1.1 Multipoint Ground Plates and Buses

The location of the ground plate shall be chosen to facilitate the interconnection of all equipment cabinets, racks and cases within a particular area. If more than one ground plate is necessary, they shall be installed at various locations within the facility. Ground buses shall be used when distributed grounding is desired with a long row of equipment cabinets. Ground plates shall be copper and at least 12 inches long, 6 inches wide and ¼ inch thick. Ground buses shall be copper. Ground bus width and thickness shall be selected from Table IX, and shall be as long as required. Ground plates and buses shall be identified with a permanently attached plastic or metal label that is green with distinguishing bright orange slashes. The label shall bear the caption “ELECTRONIC MULTIPOINT GROUND SYSTEM” in black 3/8-inch (10 mm) high letters.

4.2.7.1.2 Ground Conductors – Plate to Plate and Plate to Bus

Conductors between plates and buses in the multipoint system shall be insulated and sized in accordance with Table IX based on the maximum path length to the farthest point in the multipoint ground system from the EES. To determine the distance to the farthest point in the multipoint system, add the length of all conductors in the multipoint system to reach the farthest plate in the system via the longest path as shown in Figure XII. Divide the sum obtained by two to obtain the maximum path length. Utilize this path length to determine the conductor size from Table IX, but in no case use a conductor smaller than 4/0 AWG. These conductors shall be color-coded green with an orange tracer or shall be clearly marked for four inches at each end and wherever exposed with a green tape overlaid with an orange tracer. Additionally, when routed in cable trays, conductors shall be color-coded every three feet. Where conductors are routed through cable trays, they shall be insulated and separated from the other conductors as far as possible. These conductors shall be insulated.

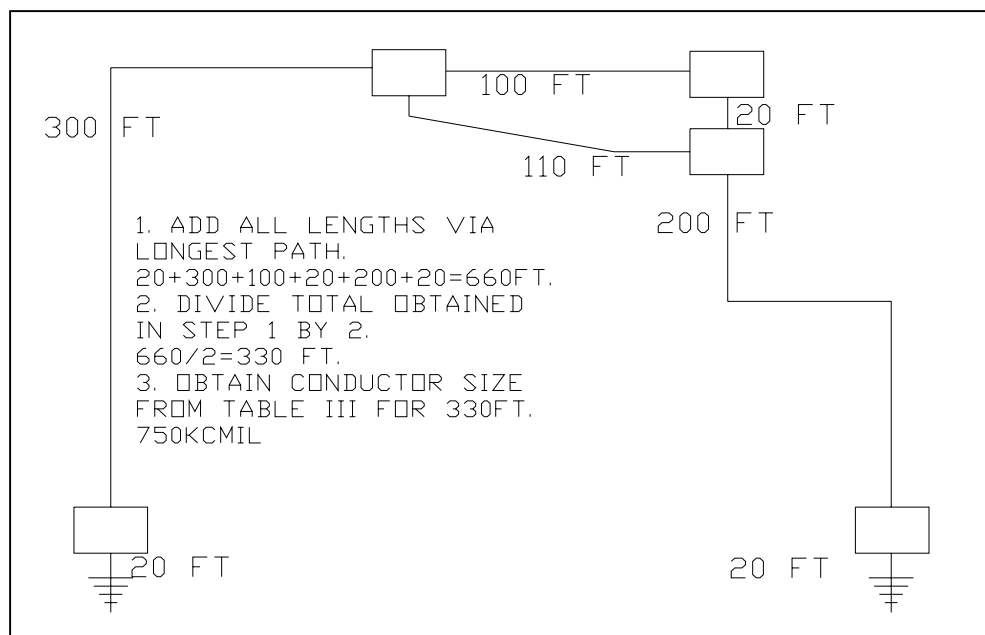


Figure XII. Multipoint Ground Conductor Size Determination

4.2.7.1.3 Ground Conductors (Plate and Bus to Equipment)

Conductors from plates and buses in the multipoint system to equipment chassis shall be sized in accordance with Table IX based on the maximum path length from the plate or bus to the equipment. These insulated conductors shall be color-coded green with an orange tracer or shall be clearly marked for 4 inches at each end and wherever exposed with a green tape overlaid with an orange tracer. Where routed through wireways, the color-coding shall be visible by opening any cover. Provide color-coding 4 inches long at intervals not exceeding 3 feet where ground conductors are routed through cable trays.

Table IX. Size of Electronic Multipoint Ground Interconnecting Conductors

Conductor Size	Max. Path Length		Bus Bar Size		Max. Path Length	
	Ft.	(m)	Inch	(mm)	Ft.	(m)
750 kcmil*	375	(114.3)	4 x 1/4	(100 x 6.4)	636	(193.9)
600 kcmil*	300	(91.4)	4 x 1/8	(100 x 3.2)	318	(96.9)
500 kcmil	250	(76.2)	3 x 1/4	(75 x 6.4)	476	(145.1)
350 kcmil	175	(53.3)	3 x 1/8	(75 x 3.2)	238	(72.5)
300 kcmil	150	(45.7)	2 x 1/4	(50 x 6.4)	318	(96.9)
250 kcmil	125	(38.1)	2 x 1/8	(50 x 3.2)	159	(48.5)
4/0 AWG	105	(32.0)	2 x 1/16	(50 x 1.6)	79	(24.1)
3/0 AWG	84	(25.6)	1 x 1/4	(25 x 6.4)	159	(48.5)
2/0 AWG	66	(20.1)	1 x 1/8	(25 x 3.2)	79	(24.1)
1/0 AWG	53	(16.2)	1 x 1/16	(25 x 1.6)	39	(11.9)
1 AWG	41	(12.5)				
2 AWG	33	(10.1)				
4 AWG	21	(6.4)				
6 AWG	13	(4.0)				

* Where these conductors are not available, parallel conductors shall be allowed, such as three 250 kcmil conductors in place of one 750 kcmil conductor, or two 300 kcmil conductors in place of one 600 kcmil conductor. The conductor sizing is based on providing a cross-sectional area of 2000 circular mils per linear foot. The bus bar sizes are chosen from available cross sections and exceed the cross-sectional requirement of 2000 circular mils per linear foot.

4.2.7.1.4 Protection

Provide mechanical protection for all conductors in the electronic multipoint ground system where they are subject to physical damage. This protection shall be provided by conduit, floor trenches, routing behind permanent structural members, or other means as applicable. Where routed through metal conduit, the conduit shall be bonded to the conductor at each end.

4.2.7.1.5 Conductor Labeling

At each multipoint grounding conductor termination the conductor shall be labeled to identify the point of termination of the other end of the conductor. This shall be accomplished by

embossed label. These conductors shall also be identified every 50 feet and in junction boxes in the manner above indicating both ends.

4.2.7.2 Signal Reference Planes

Signal reference planes (SRPs) shall be constructed of either an SRGG, SRGP, or a combination of both, in accordance with the narrative below:

- (a) **Signal Reference Ground Grid (SRGG):** A SRGG shall consist of a grid of two inch wide copper strips, 26 gauge or thicker, laid on a two feet by two feet grid, welded at each grid intersection. The SRGG shall be installed below a raised floor, at or above a dropped ceiling, or both. The perimeter of the SRGG shall extend to within six inches of the room perimeter or the edge of the raised floor (and/or dropped ceiling) area if the raised floor (and/or dropped ceiling) does not fill the entire room. The SRGG and raised floor shall be bonded together at least every six feet with bare conductors. Dropped ceiling metalwork shall be bonded to ceiling mounted SRGG using guidance provided by the OPR. A 4/0 AWG or larger bare copper conductor shall be routed around the SRGG within six inches of the grid perimeter. The copper strips of the SRGG shall be bonded to the perimeter 4/0 AWG bare copper conductor at every intersection with 4 AWG bare copper conductors. The 4/0 AWG perimeter conductor shall be bonded to the EES with a minimum of four 4/0 AWG conductors spaced as widely apart as practicable.

