Date: February 21, 2012

RE: City of Duluth Bid #12-4401
   New Passenger Terminal Bid Package 2C
   Civil Sitework & Apron/Concessions and Furnishings

Addendum No. 1

TO: Prospective Bidders

This Addendum forms a part of the Contract Documents and modifies the original Bidding Documents dated February 10, 2012. Acknowledge receipt of this Addendum in the space provided on the Bid Form. Failure to do so may subject the Bidder to disqualification.

1.0 PROJECT MANUAL

1.1 Invitation to Bid:

Delete: 8.22C Doors, Frames and Hardware (material only);
8.23C High Speed Overhead Doors shall now read: 8.23C Overhead Fabric Doors;
13.23C Breach Control shall now read: 13.22C Breach Control;
Delete: 13.22C Computer Controlled Access;
Delete: 13.23C Flight Display.

1.2 Bid Form:

Civil Sitework & Apron - Line Item No. 88 shall read: Type “C” Light with Foundation.

1.3 Table of Contents:

Part Two–Bid Information and Proposal Forms: Prevailing Wages Rates shall read: 31 pages.

1.4 Technical Specifications:

Include missing Specification Sections listed below in their entirety.

Part Eight–Technical Specifications:
Item P-153 Controlled Low Strength Material (CLSM) ......................... P-153-1–3
Item P-501 Portland Cement Concrete ......................................................... P-501-1–34
Item D-751 Manholes, Catch Basins, Inlets and Inspection Holes .......... D-751-1–9
Item L-105 Alterations, Removal and Demolition ............................... L-105-1–5
Item L-108 Underground Power Cable for Airports ............................ L-108-1–13

Part 9 – Special Provisions
SP-1 through SP-16 in its entirety.

Part Eleven–Division 1 – 16 Technical Specifications:
16670 Lightning Protection................................................................. 16670-1–13
2.0 DRAWINGS

Replace drawings listed below with sheets included with this Addendum No. 1

2.1 Volume 3 of 3 – Mechanical, Electrical, Plumbing & Fire Protection

M001 MECHANICAL LEGEND
M002 MECHANICAL SYMBOLS
M110 ENLARGED FIRST FLOOR MECHANICAL PLAN AREA A
M111 ENLARGED FIRST FLOOR MECHANICAL PLAN AREA B
M112 PARTIAL SECOND FLOOR MECHANICAL PLAN - CONCESSIONS AREA
M114 PARTIAL THIRD FLOOR MECHANICAL PLAN - CONCESSIONS AREA
M116 PARTIAL ROOF LEVEL MECHANICAL PLAN - CONCESSIONS AREA
M303 TUG TUNNEL RAMP SNOW MELT PLAN, FLOW DIAGRAM AND DETAILS
M401 MECHANICAL SCHEDULES & DETAILS
M401C MECHANICAL EQUIPMENT SCHEDULES
M503 MECHANICAL DETAILS
M506 RAMP SNOW MELT SYSTEM DETAILS
MP111 ENLARGED FIRST FLOOR MECHANICAL PIPING PLAN AREA B
MP112 ENLARGED SECOND FLOOR MECHANICAL PIPING PLAN AREA A
MP113 ENLARGED SECOND FLOOR MECHANICAL PIPING PLAN AREA B
MP114 ENLARGED THIRD FLOOR MECHANICAL PIPING PLAN AREA A
MP115 ENLARGED THIRD FLOOR MECHANICAL PIPING PLAN AREA B
E001C ELECTRICAL SYMBOLS
E112C ENLARGED SECOND FLOOR ELECTRICAL PLAN - AREA A
E116 ELECTRICAL ROOF PLAN
E117 RAMP ELECTRICAL POWER AND LIGHTING PLAN
EL112C ENLARGED SECOND FLOOR LIGHTING PLAN - AREA A
E300C BLDG POWER RISER DIAGRAM
E301 PANEL SCHEDULES
E301C PANEL SCHEDULES
E400 ELECTRICAL ABBREVIATIONS AND TABLES
E401 LIGHTING FIXTURE SCHEDULE
E404 PANEL SCHEDULES
E405 PANEL SCHEDULES
E406 PANEL SCHEDULES
E407 PANEL SCHEDULES
ET001 TECHNOLOGY/ SECURITY SYSTEMS LEGEND AND NOTES
ET401 TECHNOLOGY FIRST FLOOR PLAN
ET402 TECHNOLOGY SECOND FLOOR PLAN
ET403 TECHNOLOGY THIRD FLOOR PLAN
ET410 TECHNOLOGY FIRST FLOOR PLAN AREA A
ET411 TECHNOLOGY FIRST FLOOR PLAN AREA B
ET412 TECHNOLOGY SECOND FLOOR PLAN AREA A
ET413 TECHNOLOGY SECOND FLOOR PLAN AREA B
ET414 TECHNOLOGY THIRD FLOOR PLAN AREA A
ET415 TECHNOLOGY THIRD FLOOR PLAN AREA B
ET501 COMMUNICATIONS EQUIPMENT RACK ELEVATION
ET502 ENLARGED ROOM PLANS
ET503 ACCESS CONTROL DETAILS
ET504 ACCESS CONTROL DETAILS
ET505 ACCESS CONTROL SIGNS
ET600 ACCESS POINT SCHEDULE
ET601 SECURITY RISER
ET602 MUFIDS RISER
2.0 DRAWINGS-continued

ET603 VIDEO SURVEILLANCE RISER
ET604 NETWORK RISER
ET605 CATV & DISPLAY RISERS
ET606 COMMUNICATION RISER
P001 PLUMBING SYMBOL LIST, ABBREVIATIONS AND DRAWING LIST
P110 ENLARGED FIRST FLOOR PLUMBING PLAN AREA A
P111 ENLARGED FIRST FLOOR PLUMBING PLAN AREA B
P112 ENLARGED SECOND FLOOR PLUMBING PLAN AREA A
P114 ENLARGED THIRD FLOOR PLUMBING PLAN AREA A
P122 TUG RAMP ROOF PLUMBING PLAN
P210 FIRST FLOOR FOOD SERVICE PLUMBING PLAN
P212 SECOND FLOOR FOOD SERVICE PLUMBING PLAN
P501 PLUMBING SCHEDULES
F001 FIRE PROTECTION SYMBOL LIST, ABBREVIATIONS AND DRAWING INDEX
F110 ENLARGED FIRST FLOOR FIRE PROTECTION PLAN AREA A
F111 ENLARGED FIRST FLOOR FIRE PROTECTION PLAN AREA B
F112 ENLARGED SECOND FLOOR FIRE PROTECTION PLAN AREA A