Building structural steel within the perimeter of the grid and within 6 feet of the grid shall be bonded to the SRGG with a 4/0 AWG or larger conductor. All conduits, wireways, pipes, cable trays, or other metallic elements that penetrate the area shall be bonded to the SRGG where they enter the area and every 25 feet for their entire length within the area. All conduits, wireways, pipes, cable trays, or other metallic elements within 6 feet of the grid shall be bonded to the SRGG. These bonds shall be made with 4 AWG copper conductors minimum.

- (b) **Signal Reference Ground Plane (SRGP):** All SRGP designs shall be approved by the OPR of this document. A SRGP shall consist of copper sheets, 24 gauge thickness minimum. The sheets shall be welded by any method approved by the OPR including butt, pan or lap methods. The SRGP shall be bonded to the EES with a minimum of four 4/0 AWG conductors spaced as widely as practicable.

Building structural steel within the perimeter of the ground plane and within 6 feet of the ground plane shall be bonded to the SRGP with a 4/0 AWG or larger conductor. All conduits, wireways, pipes, cable trays, or other metallic elements that penetrate the area shall be bonded to the SRGP where they enter the area and every 25 feet for their entire length within the area. All conduits, wireways, pipes, cable trays, or other metallic elements within 6 feet of the ground plane shall be bonded to the SRGP. These bonds shall be made with 4 AWG copper conductors minimum.

All conductors and cabling shall lay on or very close (nominally, less than $\lambda/20$ of the highest system frequency) to the SRGG or SRGP. Installation of a SRGG or a SRGP shall be permitted below a raised floor, at or above a dropped ceiling, or both. Floor and ceiling portions of a

SRGG or a SRGP shall be bonded together with a minimum of four 4/0 AWG conductors spaced as widely spaced as practicable. All bonding connections between the equipment and the SRGG or SRGP shall be close-coupled, i.e., the bonding jumpers shall be as short as possible, and routed to the closest SRGG or SRGP location. When either an SRGG or an SRGP is utilized under equipment, a raised floor construction is preferred to enable routing of all connecting conductors and cabling close to the SRGG or SRGP. In this case conductors and cabling shall enter at the base of the equipment

4.2.7.3 Connection of MPG and SRP Systems to the Main and Supplemental Ground Plates

The MPG and SRP systems shall be connected to the Main and Supplemental ground plates with conductors sized in accordance with paragraph 4.2.7.1.2. Each connection shall be to the nearest MPG plate or SRP.

4.2.7.4 Connection of Electronic Enclosures to the SRS

Bonding connections to the SRS shall be allowed either to the below floor SRP or directly to the raised floor system or alternatively to an MPG as constructed in paragraph 4.2.7.1. The length of the bonding conductor shall be less than 19 inches. To prevent the possibility of problems due to resonance of a single bonding strap, two widely spaced straps of unequal length (one of the conductors shall be 30% longer or shorter than the other) shall be used to bond the equipment to the SRS. Bonding straps shall be at least 1" wide and at least 26 gauge. Bonding straps shall be in accordance with paragraph 4.1.1.3 and installed in accordance with paragraph 4.1.1.2. When necessary, any radius in the bonding connectors shall be 8 inches minimum.

4.2.8 Electronic Single Point Ground System Requirements

4.2.8.1 General

Electronic single point ground systems shall be installed in FAA facilities where required by equipment or requested by the vendor and approved by the OPR of this document. FAA facilities that do not utilize single point ground equipment are not required to install a single point ground system. The electronic single point ground system shall be isolated from the power grounding system, the lightning protection system and SRP or MPG systems (except at the main ground plate). The electronic single point ground system shall be terminated at the main ground plate or to the EES, whichever is the closest. The electronic single point ground system shall be configured to minimize conductor lengths. Conductive loops shall be avoided by maintaining a trunk and branch arrangement as shown in Figure XIII.

4.2.8.2 Ground Plates

Main, branch and feeder ground plates shall be of copper and at least 12 inches long, 6 inches wide, and ¼ inch thick. The plates shall be mounted on non-conductive material of sufficient cross section to rigidly support the plates after all conductors are connected. Bolts or other devices used to secure the plates in place shall be insulated or shall be of a non-conducting material. The plates shall be mounted in a manner that provides ready accessibility for future inspection and maintenance.

4.2.8.3 Isolation between Single Point and SRP or MPG Systems

The minimum resistance between the electronic single point ground and the SRP or MPG systems shall be 10 megohms. The resistance shall be measured after the complete network is installed and before connection to the EES or to the SRP or MPG system at the main ground plate.

4.2.8.3.1 Resistance

The maximum resistance of any bond to a ground plate shall not be greater than 1 milliohm.

4.2.8.4 Ground Conductors

All ground conductors shall be insulated copper conductors color-coded green with a yellow tracer.

4.2.8.4.1 Main Ground Conductor

When a single point ground system is established directly from the EES, the single point main ground conductor shall be an insulated 500 kcmil copper conductor not exceeding 50 feet in length. The main ground conductor shall be connected to the EES by an exothermic weld in accordance with paragraph 4.1.1.2.1.

4.2.8.4.2 Trunk and Branch Ground Conductors

An insulated trunk ground conductor shall be installed in each facility from the main ground plate to each of the branch plates as shown in Figure XIII. Insulated copper branch ground conductors shall be installed between feeder plates and branch ground plates. These conductors shall be routed to provide the shortest practical path. Trunk conductors shall be 4/0 AWG insulated copper conductors with a yellow tracer for systems where the farthest feeder plate in the system is no more than 400 feet from the EES via the conductor runs. For longer runs, select a conductor size based on providing a cross sectional area of 500 circular mils (cmil) per running foot of conductor length but in no case smaller than 250 kcmil. Trunk ground conductors shall be exothermically welded or connected with UL listed double bolted connectors to the ground plates in accordance with paragraph 4.1.1.2.4 and shall be mounted as shown on the facility drawings.

4.2.8.4.3 Electronic Equipment Ground Conductors

The conductor from the feeder ground plate (branch ground plate if there is no need for a feeder ground plate in the conductor run) to the isolated terminal or bus on the electronic equipment shall be sized at 500 cmil per running foot with a minimum size of 6 AWG.

4.2.8.5 Interconnections

All connections to the single point ground system shall be made on ground plates or buses. Split bolts and other connections to existing conductors are not allowed.

4.2.8.6 Labeling

The single point ground system shall be clearly labeled to preserve its integrity as described in the following sections.

4.2.8.6.1 Conductor Identification

At each single point grounding conductor termination the conductor shall be labeled to identify the point of termination of the other end of the conductor. This shall be accomplished by embossed label. These conductors shall also be identified every 50 feet and in junction boxes in the manner above indicating both ends.