2.1 DRAWINGS

Replace drawings list sheet G101 included with this Addendum No. 1 for: Volume 1 Civil, Landscaping, Structural; to include Mechanical, Electrical, Plumbing & Fire Protection; and Volume 2 Architectural, Signage to include Mechanical, Electrical, Plumbing & Fire Protection. Insert the following additional drawings to Volume 2: Architectural, Signage:

FS101 FOOD SERVICE EQUIPMENT PLAN AND SCHEDULE
FS201 FOOD SERVICE EQUIPMENT ELEVATIONS AND SECTIONS
FS202 FOOD SERVICE EQUIPMENT ELEVATIONS AND SECTIONS
FS301 FOOD SERVICE EQUIPMENT SPECIAL CONDITIONS PLAN AND DETAILS
FS401 FOOD SERVICE EQUIPMENT STANDARD DETAILS
FS402 FOOD SERVICE EQUIPMENT STANDARD DETAILS
FS403 FOOD SERVICE EQUIPMENT STANDARD DETAILS

3.0 OTHER:

There will be no “Request for Substitutions” considered until each Bid Division has been awarded.

END OF ADDENDUM NO. 1
REQUEST FOR BID

DATE  2/10/2012

BID #  12-4401

RETURN BY BID OPENING TIME TO:

PURCHASING DIVISION
100 CITY HALL
Duluth, MN 55802
Buyer: Dennis Sears
PHONE: 218-730-5340
FAX: 218-730-5921

NEW PASSENGER TERMINAL BP-2C SITWORK & APRON CONCESSIONS AND FURNISHINGS

THIS BID FORM INCORPORATES THREE (3) COMBINED FORMS TO INCLUDE:

NO. 1 - LINE ITEM BID SCHEDULE FOR CIVIL SITWORK & APRON
NO. 2 - ITEMIZED BID FORM SECTION 11400 FOOD SERVICE EQUIPMENT
NO. 3 - WORK SCOPE DIVISIONS 1-16

BID OPENING AT 2:00 PM on THURSDAY, MARCH 8, 2012

Note: all bids must be written, signed and transmitted in a sealed envelope, plainly marked with the bid number, subject matter and opening date. The City of Duluth reserves the right to split award where there is a substantial savings to the City, waive informalities and to reject any and all bids. Bidder should state in proposal if bid price is based on acceptance of total order. Sales tax shall be included in the unit price. Bidder to state freight charges if the proposal F.O.B. is shipping point, freight not allowed. Low bid will not be the only consideration for award of bid. Bid Form shall be signed by authorized bidder’s representative as indicated on signature lines and addendums need to be acknowledged with this request for bid form.

RETURN BID IN DUPLICATE WITH DUPLICATE DESCRIPTIVE LITERATURE
FOR BID RESULTS, ENCLOSE A SELF-ADDRESSED, STAMPED ENVELOPE WITH BID

BID DEPOSIT REQUIREMENTS: 5% OF BID AMOUNT
Deposit shall mean cash, cashier’s check or corporate surety bond payable to or in favor of the City of Duluth.

A PERFORMANCE BOND AND A PAYMENT BOND shall be required of the successful bidder, BOTH in the full amount of the bid.

INSURANCE CERTIFICATE required per attached requirements.
Designated F.O.B. Point: Jobsite

Tax: Federal Excise Tax Exemption
Account No. 41-74-0056 K

Vendor Email Address: ____________________________ FREIGHT CHARGE $ N/A

NAME: ____________________________
ADD1: ____________________________
ADD2: ____________________________
ADD3: ____________________________

TOTAL BID PRICE # ____________________________
TO INCLUDE ANY ADDITIONAL PAGES.

PAYMENT TERMS $ ____________________________
F.O.B. POINT ____________________________
DELIVERY DATE ____________________________

(Payment)
(Tele. #)

The City of Duluth is an Equal Opportunity Employer.

DULUTH AIRPORT AUTHORITY
DULUTH INTERNATIONAL AIRPORT
NEW PASSENGER TERMINAL
BP-2C SITWORK APRON
CONCESSIONS AND FURNISHINGS

Bid Docs.xls
FEBRUARY 10, 2012
ISSUE FOR BID
ADDENDUM NO. 1
**********SCHEDULE OF PRICES**********

NEW PASSENGER TERMINAL BP-2C SITEWORK & APRON
CONCESSIONS AND FURNISHINGS

Make all extensions and total the bid.

This Bid Form will consist of a Line Item Base Bid for the Civil Sitework & Apron including four (4) Add Alternates; plus Multiple Bid Divisions for the Concessions and Furnishings (Building work)

(Civil Sitework & Apron)--Total Base Bid Line Item $__________

(Civil Sitework & Apron)--Total Add Alternate No. 1 $__________

(Civil Sitework & Apron)--Total Add Alternate No. 2 $__________

(Civil Sitework & Apron)--Total Add Alternate No. 3 $__________

(Civil Sitework & Apron)--Total Add Alternate No. 4 $__________

(Civil Sitework & Apron) Total Base Bid including Add Alternates $__________

SEE ATTACHED BID FORM FOR CONCESSIONS AND FURNISHINGS WORK SCOPE DIVISIONS

The basis of award shall be the lowest bid for either the Line Item Total or Line Item Totals with any combination of Add Alternates No 1, 2, 3 and 4. The basis of the award of the contract shall be at the sole discretion of the City of Duluth/Duluth Airport Authority. The award of the individual Additive Alternates is at the sole discretion of the City of Duluth/DAA, based on available Federal Funding. The City of Duluth/DAA reserves the right to award either the Base Bid or the Base Bid and Alternates No. 1 2, 3 and/or 4. There will be no additional allowance in the Contract Time if the Additive Alternate is awarded.