4.2.8.6.2 Ground Plate Labeling

All ground plates shall be protected with a clear plastic protective cover spaced $\frac{3}{4}$ inch (19 mm) from the plate and extending 1 inch (25.4 mm) beyond each edge. This cover shall have a green label with distinguishing bright yellow slashes attached bearing the caption: "CAUTION, ELECTRONIC SINGLE POINT GROUND" in black $\frac{3}{8}$ inch high (10 mm) letters.

4.2.8.6.3 Protection

Provide mechanical protection for all conductors in the electronic single point ground system where they are subject to damage. This protection shall be provided by conduit, floor trenches, routing behind permanent structural members, or other means as applicable. Single point ground conductors shall be isolated from contact with any metal elements.

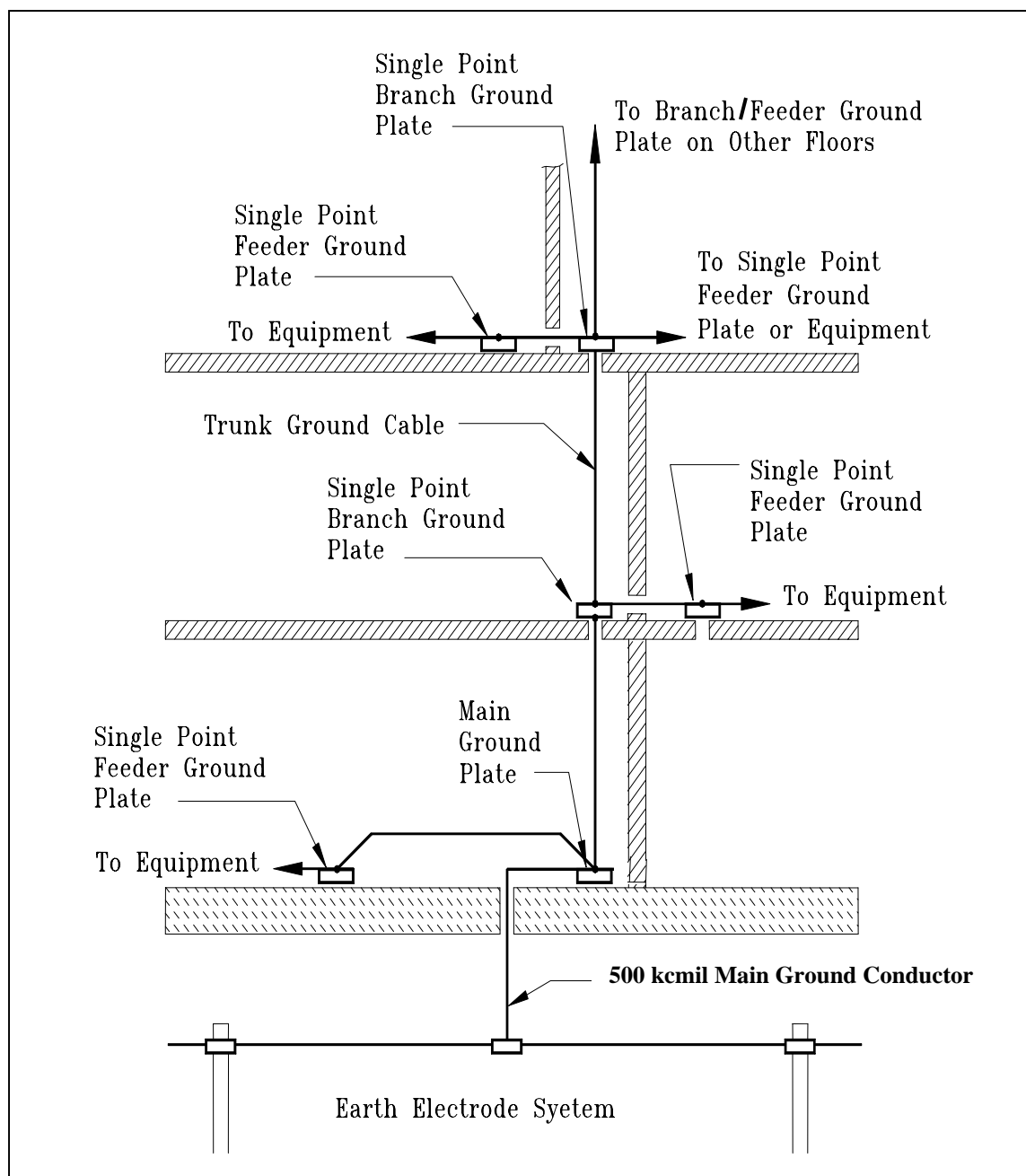


Figure XIII. Electronic Single Point Ground System Installation

4.2.9 DC Bus Grounding Requirements

Contact the OPR for specific DC Bus grounding designs.

4.2.10 National Electrical Code (NEC) Grounding Compliance

4.2.10.1 General

The facility electrical grounding shall exceed requirements of NEC Article 250 as specified herein.

4.2.10.2 Grounding Electrode Conductors

Grounding electrode conductors shall conform to the following:

- (a) Facilities shall have the grounded conductor (neutral) connected to the EES by a copper grounding electrode conductor at the service disconnecting means. The grounding electrode conductor shall be sized in accordance with the NEC, but never smaller than 2 AWG.
- (b) The grounding electrode conductor connection shall be made to the neutral bus in the service disconnecting means.
- (c) If the grounding electrode conductor is spliced using a hydraulically crimped connector, the connector will comply with paragraph 4.1.1.2.4.4. When a grounding electrode conductor is routed through a metal enclosure, e.g., conduit, the enclosure shall be bonded at each end to the grounding electrode conductor.
- (d) An equipment grounding conductor shall be routed with associated phase conductors to a second building or structure. The grounded conductor routed from the first building or structure shall not be connected to the equipment grounding conductor or EES at the second building or structure.
- (e) For a separately derived system, the system bonding jumper and the grounding electrode conductor shall be located at the first downstream system disconnecting means or overcurrent device. For the grounding electrode conductor the connection shall be to the nearest effectively grounded structural metal member. Where it is not feasible to connect the grounding electrode conductor to a structural metal member, the EES shall be used. The grounding electrode conductor shall be copper and sized in accordance with NEC requirements, except that it shall not be smaller than 2 AWG.

Separately derived systems, other than at the top of a tall ATCT, serving NAS critical and essential services shall have an additional grounding electrode conductor terminated to the EES.

4.2.10.3 Equipment Grounding Conductors

The equipment grounding conductor shall be a green-insulated wire routed in the same raceway as its' related phase and neutral conductors. Cord-connected equipment requiring an equipment ground shall include the equipment grounding conductor as an integral part of the power cord. Where power is supplied to electronic equipment through a cable and connector, the connector shall contain a pin to continue the equipment grounding conductor to the equipment chassis. Conduit or cable shields shall not be used as the equipment grounding conductor. All installations shall be in accordance with the NEC, FAA-C-1217 and with the following:

- (a) Parity-sized equipment grounding conductors, same sized as the associated phase conductors, shall be used when it is recommended as good practice in a manufacturer's equipment installation requirements. Where a parity-sized equipment grounding conductor is installed it shall be bonded to bonding bushings at each end of the raceway with a bonding jumper the same size as the equipment grounding conductor. This shall be accomplished for branch circuits as a minimum.
- (b) Grounding terminals in all receptacles on multioutlet assemblies shall be hardwired to an equipment grounding conductor. Strips that depend upon serrated or toothed fingers for

grounding shall not be used.