A Mandatory pre-bid meeting will be held on Thursday, March 1, 2012 at 2:00 p.m. In the Skyline Room, 2nd Floor, Passenger Terminal Building, Duluth International Airport
ADDENDUM RECEIPT ACKNOWLEDGEMENTS:

ADDENDUM NO.       , DATED
ADDENDUM NO.       , DATED
ADDENDUM NO.       , DATED
ADDENDUM NO.       , DATED
ADDENDUM NO.       , DATED
ADDENDUM NO.       , DATED

CONTRACTOR NAME:

THE CONTRACTOR AGREES TO ALL OF THE PROVISIONS CONTAINED IN THE CONTRACT DOCUMENTS. ENCLOSED HEREWITH FIND A CERTIFIED CHECK OR BID BOND IN THE AMOUNT OF AT LEAST 5% OF THE AMOUNT OF PROPOSAL MADE PAYABLE TO THE CITY OF DULUTH AS A PROPOSAL GUARANTEE WHICH IT (see additional page(s))

IS AGREED BY THE UNDERSIGNED WILL BE FORFEITED IN THE EVENT THE FORM OF CONTRACT AND BOND IS NOT EXECUTED, IF AWARDED TO THE UNDERSIGNED.

SIGNED: ______________________ FOR

A PARTNERSHIP (OR)

A CORPORATION INCORPORATED UNDER THE LAWS OF THE STATE OF:

PRESIDENT ______________________
VICE-PRES. ______________________
SECRETARY ______________________
TREASURER ______________________
ADDRESS(ES) ______________________

BEING DULY SWORN, DEPOSES AND SAYS THAT THERE ARE NO OTHER PERSONS COMPRISING ABOVE COMPANY OR FIRM THAN THE ABOVE NAMES, AND THAT THERE ARE NO PERSONS OR
CORPORATIONS INTERESTED IN THE FORGOING PROPOSALS, EITHER AS PRINCIPAL OR SUBCONTRACTOR, OTHER THAN THE ABOVE NAMES; ALSO THAT THE PROPOSALS ARE MADE WITHOUT ANY CONNECTION WITH ANY PERSON OR PERSONS MAKING ANY PROPOSAL FOR THE ABOVE WORK; THAT THEY ARE IN ALL RESPECTS FAIR AND WITHOUT COLLUSION OR FRAUD; AND THAT NO PERSON ACTING IN ANY OFFICIAL CAPACITY FOR THE CITY OF DULUTH IS DIRECTLY OR INDIRECTLY INTERESTED THEREIN, OR IN ANY PORTION OF THE PROFIT THEREOF.

_______________________________________________________________

SUBSCRIBED AND SWORN TO BEFORE ME THIS

__________________________

DAY OF ___________

A.D.,

_______________________________________________________________

NOTARY PUBLIC

IMPORTANT NOTE BIDDERS:
ALL APPLICABLE SALES AND/OR USE TAXES ARE TO BE INCLUDED IN BID PRICING. ALSO, ALL BIDS ARE TO BE P.O.B. JOBSITE.

DULUTH AIRPORT AUTHORITY
DULUTH INTERNATIONAL AIRPORT
NEW PASSENGER TERMINAL
BP-2C SITEWORK APRON
CONCESSIONS AND FURNISHINGS
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<td>51</td>
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<td>STORM SEWER PIPE, 4&quot; SDR35</td>
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<td>53</td>
<td>D-705.5.1</td>
<td>INSTALL 6&quot; UNDERDRAIN WITH FABRIC PIPE WRAP AND POROUS BACKFILL</td>
<td>LF</td>
<td>9070</td>
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<td>54</td>
<td>D-705.5.2</td>
<td>REMOVE SEWER PIPE (STORM), 12&quot; - 18&quot; DIA.</td>
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<td>56</td>
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<td>60</td>
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<td>62</td>
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<td>64</td>
<td>D-751.7.9</td>
<td>STORM DRAINAGE FRAME AND COVER, AS SPECIFIED</td>
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<td>D-751.7.10</td>
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<td>66</td>
<td>D-751.7.11</td>
<td>ADJUST EXISTING STORM OR SANITARY MH CASTING</td>
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<td>67</td>
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<td>69</td>
<td>F-162.5.3</td>
<td>6' CHAIN LINK FENCE W/ 3 STRANDS BARBED WIRE</td>
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<td>TEMPORARY FENCE 6' CHAIN LINK FENCE, NO CONCRETE FULL POSTS, NO TOP RAIL, OR BARBED WIRE</td>
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<td>F-162.5.5</td>
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<td>72</td>
<td>T-901.5.1</td>
<td>HYDROSEEDING AND WOOD FIBER MULCH WITH FERTILIZER</td>
<td>ACRE</td>
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<td>TOPSOILING (FURNISHED FROM OFF THE SITE)</td>
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<td>75</td>
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<td>REMOVE LIGHT AND FOUNDATION (SIDEWALK)</td>
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<td>76</td>
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<td>1/C NO. 8 AWG, 5KV, TYPE L-824 CABLE, SERIES LIGHTING CABLE INSTALLED IN DUCTBANK OR CONDUIT</td>
<td>LF</td>
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<td>77</td>
<td>L-108-5.2</td>
<td>1/C NO. 6 AWG, BARE COPPER COUNTERPOISE WIRE INSTALLED IN TRENCH, INCLUDING GROUNDING CONNECTORS</td>
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<td>78</td>
<td>L-108-5.3</td>
<td>3/C #6 600V THHN CABLE</td>
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<td>81</td>
<td>L-110.5.1</td>
<td>1-WAY, 2&quot; SCHEDULE 80 PVC, DIRECT BURIED</td>
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<td>82</td>
<td>L-125-5.1</td>
<td>MEDIUM INTENSITY TAXIWAY EDGE LIGHT, L861, 30&quot; HEIGHT, 6.6A, BASE MOUNT, 360 BLUE LENS, LED LAMP</td>
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<td>83</td>
<td>L-125-5.4</td>
<td>TEMPORARY TAXIWAY EDGE LIGHTING</td>
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<td>84</td>
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<td>STRUCTURE EXCAVATION CLASS R</td>
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<td>85</td>
<td>NDOT 2504.602/0002</td>
<td>INSTALL HYDRANT &amp; VALVE</td>
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<td>86</td>
<td>NDOT 2504.603/0003</td>
<td>6&quot; WATERMAIN DUCTILE IRON CL 53</td>
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<td>87</td>
<td>NDOT 2564.337/0001</td>
<td>HANDICAP PARKING SIGN R7-9M</td>
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<td>88</td>
<td>SF 5.3</td>
<td>TYPE 'C' LIGHT WITH FOUNDATION</td>
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</table>
**LOCATION:** Duluth International Airport  
**PROJECT DESCRIPTION:** NEW PASSENGER TERMINAL - SITEWORK/APRON

### BID ITEM  
**SPEC. NUMBER**  
**ITEM DESCRIPTION**  
**UNIT**  
**ESTIMATED QUANTITY**  
**UNIT COST**  
**TOTAL COST**  

<table>
<thead>
<tr>
<th>Bid Item</th>
<th>Spec. Number</th>
<th>Item Description</th>
<th>Unit</th>
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<th>Unit Cost</th>
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<tr>
<td>89</td>
<td>SP 6.3</td>
<td>Programmable Circuit Breaker, Square D Type NF Powerlink or Approved Equal</td>
<td>Each</td>
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<td>90</td>
<td>SP 7.3</td>
<td>Entrance &amp; Exit Gates w/ Detector Loops w/ Foundation</td>
<td>Each</td>
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<td>91</td>
<td>SP 8.3</td>
<td>Provide and Install Parking Stops</td>
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<td>92</td>
<td>SP 9.3</td>
<td>Building Demolition</td>
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<td>93</td>
<td>SP 10.3</td>
<td>Remove Valve and Cap Water Line</td>
<td>Each</td>
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<td>94</td>
<td>SP 11.3</td>
<td>Building Utility Coordination and Demolition (Utility Allowance)</td>
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<td>95</td>
<td>SP 12.4</td>
<td>Traffic Control Allowance</td>
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<td>96</td>
<td>SP 14.3</td>
<td>Commercial Vehicle Gate w/ Detector Loops, Proximity Access Tags, and Foundation</td>
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<td>SP 15.9</td>
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<td>SP 16.3</td>
<td>Private Utility Locating Service</td>
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**BASE BID TOTAL**  
**CIVIL SITEWORK & APRON**

### ALTERNATIVE #1 - CONSTRUCT EAST APRON & TAXIWAY 'A' WIDENING AND SHOULDERS

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<tr>
<td>99</td>
<td>P-109.5.2</td>
<td>Sawing Bituminous Pavement (Full Depth)</td>
<td>LF</td>
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<td>P-107.4.3</td>
<td>Remove and Dispose Asphalt Pavement Full Depth</td>
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<td>101</td>
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<td>Unclassified Excavation</td>
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<td>102</td>
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<td>Geotextile Fabric Type V</td>
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<td>103</td>
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<td>Crushed Aggregate Base Course</td>
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<td>105</td>
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<td>Bituminous Base Course, 1&quot; Maximum Aggregate</td>
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<td>106</td>
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<td>12&quot; Thick Portland Cement Concrete Pavement</td>
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<td>108</td>
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<td>Remove Guidance Sign and Foundation</td>
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<td>109</td>
<td>L-105.7.2</td>
<td>Remove Electrical Handhole</td>
<td>Each</td>
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<td>110</td>
<td>L-105.7.3</td>
<td>Remove Base Mounted Airfield Edge Light</td>
<td>Each</td>
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<td>111</td>
<td>L-108-5.1</td>
<td>1/C NO. 8 AWG, 5KV, TYPE L-824 Cable, Series Lighting Cable Installed in Ductbank or Conduit</td>
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<td>112</td>
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<td>1/C No. 6, Bare Copper Counterpoise Wire Installed in Trench, Including Ground Rods and Grounding Connectors</td>
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<td>113</td>
<td>L-110.5.1</td>
<td>1-WAY, 2&quot; Schedule 40 PVC, Direct Buried</td>
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<td>114</td>
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<td>115</td>
<td>L-125-5.1</td>
<td>Medium Intensity Taxiway Edge Light, L861, 30&quot; Height, 6.6A, Base Mount, 360 Blue Lens, LED Lamp</td>
<td>Each</td>
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<td>116</td>
<td>L-125-5.2</td>
<td>L-858 Guidance Sign, Size 1, Style 3, Mode 2, 2 Module</td>
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<td>117</td>
<td>L-125-5.3</td>
<td>Junction Box, L-867, Class 1, Size 8, 24&quot; Deep, 12&quot; Wide</td>
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**ALTERNATIVE NO. 1 TOTAL**  
**CONSTRUCT EAST APRON & TAXIWAY A WIDENING AND SHOULDERS**

### ALTERNATIVE #2 - CONSTRUCT PERIMETER ROAD EXTENSION & SNOW MELT PAVEMENT
## NEW PASSENGER TERMINAL - SITWORK/APRON

### BID ITEM

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<th>SPEC. NUMBER</th>
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<td>SY</td>
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<td>P-152.4.1</td>
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<td>P-154.6.1</td>
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<td>P-209.5.1</td>
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<td>P-401.8.1</td>
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<td>P-401.8.2</td>
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### ALTERNATIVE NO. 3 - APRON DEICING CONTAINMENT SYSTEM

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<td>S-101.5.1</td>
<td>GEOSYNTHETIC CLAY LINER AND CUSHION LAYER</td>
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<td>INSTALL 6&quot; UNDERDRAIN WITH FABRIC</td>
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**SUBTOTAL**