- (c) All flexible metal conduits shall be provided with an external bonding jumper in addition to the internal equipment grounding conductor. The bonding jumper shall be a 6 AWG green-insulated stranded copper conductor. The bonding jumper shall terminate on fittings listed for grounding at each end of the flexible metal conduit.
- (d) A separate equipment grounding conductor shall be provided for each overcurrent device and as required by the NEC.

4.2.10.4 Color Coding of Conductors

4.2.10.4.1 Grounded Conductors

- (a) Grounded conductors shall be insulated and color-coded white for 120/208V and 120/240V and gray for voltages above 120/240V. Conductors larger than 6 AWG shall be allowed to be re-identified as the grounded conductor except that green conductors shall not be re-identified.
- (b) In any raceway, box, cable tray, or enclosure, where grounded conductors of different systems are present, each grounded conductor shall be identified by system, in accordance with the NEC.
- (c) Color-coding of grounded conductors shall be applied at each connection and at every point where the conductor is accessible. Where routed through raceways with covers, the color coding shall be visible by removing or opening any cover. Where conductors are routed through cable trays, color coding 3 inches (75 mm) in length shall be provided at intervals not exceeding 3 feet (0.9 m).

4.2.10.4.2 Equipment Grounding Conductors

- (a) Equipment grounding conductors shall be solid green in color. Insulated conductors larger than 6 AWG shall be allowed to be re-identified with green tape. White or gray conductors shall not be re-identified as equipment grounding conductors. The equipment grounding conductor from the grounding terminal of an isolated receptacle shall be color-coded green with yellow and red tracers.
- (b) Color-coding of equipment grounding conductors shall be applied at each connection and at every point where the conductor is accessible. Where routed through raceways with covers, the coding shall be visible by removing or opening any cover. Where conductors are routed through cable trays, color coding 3 inches (75 mm) long shall be provided at intervals not exceeding 3 feet (0.9 m).
- (c) Some COTS equipment is supplied with a green and yellow equipment grounding conductor. These conductors do not need to be replaced. These conductors shall not be connected to the single point ground system.

4.2.10.4.3 Control and DC Power Cables and Conductors

Color-coding for conductors in control cables shall be in accordance with NEMA Standard WC-5. DC power conductors, including battery cables, shall be color-coded as follows: a red for positive conductor and black for a negative conductor. The red conductor shall be marked with a positive (+) symbol and the black conductor shall be marked with a (-) symbol. The symbols shall be applied to the conductor with a shrink embossed label.

4.2.10.5 Non-Current-Carrying Metal Equipment Enclosures

- (a) All non-current-carrying metal enclosures such as raceways, cable trays and panel boards shall be electrically continuous. Insulating finishes shall be removed between grounding/bonding areas of mating surfaces or bonding jumpers. Ferrous conduit (galvanized rigid metal conduit only) shall be equipped with bonding bushings at each end and the equipment grounding conductor shall be bonded to the bushings with a bonding jumper the same size as the equipment grounding conductor. This shall be accomplished in accordance with Figure XIV.
- (b) Ferrous materials shall be used for enclosures, raceways, and cable trays to provide shielding from magnetic fields
- (c) All battery supporting racks shall be bonded either directly to the EES or to any grounded structure with a 2 AWG conductor.

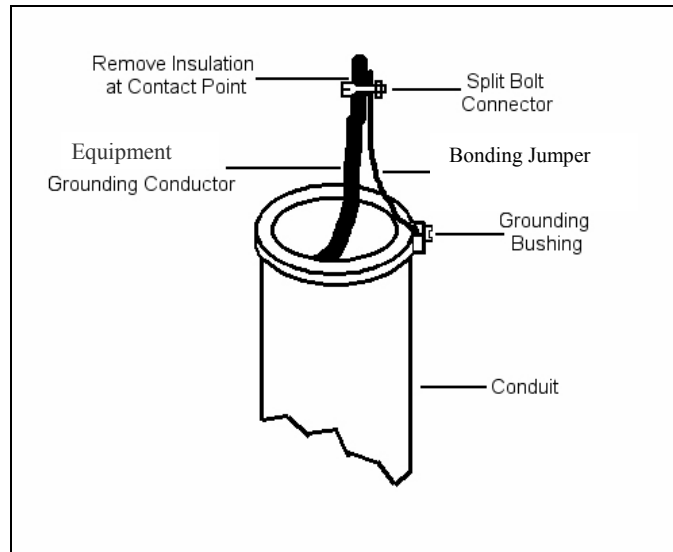


Figure XIV. Bonding of Conduit and Grounding Conductor

4.2.11 Airport Traffic Control Towers (ATCT) Special Requirements

ATCT's (Figure XV) having electronic areas in the cab, junction and sub-junction levels at the top of the shaft and also in the associated base building present a unique set of challenges for implementing lightning and transient protection. The numerous conductors running between electronic equipment located in the base building and beneath the tower cab are subject to large electromagnetic fields during a lightning strike. For this reason, special techniques shall be applied to provide an environment that minimizes the damaging effects of lightning. These techniques are mandatory for ATCT facilities with base buildings that meet the following:

- (a) Over 100 feet in height to the highest point of the building, and
- (b) Located in areas with a lightning flash density of $0.5/\text{km}^2/\text{year}$ ($1.3/\text{mile}^2/\text{year}$) or greater.

These techniques are recommended for application to all ATCT facilities.

4.2.11.1 General

The lightning protection, electrical, electromechanical, electronic systems, and building steel of structures shall be bonded together for safety. It is not possible for equipment near the top of the tower and at the base to have the same electrical potential during a lightning strike. It is therefore necessary to reference all systems at the top of the tower to each other and treat this area as a separate facility. SPD's shall be provided at the base building/tower shaft facility entrance and at the top of the shaft.

4.2.11.2 Main Ground Connections

In order to assure good high frequency grounding during normal operation a low impedance connection must be provided to the EES. A main ground plate shall be established on the lowest level with electrical, electromechanical, or electronic equipment serving the ATCT cab (see Figure XV). All grounding systems present at or above this level within the ATCT shall be connected to this main ground plate. A 1-foot wide 26 gauge or thicker copper strap shall connect this main ground plate to a plate at the base of the ATCT. This strap shall be routed continuously from the main ground plate to the base plate without sharp bends, loops, kinks, or splices and will provide two square feet of surface per linear foot of conductor. Substitution of a combination of conductors providing the same surface area per linear foot shall be allowed. This strap or conductors shall be mechanically bonded to the main ground plate and the base plate. The strap shall be sandwiched between the plate at each end and a 1"x1"x1/8" copper bar to insure good electrical contact and mechanical strength. Connect the base plate to the EES in an access well with two exothermically welded 500 kcmil conductors. The OPR should be consulted for assistance in meeting this requirement.

4.2.11.3 Power Distribution

All power distribution for the areas at the top of the ATCT shall be via separately derived systems. These separately derived systems shall be grounded in accordance with the requirements of NEC article 250 and paragraph 4.2.10.2(e) at the first downstream disconnecting means or overcurrent device. This point of connection is mandated to facilitate the effective installation of an SPD. An SPD, in accordance with paragraph 4.2.2.2 shall be installed on the load side of the first downstream disconnecting means or overcurrent device of each separately derived system. The ground bus at the first disconnecting means or overcurrent device shall be bonded to the main ground plate established in accordance with the requirements paragraph 4.2.11.2. This connection is in addition to the grounding electrode conductor requirements of NEC article 250.

The interior metallic piping systems at the top of the ATCT shall be bonded to the main ground plate established in accordance with the requirements paragraph 4.2.11.2. This connection is in addition to the bonding requirements of NEC article 250.

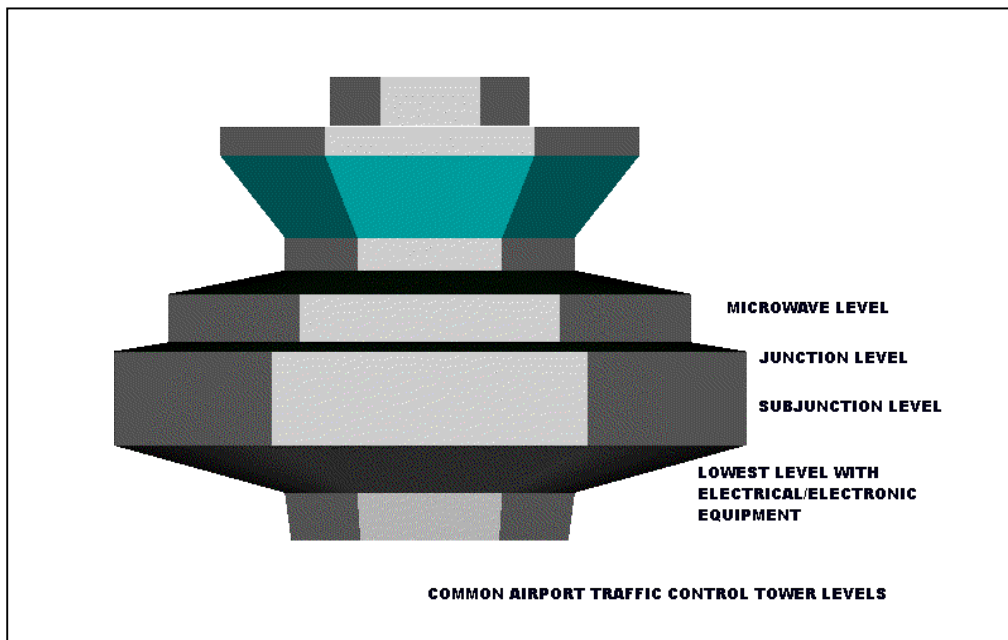


Figure XV. Airport Traffic Control Tower Levels

4.2.11.4 Bonding

Metal elements comprising the ATCT shall be bonded together and to the EES.

Provision shall be made to ensure that all rebar used in tower construction is electrically bonded together – continuous laterally and vertically to the EES – for the entire ATCT. Rebar shall be bonded to the EES with a minimum 2 AWG copper conductor that is applied via an exothermic weld or a hydraulically crimped termination.

At the top of the ATCT, the tower cab and all equipment locations supporting the cab shall be enveloped in a rudimentary Faraday cage. This shall be accomplished by bonding together all structural and fabrication steel. In turn, this steel cage shall be electrically bonded to the rebar in the concrete construction. Penetrations of the Faraday cage, e.g., conduit, water pipe, etc., shall be bonded to the cage at the point of entry. Bonding jumpers shall be a minimum 2 AWG copper conductor.

At all levels of an ATCT, horizontal metal transitions (floors, stairs, walkways, etc.) shall be bonded to structural steel and/or rebar. Elevator support structures shall be bonded to horizontal metal transitions and to the EES. All bonding jumpers shall be a minimum 2 AWG copper conductor.

If this last requirement cannot be met, contact the OPR of this document.

4.2.11.5 Signal, Communications, Axial Cables and Control Line Protection

Transient protection shall be applied at each end of vertical cables routed between the equipment room near the top of the ATCT and the associated base building. Cables between the tower cab

and equipment room areas shall be protected in accordance with paragraphs 4.2.2.5 through 4.2.2.7. Both facility and equipment levels of protection shall be provided for these lines. Enclosing metallic cabling in ferrous conduit or the use of all dielectric fiber optic cable can significantly reduce the threat of lightning related damage to ATCT and base building circuits.

4.2.11.6 Signal Reference Structure

An SRS shall be constructed in accordance with paragraph 4.2.7. This shall be accomplished for the cab and all other areas at the top of the ATCT that contain electrical, electromechanical or electronic equipment serving the cab.

4.2.11.7 Floor Coverings for Electronic Equipment and Operational Areas

Floor coverings for the cab and areas serving the cab shall be either tile or carpeting and shall be of static dissipative material. These shall be installed per manufacturers' specifications and connected to a component of the SRS – except to any single point ground system. The floor covering and installation shall meet the requirements of paragraph 4.1.3.4.8.

4.2.11.8 Single Point Grounding

Single point ground systems, if required, shall be constructed in accordance with paragraph 4.2.8. All single point ground systems and independent ground systems mandated by equipment manufacturers shall be bonded to the ATCT main ground plate established in accordance with the requirements paragraph 4.2.11.2.

4.3 Equipment Requirements

Electronic equipment installed in FAA NAS facilities must comply with the requirements contained in this section.

4.3.1 Electronic Signal Lines and Cables

Electronic signal lines shall be shielded twisted pairs with an insulated covering. Cables consisting of multiple twisted pairs shall have the individual shields isolated from each other. Cables shall have an overall shield with an overall insulated covering.

4.3.1.1 Termination of Individual Shields

Termination of individual shields shall be in accordance with paragraph 4.1.2.3.2.

4.3.1.2 Termination of Overall Shields

Termination of overall shields shall be in accordance with paragraph 4.1.2.3.3.

4.3.2 Signal Control and Data Line Entrance

Procurement organizations are responsible for ensuring that electronic equipment, such as radars, nav aids, or transmitters, supplied for use in FAA operational facilities, shall be provided with transient protection that reduce surges and transients to below the equipment transient susceptibility level. Signal control and data line entrance protection shall be provided as an integral part of all electronic equipment mounted internally or on the exterior of the equipment and at the facility entrance. The equipment susceptibility level is defined as the transient level

on the signal, control or data lines that cause damage, degradation, or upset to electronic circuitry connected to the line. Protection for these lines is in addition to the facility protection levels specified in paragraphs 4.2.2.5 through 4.2.2.7. The procurement organizations are responsible for ensuring that testing is performed to determine voltage, current, or energy levels that will cause immediate damage to components, shorten operating life, or cause operational upset to the equipment. These tests shall consider all electrical and electronic equipment components exposed to the effects of surges or transients. The procurement organization shall ensure that facility and equipment entrance protection is coordinated to limit transients at the equipment to below the equipment susceptibility level. Requirements of this paragraph shall be included in the comprehensive control and test plans outlined in paragraph 4.1.4.2. In all cases, the following characteristics shall be evaluated.

- (a) Component damage threshold. The damage threshold is the transient level that renders the component nonfunctional or operationally deficient. For solid-state components, voltage is usually the relevant parameter.
- (b) Component degradation level. The component degradation level is the transient voltage or energy level that shortens the useful life of the component.
- (c) Operational upset level. The operational upset level is the transient voltage or energy level that causes an unacceptable change in operating characteristics for longer than 10 milliseconds for analog equipment or a change of logic state for digital equipment.