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### ALTERNATIVE NO. 4 - CONSTRUCT WEST APRON PAVEMENT

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<tr>
<td>P-107.4.1</td>
<td>REMOVE AND DISPOSE COMPOSITE PAVEMENT FULL DEPTH (INCLUDES CONCRETE AND ASPHALT AIRFIELD PVMT)</td>
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<td>SY</td>
<td>1203</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-154.6.1</td>
<td>SAND SUBBASE COURSE</td>
<td>CY</td>
<td>1604</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-209.5.1</td>
<td>CRUSHED AGGREGATE BASE COURSE</td>
<td>CY</td>
<td>267</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-401.8.1</td>
<td>BITUMINOUS BASE COURSE, 1&quot; MAXIMUM AGGREGATE</td>
<td>TON</td>
<td>288</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-501.8.1</td>
<td>12&quot; THICK PORTLAND CEMENT CONCRETE PAVEMENT</td>
<td>SY</td>
<td>1203</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ALTERNATE NO. 4 TOTAL CONSTRUCT WEST APRON PAVEMENT**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>ALTERNATE NO. 4 TOTAL CONSTRUCT WEST APRON PAVEMENT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ITEM P-153 CONTROLLED LOW-STRENGTH MATERIAL (CLSM)

DESCRIPTION

153.1.1 This item shall consist of furnishing, transporting, and placing a controlled low-strength material (CLSM) as flowable backfill in trenches or at other locations shown on the plans or as directed by the Engineer.

MATERIALS

153-2.1 MATERIALS

a. Portland Cement. Portland cement shall conform to the requirements of ASTM [150] Type [II]. If for any reason, cement becomes partially set or contains lumps of caked cement, it shall be rejected. Cement salvaged from discarded or used bags shall not be used.

b. Flyash. Flyash shall conform to ASTM C 618, Class C or F.

c. Fine Aggregate (Sand). Fine aggregate shall conform to the requirements of ASTM C 33 except for aggregate gradation. Any aggregate gradation which produces performance characteristics of the CLSM specified herein will be accepted, except as follows.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 in (19.0 mm)</td>
<td>100</td>
</tr>
<tr>
<td>No. 200 (0.075 mm)</td>
<td>0 - 12</td>
</tr>
</tbody>
</table>

d. Water. Water used in mixing shall be free of oil, salt, acid, alkali, sugar, vegetable matter, or other substances injurious to the finished product.

MIX DESIGN

153-3.1 PROPORTIONS. The contractor shall submit, to the Engineer, a mix design including the proportions and source of materials, admixtures, and dry cubic yard (cubic meter) batch weights. The mix shall contain a minimum of 50 pounds of cement and 250 pounds flyash per cubic yard (30 kg of cement and 148 kg of flyash per cubic meter), with the remainder of the volume composed of sand, water, and any approved admixtures.

a. Compressive Strength. CLSM shall be designed to achieve a 28-day compressive strength of 100 to 200 psi (690 to 3,680 kPa) when tested in accordance with ASTM D 4832. There should be no significant strength gain after 28 days. Test specimens shall be made in accordance with ASTM D 4832.

b. Consistency. Consistency of the fresh mixture shall be such that the mixture may be placed without segregation. A desired consistency may be approximated by filling an open-ended 3 in (75 mm) diameter cylinder, 6 in (150 mm) high to the top, with the mixture and the cylinder immediately pulled straight up. The correct consistency of the mixture will produce an approximate 8 in (205 mm) diameter circular-type spread without segregation. Adjustments of the proportions of materials should be made to
achieve proper solid suspension and flowable characteristics, however the theoretical yield shall be maintained at one cubic yard (cubic meter) for the given batch weights.

CONSTRUCTION METHODS

153-4.1 PLACEMENT.

a. Placement. CLSM may be placed by any reasonable means from a mixing unit into the space to be filled. Agitation is required during transportation and waiting time. Placement shall be performed in such a manner that structures or pipes are not displaced from their desired final position and intrusion of CLSM into undesirable areas is avoided. The material shall be brought up uniformly to the fill line shown on the plans or as directed to the Engineer. Each placement of CLSM shall be as continuous an operation as possible. If CLSM is placed in more than one layer, the base layer shall be free of surface water and loose of foreign material prior to placement of the next layer.

b. Limitations of Placement. CLSM shall not be placed on frozen ground. Mixing and placing may begin when the air or ground temperature is at least 35 °F (2 °C) and rising. At the time of placement, CLSM shall have a temperature of at least 40 °F (4 °C). Mixing and placement shall stop when the air temperature is 40 °F (4 °C) and falling or when the anticipated air or ground temperature will be 35 °F (2 °C) or less in the 24 hour period following proposed placement.

153-4.2 CURING AND PROTECTION

a. Curing. The air in contact with the CLSM should be maintained at temperatures above freezing for a minimum of 72 hours. If the CLSM is subjected to temperatures below 32 °F (0 °C), the material may be rejected by the Engineer if damage to the material is observed.

b. Protection. The CLSM shall not be subject to loads and shall remain undisturbed by construction activities for a period of 48 hours or until a compressive strength of 15 psi (105 kPa) is obtained. The Contractor shall be responsible for providing evidence to the Engineer that the material has reached the desired strength. Acceptable evidence shall be based upon compressive tests made in accordance with paragraph 153-3.1a.

MATERIAL ACCEPTANCE

153-5.1 Acceptance. Acceptance of CLSM delivered and placed as shown on the plans or as directed by the Engineer shall be based upon mix design approval and batch tickets provided by the Contractor to confirm that the delivered material conforms to the mix design. The Contractor shall verify by additional testing, each 5,000 cubic yards (3,825 cubic meters) of material used. Verification shall include confirmation of material proportions and tests of compressive strength to confirm that the material meets the original mix design and the requirements of CLSM as defined in this specification. Adjustments shall be made as necessary to the proportions and materials prior to further production.

METHOD OF MEASUREMENT

153-6.1 Measurement. Controlled low strength material shall be measured by the number of [cubic yards (cubic meters)] as computed from the neatline plan and section, adjusted for the quantities for any embedments, and as specified, completed, and accepted.
BASIS OF PAYMENT

153-7.1 Payment. Accepted quantities of controlled low strength material shall be paid for at the contract unit price per cubic yard (cubic meter). Payment shall be full compensation for all materials, equipment, labor, and incidentals required to complete the work as specified. No direct payment shall be made for the work described in this specification. The work described in this specification is incidental to other items and shall be paid for in the respective bid item SP-9 Building Demolition pay item 9.3.