4.3.2.1 Lines and Cables Requiring Protection

Surge protective devices shall be placed on both ends of signal, data, and control lines longer than 10 feet connecting pieces of equipment not located on and bonded to the same SRS, or when the SRGG, SRGP, and the multipoint ground system is located in different rooms or on different floors. (refer to Figure XVI). This includes all signal, data, and control lines. This equipment shall be protected as specified in paragraph 4.3.2.

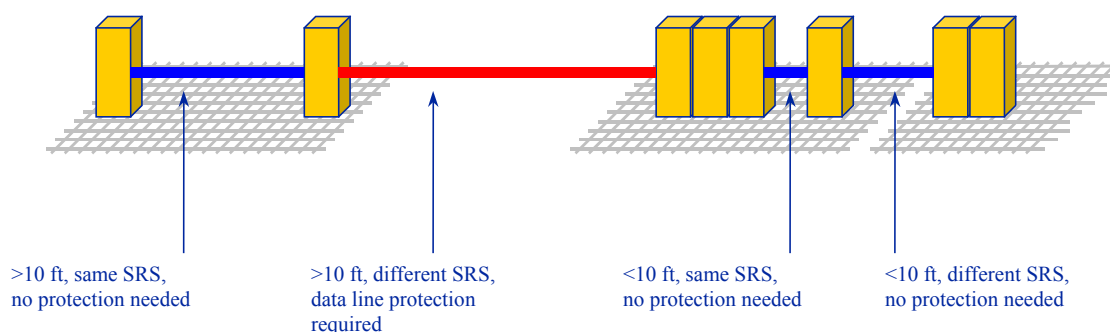


Figure XVI. Lines and Cables Requiring Protection

4.3.3 Power Entrance

Surge protective devices, components or circuits for protection of electronic equipment power lines shall be provided by the equipment manufacturer as an integral part of all electronic equipment mounted internally or on the exterior of the equipment at the cable entrance (see paragraph 4.2.2.1). These devices shall be positioned at the AC power conductor entrance to electronic equipment housed in a shielded, compartmentalized enclosure. SPDs at equipment shall provide a clamping level less than the equipment operational upset susceptibility level as

defined in paragraph 4.3.2(c) and must conform to the relevant columns of Table X, Table XI, and Table XII.

- (a) Maximum continuous operating voltage (MCOV). The maximum continuous operating voltage is the maximum RMS voltage an SPD will withstand at its maximum operating temperature continuously without degradation or change to any of its parameters greater than +/-10%. The MCOV will be at least 10% above the nominal system voltage. Leakage current as defined below shall not be exceeded.
- (b) Leakage current. The DC leakage current will be less than 1mA for voltages at or below $1.414 \times \text{MCOV VDC}$.
- (c) Clamp (discharge) voltage. Clamp (discharge) voltage is the maximum voltage that appears across an SPD output terminal while conducting surge currents. Clamp (discharge) voltage measured at 3kA (to ensure performance in the linear region without impacting the device lifetime performance) 8/20 microseconds shall not change more than 10% over the operating life of the Surge Protection Device as defined in Table XII. Electronic Equipment Power Entrance SPD Requirements.
- (d) Overshoot voltage. Overshoot voltage shall not exceed 2 times the SPD clamp voltage for more than 10 nanoseconds. Overshoot voltage is the surge voltage level that appears across the SPD terminals before the device turns on and clamps the surge to the specified voltage level.
- (e) Self-restoring capability. The SPD shall automatically return to an off state after surge dissipation when line voltage returns to normal.
- (f) Operating lifetime. The SPD shall safely dissipate the number and amplitude of surges listed in Table XII.
- (g) Fusing. Any fusing shall not increase the clamp voltage of the SPD and shall pass the surge current levels listed in Table XII up to the 20kA level without opening. Any fusing provided shall be coordinated with the supply fusing.

4.3.3.1 Slope Resistance

It is the purpose of this parameter to create a regime where it is possible to ensure device coordination. The slope resistance for the equipment protection shall meet the requirements of Table X and is calculated via the formula below:

$$R_{\text{slope}} = (V_{10} - V_1) / 9000$$

Where V_{10} = the clamping voltage measured at 10kA 8/20 μ s
and

Where V_1 = the clamping voltage measured at 1kA 8/20 μ s

The values of V_{10} and V_1 used shall be measured values determined in actual testing of the SPDs and not calculated.

Table X. Equipment Power Entrance Slope Resistance Requirements

Location	Slope Resistance
Electronic equipment power entrance	60 mΩ Minimum

The voltages that must be achieved during testing at 3kA with an 8/20μs current impulse is shown in Table VI. All voltages shall be measured at the device terminals. The 8/20μs current impulse wave shape shall not lead or lag the voltage wave shape by more than 30 degrees.

Table XI. Protection Voltages at 3kA for the Equipment Power Entrance

Location	System Voltage	V ₃	Limit
Electronic equipment power entrance	120/208 120/240	550 L-N, L-G 850 L-L	Minimum
Electronic equipment power entrance	277/480	850 L-N, L-G 1350 L-L	Minimum
Electronic equipment power entrance	380Delta	1350 L-L, L-G	Minimum
Electronic equipment power entrance	480 Delta	1350 L-L, L-G	Minimum

Table XII. Electronic Equipment Power Entrance SPD Requirements

Surge Current Amplitude 8/20μs Waveform	Surge Number lifetime Electronic equipment power entrance
1kA	100
10kA	25
20kA	1

Each level of surge current and the number required represents a single lifetime of an SPD.

4.3.3.2 DC Power Supply Transient Suppression

Procurement organizations are responsible for ensuring that power supplies that use 60 Hertz (Hz) power and furnish DC operating voltages to solid-state equipment used in direct support of the NAS, shall have transient suppression components from each output of the power supply to the equipment chassis. The chassis side of suppressors shall be connected as directly as possible to rectifier output ground. Operating characteristics of suppression components provided for power supply rectifier output lines shall be as follows:

- (a) Operating lifetime. The transient suppressors shall safely dissipate 1000 surges with an amplitude of 200 Amps and a waveform of 1.2/50 μ s. Methods of testing shall be in accordance with the guidance in IEEE C62.45.
- (b) Limiting Voltage. The voltage shall be limited to a point 20% below the maximum Peak Inverse Voltage (PIV) of the DC rectifier.

4.3.3.3 Externally Mounted Electronic Equipment

When electronic equipment is not enclosed in a facility (e.g. RVR, LLWAS, OM, etc.) the power SPD protection specified in this document rated for facility entrance shall be provided. For the signal and control cables of this equipment both facility and electronic equipment entrance shall be provided at the equipment entrance as a combined protector. The grounding conductor shall be bonded to the equipment chassis and shall be of minimum length and routed to avoid sharp bends, kinks or loops. Access shall be provided for visual inspection and replacement of these SPDs.

4.3.4 Electronic Equipment Grounding

4.3.4.1 Electronic Cabinets, Racks, and Cases

All electronic cabinets, racks, and cases shall provide a grounding terminal or bus whereby a grounding jumper or wire can be mechanically connected through an electrically conductive surface to the basic frame. The metal enclosure of each individual unit or piece of electronic equipment shall be bonded to its cabinet, rack, or directly to the SRP or MPG system.