Payment will be made under:

<table>
<thead>
<tr>
<th>Item P-153-7.1</th>
<th>Controlled Low Strength Material (CLSM) Per Cubic Yard (Cubic Meter)</th>
</tr>
</thead>
</table>

TESTING REQUIREMENTS

ASTM D 4832 Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

MATERIAL REQUIREMENTS

ASTM C 33 Specification for Concrete Aggregates
ASTM C 150 Specification for Portland Cement
ASTM C 618 Specification for Coal Flyash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 595 Specification for Blended Hydraulic Cements

END OF ITEM P-153
ITEM P-501  PORTLAND CEMENT CONCRETE PAVEMENT

DESCRIPTION

501-1.1 This work shall consist of pavement composed of Portland cement concrete, [with reinforcement] [without reinforcement] constructed on a prepared underlying surface in accordance with these specifications and shall conform to the lines, grades, thickness, and typical cross sections shown on the plans.

MATERIALS

501-2.1 AGGREGATES.

a. Reactivity. Aggregates shall be tested for deleterious reactivity with alkalies in the cement, which may cause excessive expansion of the concrete. Tests of coarse and fine aggregate shall be made in accordance with ASTM C 1260. If the expansion of the coarse or fine aggregate test specimens, tested in accordance with ASTM C 1260, does not exceed 0.10 % at 16 days from casting, the coarse or fine aggregates shall be accepted.

If the expansion at 16 days is greater than 0.10%, tests of combined materials shall be made in accordance with ASTM C 1260 or ASTM C 1567 using the aggregates, cementitious materials, and/or specific reactivity reducing chemicals in the proportions proposed for the mixture design. If the expansion of the proposed combined materials test specimens, tested in accordance with ASTM C 1260 or ASTM C 1567, does not exceed 0.10 % at 30 days from casting, the proposed combined materials will be accepted. If the expansion of the proposed combined materials test specimens is greater than 0.10% at 30 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10 % at 30 days, or new aggregates shall be evaluated and tested.

b. Fine Aggregate. Fine aggregate shall conform to the requirements of ASTM C 33. Gradation shall meet the requirements of Table 1 when tested in accordance with ASTM C 136, except as may otherwise be qualified under Section 6 of ASTM C 33.

| TABLE 1. GRADATION FOR FINE AGGREGATE  
| (ASTM C 33) |
|---|---|
| Sieve Designation (Square Openings) | Percentage by Weight Passing Sieves |
| 3/8 in. (9.5 mm) | 100 |
| No. 4 (4.75 mm) | 95-100 |
| No. 8 (2.36 mm) | 80-100 |
| No. 16 (1.18 mm) | 50-85 |
| No. 30 (600 micro-m) | 25-60 |
| No. 50 (300 micro-m) | 10-30 |
| No. 100 (150 micro-m) | 2-10 |

c. Coarse Aggregate. Coarse aggregate shall conform to the requirements of ASTM C 33. Gradation, within the separated size groups, shall meet the requirements of Table 2 when tested in accordance with ASTM C 136. When the nominal maximum size of the aggregate is greater than 1 inch, the aggregates shall be furnished in two size groups.
Aggregates delivered to the mixer shall consist of crushed stone, crushed or uncrushed gravel, air-cooled blast furnace slag, crushed recycled concrete pavement, or a combination thereof. The aggregate shall be composed of clean, hard, uncoated particles and shall meet the requirements for deleterious substances contained in ASTM C 33, Class [4m]. Dust and other coating shall be removed from the aggregates by washing. The aggregate in any size group shall not contain more than 8 percent by weight of flat or elongated pieces when tested in accordance with ASTM D 4791. A flat or elongated particle is one having a ratio between the maximum and the minimum dimensions of a circumscribing rectangular prism exceeding 5 to 1.

The percentage of wear shall be no more than [40] when tested in accordance with ASTM C 131 or ASTM C 535.

### TABLE 2. GRADATION FOR COARSE AGGREGATE

<table>
<thead>
<tr>
<th>Sieve Designations (square openings)</th>
<th>From 2&quot; to No. 4 (50.8 mm - 4.75 mm)</th>
<th>From 1-1/2&quot; to No. 4 (38.1 mm - 4.75 mm)</th>
<th>From 1&quot; to No. 4 (25.0 mm-4.75 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>in.</strong></td>
<td><strong>mm</strong></td>
<td><strong>#3 2&quot;-1&quot;</strong></td>
<td><strong>#57 1&quot;-No.4</strong></td>
</tr>
<tr>
<td>2-1/2</td>
<td>63</td>
<td>100</td>
<td>---</td>
</tr>
<tr>
<td>2</td>
<td>50.8</td>
<td>90-100</td>
<td>100</td>
</tr>
<tr>
<td>1-1/2</td>
<td>38.1</td>
<td>35-70</td>
<td>100</td>
</tr>
<tr>
<td>1</td>
<td>25.0</td>
<td>0-15</td>
<td>95-100</td>
</tr>
<tr>
<td>3/4</td>
<td>19.0</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>1/2</td>
<td>12.5</td>
<td>0-5</td>
<td>25-60</td>
</tr>
<tr>
<td>3/8</td>
<td>9.5</td>
<td>---</td>
<td>20-55</td>
</tr>
<tr>
<td>No. 4</td>
<td>4.75</td>
<td>---</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 8</td>
<td>2.36</td>
<td>---</td>
<td>0-5</td>
</tr>
</tbody>
</table>

### GRADATION FOR COARSE AGGREGATE

<table>
<thead>
<tr>
<th>Percentage by Weight Passing Sieves</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 1 ½&quot; to No. 4 (38.1 mm – 4.75 mm)</td>
</tr>
<tr>
<td><strong>in.</strong></td>
</tr>
<tr>
<td>2-1/2</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1-1/2</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>3/4</td>
</tr>
<tr>
<td>1/2</td>
</tr>
<tr>
<td>3/8</td>
</tr>
<tr>
<td>No. 4</td>
</tr>
<tr>
<td>No. 8</td>
</tr>
</tbody>
</table>
Aggregate susceptibility to Disintegration (D) Cracking. Aggregates that have a history of D-cracking shall not be used. Prior to approval of mixture design and production of Portland cement concrete the Contractor shall submit written certification that the aggregate does not have a history of D-Cracking and that the aggregate meets the specified State requirements.

(1) Other sources of crushed stone aggregate shall be approved if the durability factor as determined by ASTM C 666 is greater than or equal to 95 and all other quality test requirements within these specifications are fulfilled. The FAA will consider and reserves final approval of other State classification procedures.

(2) Crushed gravel and sand-gravel aggregates shall not be required to meet freeze-thaw durability ratings. These aggregates shall be approved for use in concrete by the state highway agency in the state from which the aggregate originates and the state in which they are to be used and shall meet all other criteria within these specifications.

501-2.2 CEMENT. Cement shall conform to the requirements of ASTM [C150] Type [I].

If for any reason, cement becomes partially set or contains lumps of caked cement, it shall be rejected. Cement salvaged from discarded or used bags shall not be used.

Only cements containing less than 0.6% equivalent alkali or cements that can demonstrate a positive reduction in the expansion created by alkali-silica reactions shall be used.

501-2.3 CEMENTITIOUS MATERIALS.

a. Fly Ash or Natural Pozzolan. Fly ash shall meet the requirements of ASTM C 618, Class C, F, or N with the exception of loss of ignition, where the maximum shall be less than 6 percent for Class F or N. [The supplementary optional chemical and physical properties of Table 3 contained in ASTM C 618 shall apply.] Fly ash such as is produced in furnace operations utilizing liming materials or soda ash (sodium carbonate) as an additive shall not be acceptable. The Contractor shall furnish vendor's certified test reports for each shipment of Fly Ash used in the project. The vendor's certified test report can be used for acceptance or the material may be tested independently by the Engineer.

b. Blast Furnace Slag (Slag Cement). Ground Granulated Blast Furnace (GGBF) slag shall conform to ASTM C 989, Grade 100 or 120. GGBF shall be used only at a rate between 25 and 55 percent of the total cementitious material by mass.

501-2.4 PREMOLDED JOINT FILLER. Premolded joint filler for expansion joints shall conform to the requirements of [ASTM D 1751] [ASTM D 1752, Type II or III] and shall be punched to admit the dowels where called for on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint, unless otherwise specified by the Engineer. When the use of more than one piece is required for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening means satisfactory to the Engineer.

501-2.5 JOINT SEALER. The joint sealer for the joints in the concrete pavement shall meet the requirements of Item P-605 and shall be of the type(s) specified in the plans.

The following sealant products or approved equal are known to be acceptable.

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Manufacturer</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dow Corning 888 (Concrete to Concrete)</td>
<td>Dow Corning Corp.</td>
<td>Midland, MI 48647</td>
</tr>
<tr>
<td>Dow Corning 890-SL (Concrete to Asphalt)</td>
<td>Dow Corning Corp.</td>
<td>Midland, MI 48647</td>
</tr>
</tbody>
</table>
501-2.6 STEEL REINFORCEMENT. Reinforcing shall consist of [Welded Wire Steel Fabric] conforming to the requirements of ASTM [A185]. If deformed bars are utilized in lieu of the welded wire fabric, the deformed bars shall conform to ASTM A615 Grade 60, and be epoxy coated as specified and detailed on the plans.

501-2.7 DOWEL AND TIE BARS. Tie bars shall be deformed steel bars and conform to the requirements of ASTM A 615 or ASTM A 996, except that rail steel bars, Grade 50 or 60, shall not be used for tie bars that are to be bent or restraightened during construction. Tie bars designated as Grade 40 in ASTM A 615 can be used for construction requiring bent bars.

Dowel bars shall be plain steel bars conforming to ASTM A 615 or ASTM A 966 and shall be free from burring or other deformation restricting slippage in the concrete. High strength dowel bars shall conform to ASTM A 714, Class 2, Type S, Grade I, II or III, Bare Finish. Before delivery to the construction site each dowel bar shall be painted with one coat of paint conforming to MIL-DTL-24441/20A. SSPC Paint 5 or SSPC Paint 25. Metal or plastic collars shall be full circular device supporting the dowel until the epoxy hardens.

The sleeves for dowel bars used in expansion joints shall be metal or other type of an approved design to cover 2 to 3-inches (50 mm to 75 mm) of the dowel, with a closed end and with a suitable stop to hold the end of the bar at least 1-inch (25 mm) from the closed end of the sleeve. Sleeves shall be of such design that they will not collapse during construction.

501-2.8 WATER. Water used in mixing or curing shall be clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. Water will be tested in accordance with the requirements of AASHTO T 26. Water known to be of potable quality may be used without testing.

501-2.9 COVER MATERIAL FOR CURING. Curing materials shall conform to one of the following specifications:

a. Liquid membrane-forming compounds for curing concrete shall conform to the requirements of ASTM C 309, Type 2, Class B, or Class A if wax base only.

b. White polyethylene film for curing concrete shall conform to the requirements of ASTM C 171.

c. White burlap-polyethylene sheeting for curing concrete shall conform to the requirements of ASTM C 171.

d. Waterproof paper for curing concrete shall conform to the requirements of ASTM C 171.

501-2.10 ADMIXTURES. The use of any material added to the concrete mix shall be approved by the Engineer. The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the Engineer 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 Engineer 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.
a. Air-Entraining Admixtures. Air-entraining admixtures shall meet the requirements of ASTM C 260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entrainment agent and any water reducer admixture shall be compatible.

b. Chemical Admixtures. Water-reducing, set retarding, and set-accelerating admixtures shall meet the requirements of ASTM C 494, including the flexural strength test.

501-2.11 EPOXY-RESIN. Epoxy-resin used to anchor dowels and tie bars in pavements shall conform to the requirements of ASTM C 881, Type I, Grade 3, Class C. Class A or B shall be used when the surface temperature of the hardened concrete is below 60 degrees F (16 degrees C).

501-2.12 MATERIAL ACCEPTANCE. Prior to use of materials, the Contractor shall submit certified test reports to the Engineer for those materials proposed for use during construction. The certification shall show the appropriate ASTM test(s) for each material, the test results, and a statement that the material passed or failed.

The Engineer 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.