4.3.4.2 Isolated Grounding Receptacles

For reduction of electrical noise, isolated receptacles installed in accordance with the NEC shall be permitted. The isolated equipment grounding conductors used for these receptacles shall be color-coded green with red and yellow tracers at each termination, and when passing through an enclosure without termination.

4.3.4.3 Portable Equipment (with grounding conductor)

Portable electrical or electronic equipment cases, enclosures, and housings shall be considered to be adequately grounded for fault protection through the equipment grounding conductor of the power cord, provided continuity is firmly established between the case, enclosure or housing, and the receptacle ground terminal. The power cord equipment grounding conductor shall not be used for signal grounding.

4.3.4.4 AC Power Filters

All filter cases shall be directly bonded in accordance with paragraph 4.1.1.10 to the equipment case or enclosure. Filter leakage current shall not exceed 5 milliamperes (mA) per filter. Transient suppression devices, components or circuits shall be installed in accordance with paragraph 4.2.2.1.

4.3.5 Equipment Signal Grounding Requirements

4.3.5.1 Input and Output Electronic Signals

Where a common signal reference is used, low frequency analog input and output signals shall be balanced with respect to the signal reference. Extreme care shall be taken to maintain isolation between the single point ground system and the SRP or MPG system, except at the main ground plate or EES.

4.3.5.2 Multipoint Grounding of Electronic Equipment

When permitted by circuit design requirements, all internal ground references shall be directly bonded to the chassis and the equipment case. Where mounted in a rack, cabinet or enclosure, the electronic equipment case shall be bonded to the racks, cabinet or enclosure in accordance with paragraph 4.3.4.1. The DC resistance between any two points within a chassis or electronic equipment cabinet serving as ground shall be less than 25 milliohms total and not more than 2.5 milliohms per joint. Shields shall be provided as required for personnel protection and electromagnetic interference reduction.

4.3.5.2.1 Prevention of Resonance in Bonding Straps

To prevent the possibility of problems due to resonance of a single bonding strap, two widely spaced straps of unequal length shall be used to connect the equipment to the multipoint grounding bus in the equipment cabinet. Bonding shall be in accordance with the recommended practices as expressed in paragraph 4.2.7.4 and IEEE Std 1100-1999 paragraph 8.5.4.6.

4.3.5.3 Single Point Grounding of Electronic Equipment

When electronic equipment performance necessitates an isolated electronic single point ground system for proper operation, all the equipment and its installation shall comply with the following:

The single point ground system or plane shall be isolated from the electronic equipment case. If a metal chassis is used as the electronic single point ground, the chassis shall be floated relative to the case. Design practices shall be such that the single point ground of the electronic equipment can be properly interfaced with other electronic equipment without compromising the system. If necessary, this single point ground system shall be filtered for high frequencies.

4.3.5.3.1 Single Point Input and Output Signal Requirements

The “high” and “low” sides of input and output signals shall be isolated from the electronic equipment case and balanced with respect to the signal reference. Operating and adjusting controls, readouts or indicating devices, protective devices, monitoring jacks and signal connectors shall be designed to isolate both the high and low side of the signal from the case.

4.3.5.3.2 Single Point Case Isolation Requirements

The isolation between the single point ground system terminals and the case shall be 10 megohms or greater with all external power, signal and control lines disconnected from the electronic equipment.

4.3.5.3.3 Single Point Power Isolation Requirements

The isolation between the single point ground system terminals and each power conductor (including AC neutral) shall be 10 megohms or greater with the power switch in the on position and the power disconnected from the supply.

4.3.5.4 Equipment Single Point Ground Terminals

Insulated single point ground system terminal(s) shall be provided on each electronic equipment case where an isolated signal reference is required. The single point ground reference for the internal circuits shall be connected to this terminal. This terminal(s) shall be used to terminate cable shields as appropriate, and to connect the isolated signal ground of the electronic equipment to the single point ground system in the facility. A connector pin, a screw or pin on a terminal strip, an insulated stud, jack or feed through, or an insulated wire shall be an acceptable terminal so long as each terminal is clearly marked, labeled, or coded in a manner that does not interfere with its intended function. These marks, codes, or labels shall be permanently affixed and shall utilize green with yellow stripes. Wire insulation shall be green with a yellow tracer.

4.3.5.4.1 Connection of Electronic Equipment to the Single Point Ground System

Each equipment single point ground terminal shall be connected to the facility single point ground system in accordance with the following:

- (a) Individual units or pieces of electronic equipment which by nature of their location or function cannot or should not be mounted with other electronic equipment, shall have an insulated copper conductor installed between the electronic single point ground terminal specified in paragraph 4.3.5.4 and the nearest electronic single point ground system ground plate. This conductor shall have a cross-sectional area of 500 circular mils per linear foot with a minimum size of 6 AWG.
- (b) Where two or more units or pieces of electronic equipment are mounted together in a rack or cabinet, a single point ground bus bar shall be installed as shown in Figure XVII. The bus bar shall be copper and shall provide a minimum cross-sectional area of 125,000 circular mils (e.g., a 1 inch by 1/8 inch bus bar). The bus bar shall be drilled and tapped for #10 screws. The holes shall be located as required by the relative location of the isolated electronic single point grounding terminals on the electronic equipment. The bus bar shall be mounted on insulating supports that provide at least 10 megohms resistance between the bus bar and the rack or cabinet.
- (c) Each electronic equipment isolated single point ground terminal shall be interconnected to the bus bar by means of a solid or flexible tinned (6 AWG minimum) copper jumper of sufficient cross sectional area so that its resistance is 5 milliohms or less. The jumper shall be insulated or mounted in a manner that maintains the required degree of isolation between the reference conductor and the enclosure. The interconnecting jumper shall be attached to the bus bar at a point nearest to the single point ground terminal to which the strap is attached. An insulated copper conductor shall be installed from the bus bar in the cabinet to the nearest electronic single point ground system. This conductor shall provide at least 500 circular mils per linear foot, and must be a minimum 6 AWG conductor.

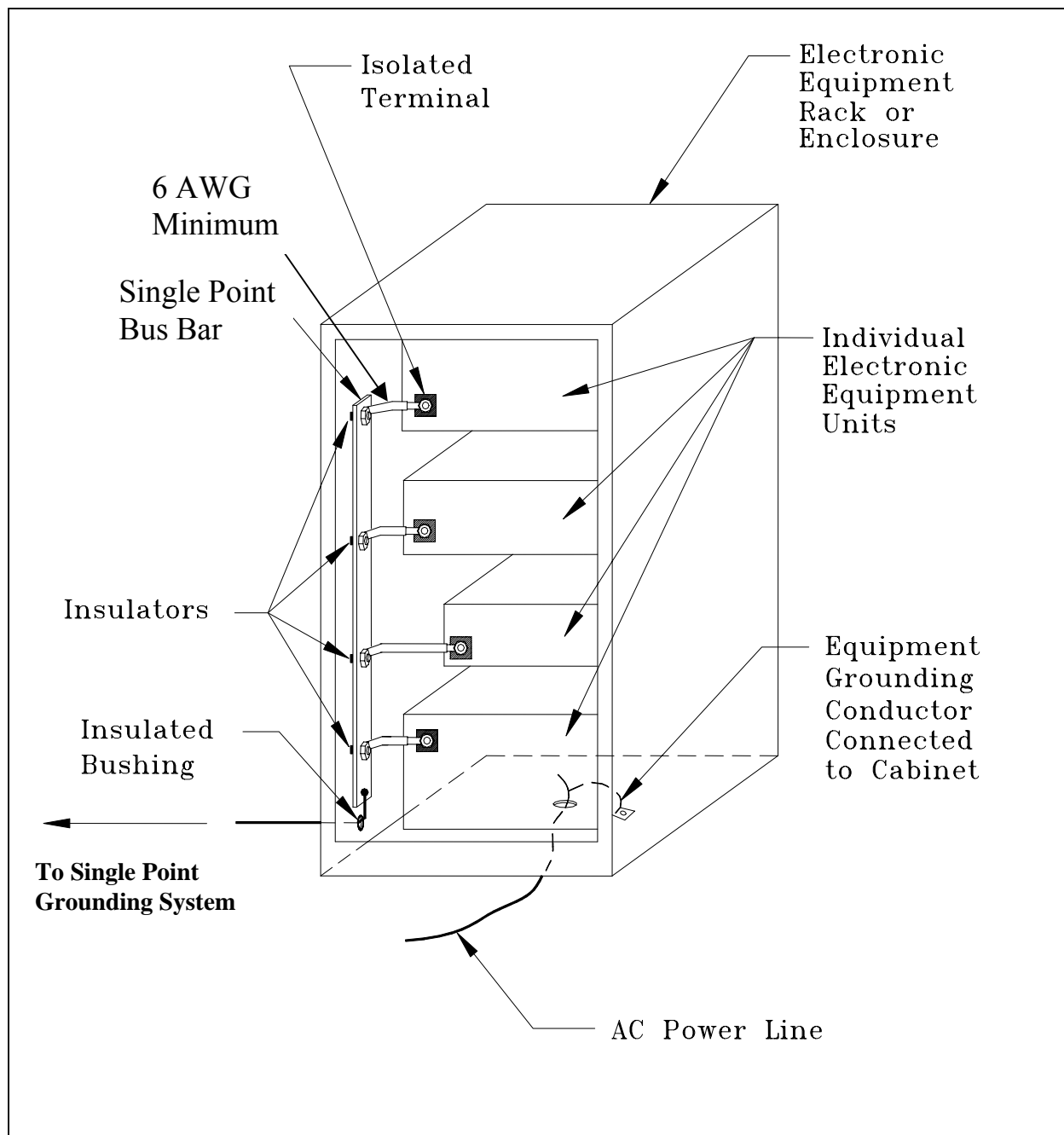


Figure XVII. Single Point Electronic Ground Bus Bar Installation in Rack or Cabinet

4.3.6 Equipment Shielding Requirements

4.3.6.1 Control of Apertures

Unnecessary apertures shall be avoided. Only those shield openings needed to achieve proper functioning and operation of the equipment shall be provided. Controls, switches, and fuse holders shall be mounted so close metal-to-metal contact is maintained between the cover housing of the devices and the case. Metal control shafts shall be grounded in accordance with paragraph 4.3.6.2. Where nonconductive control shafts are necessary, a close fitting metal sleeve peripherally bonded to the case shall be provided for the shaft. The length of the sleeve shall be no less than four times its diameter. Lights shall be filtered or shielded as needed to maintain the required degree of shielding effectiveness. Ventilation and drainage holes shall utilize appropriate shielding techniques. Care shall be taken to assure that the shielding is well bonded to the shield completely around the opening.

4.3.6.2 Metal Control Shafts

Metal control shafts shall be grounded to the equipment case through a low impedance path provided by close-fitting conductive gaskets, metal finger stock, or grounding nuts.

4.3.6.3 Shielded Compartments

Shields shall be bonded to the chassis for fault protection in accordance with paragraph 4.1.1.

4.3.7 Circuit and Equipment ESD Design Requirements

4.3.7.1 Circuit Design and Layout

The design, layout, and packaging of assemblies, circuits, and components integrated into electrical and electronic equipment shall incorporate methods and techniques to reduce susceptibility to ESD.

4.3.7.2 Component Protection

External protection shall be provided for all integrated circuits, discrete components, and other parts without internal ESD protection that are inherently susceptible to ESD. Protective components shall be installed as close as possible to the ESD susceptible item.

4.3.7.3 ESD Withstand Requirements

In the installed and operational configuration, all equipment cabinets, enclosures, racks, controls, meters, displays, test points, interfaces, etc., shall withstand a static discharge of 15,000 Volts per ESD Association Standard Test Method ESD-STM 5.1, Electrostatic Discharge Sensitivity Testing – Human Body Model (HBM). Equipment that is tested shall not suffer any operational upset or damage to any component or assembly to successfully pass ESD withstand requirements.

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5 DETAILED REQUIREMENTS

Section is not applicable to this standard.

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6 NOTES

6.1 Acronyms and Abbreviations

The following are acronyms and abbreviations used in this standard

A	Amperes	L-L	Line to Line
AC	Alternating current	L-N	Line to Neutral
ANSI	American National Standards Institute	LRU	Line replacement unit
AWG	American Wire Gauge	m	Meter
Cm	Centimeter(s)	mA	Milliampere
Cmil	Circular mils	MCM	See kcmil
DC	Direct current	MCOV	Maximum continuous operating voltage
e.g.	For example	MHz	Megahertz
EES	Earth electrode system	MPG	Electronic multipoint ground system
EMI	Electromagnetic interference	mm	Millimeter(s)
EPP	Equipotential plane	NAS	National Airspace System
EOS	Electrical overstress	NEC	National Electrical Code
ESD	Electrostatic discharge	NEMA	National Electrical Manufacturers Association
Et.al.	And others	NFPA	National Fire Protection Association
FAA	Federal Aviation Administration	No.	Number
ft.	Foot (feet)	OPR	Office of Primary Responsibility
GP	Groundable point	PVC	Polyvinyl chloride
Hz	Hertz	RF	Radio frequency
i.e.	That is	RGS	Rigid galvanized steel
in.	Inch(es)	RFI	Radio frequency interference
IEEE	Institute of Electrical and Electronics Engineers	RMM	Remote maintenance monitoring
kA	Kiloampere	SAS	Silicon avalanche diode suppressors
kcmil	Thousand circular mils	SDM	Service disconnecting means
kg	Kilogram	SPD	Surge protective device
kHz	Kilohertz	SPG	Electronic single point ground system
LAN	Local area network	SRG	Signal reference grid
LPGBS	Lightning Protection, Grounding, Bonding and Shielding	UL	Underwriters Laboratories
“	Inch(es)	μs	Microseconds
#	Number	‘	Foot (feet)
L-G	Line to Ground	V	Volts

6.2 Guidelines

Engineering design guidelines are provided for lightning protection, grounding, bonding, shielding, and transient protection in FAA Orders 6950.19 and 6950.20. Guidance for EMI protection is in MIL-HDBK-253, and for electrostatic discharge (ESD) in NFPA 77, DOD-HDBK-263, DOD-STD-1686 and IEEE1100.

6.3 Version Cross-Reference

Due to the major reorganization of FAA-STD-019e it is not feasible to provide an exact cross-reference between this standard and the previous version, FAA-STD-019d. However the handbook to FAA-STD-019e will provide information on requirements revisions and detail cost effective methods of applying them. Where possible references to the original requirements in FAA-STD-019d will be provided.