MIX DESIGN

501-3.1 PROPORTIONS. Concrete shall be designed to achieve a 28-day flexural strength that meets or exceeds the acceptance criteria contained in paragraph 501-5.2 for a flexural strength of [650] psi. The mix shall be designed using the procedures contained in Chapter 9 of the Portland Cement Association's manual, "Design and Control of Concrete Mixtures".

The Contractor shall note that to ensure that the concrete actually produced will meet or exceed the acceptance criteria for the specified strength, the mix design average strength must be higher than the specified strength. The amount of overdesign necessary to meet specification requirements depends on the producer's standard deviation of flexural test results and the accuracy that that value can be estimated from historic data for the same or similar materials.

The minimum cementitious material (cement plus fly ash, or GGBFS) shall be [564] pounds per cubic yard (4 kg per cubic meter). The ratio of water to cementitious material, including free surface moisture on the aggregates but not including moisture absorbed by the aggregates shall not be more than [0.4] by weight.

Prior to the start of paving operations and after approval of all material to be used in the concrete, the Contractor shall submit a mix design showing the proportions and flexural strength obtained from the concrete at 7 and 28 days. The mix design shall 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 fineness modulus of the fine aggregate and the air content shall also be shown. The mix design shall be submitted to the Engineer at least [14] days prior to the start of operations. The submitted mix design shall not be more than 90 days old. Production shall not begin until the mix design is approved in writing by the Engineer.

Should a change in sources be made, or admixtures added or deleted from the mix, a new mix design must be submitted to the Engineer for approval. Previously approved mix designs for airfield paving older than 90 days shall not be used without reapproval.

Flexural strength test specimens shall be prepared in accordance with ASTM C 192 and tested in accordance with ASTM C 78. The mix determined shall be workable concrete having a slump (taken at
the site of placement) for side-form concrete between 1 and 2-inches (25 mm and 50 mm) as determined by ASTM C 143. For vibrated slip-form concrete, the slump shall be between 1/2 inch (13 mm) and 1 1/2-inches (38 mm).

501-3.2 CEMENTITIOUS MATERIALS.

a. Fly Ash. Fly ash may be used in the mix design. When fly ash is used as a partial replacement for cement, the minimum cement content may be met by considering Portland cement plus fly ash as the total cementitious material. The replacement rate shall be determined from laboratory trial mixes, but shall be between 20 and 30 percent by weight of the total cementitious material. If fly ash is used in conjunction with ground granular blast furnace slag the maximum replacement rate shall not exceed 10 percent by weight of total cementitious material.

b. Ground Slag. Ground blast furnace slag may be used in a mix design containing Type I or Type II cement. The slag, or slag plus fly ash if both are used, may constitute between 25 to 55 percent 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 degrees F (13 degrees C) the percent slag shall not exceed 30 percent by weight.

501-3.3 ADMIXTURES.

a. Air-Entraining. Air-entraining admixture shall be added in such a manner that will insure uniform distribution of the agent throughout the batch. The air content of freshly mix air-entrained concrete shall 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 shall be [5.5]. Air content shall be determined by testing in accordance with ASTM C 231 for gravel and stone coarse aggregate and ASTM C 173 for slag and other highly porous coarse aggregate.

b. Chemical. Water-reducing, set-controlling, and other approved admixtures shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements. Tests shall be conducted on trial mixes, with the materials to be used in the work, in accordance with ASTM C 494.

501-3.4 TESTING LABORATORY. The laboratory used to develop the mix design shall meet the requirements of ASTM C 1077. The laboratory accreditation will include ASTM C 78. A certification that it meets these requirements shall be submitted to the Engineer prior to the start of mix design. The certification shall include evidence that the laboratory is inspected/accredited for the test methods required herein by a nationally recognized laboratory inspection accreditation organization and shall contain as a minimum:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A statement that the equipment used in developing the mix design is in calibration.

c. A statement that each test specified in developing the mix design is offered in the scope of the laboratory’s services.

d. A copy of the laboratory's quality control system.
CONSTRUCTION METHODS

501-4.1 EQUIPMENT. Equipment necessary for handling materials and performing all parts of the work shall be approved by the engineer as to design, capacity, and mechanical conditions. The equipment shall be at the jobsite sufficiently ahead of the start of paving operations to be examined thoroughly and approved.

a. Batch Plant and Equipment. The batch plant and equipment shall conform to the requirements of ASTM C 94.

b. Mixers and Transportation Equipment.

(1) General. Concrete may be mixed at a central plant, or wholly or in part in truck mixers. Each mixer shall 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.

   a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

   b. A statement that the equipment used in developing the mix design is in calibration.

   c. A statement that each test specified in developing the mix design is offered in the scope of the laboratory's services.

   d. A copy of the laboratory's quality control system.

(2) Central plant mixer. Central plant mixers shall conform to the requirements of ASTM C 94.

The mixer shall be examined daily for changes in condition due to accumulation of hard concrete or mortar or wear of blades. The pickup and throwover blades shall be replaced when they have worn down 3/4-inch (19 mm) or more. The Contractor shall 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 shall conform to the requirements of ASTM C 94.

(4) Nonagitator trucks. Nonagitating hauling equipment shall conform to the requirements of ASTM C 94.

c. Finishing Equipment. The standard method of constructing concrete pavements on FAA projects shall be with an approved slip-form paving equipment designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine so a dense and homogeneous pavement is achieved with a minimum of hand finishing. The paver-finisher shall be a heavy duty, self-propelled machine designed specifically for paving and finishing high quality concrete pavements. It shall weigh at least 2200 lbs. per foot 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 yards of cement concrete pavement or requiring individual placement areas of less than 500 square yards, or irregular areas at locations inaccessible to slip-form paving equipment, cement concrete pavement may be placed with approved placement and finishing...
equipment utilizing stationary side forms. Hand screeding and float finishing may only be utilized on small irregular areas as allowed by the Engineer.

d. **Vibrators.** Vibrator shall be the internal type. Operating frequency for internal vibrators shall be between 8,000 and 12,000 vibrations per minute. Average amplitude for internal vibrators shall be 0.025-0.05-inches (0.06-0.13 cm).

The number, spacing, and frequency shall be as necessary to provide a dense and homogeneous pavement and meet the recommendations of ACI 309, Guide for Consolidation of Concrete. Adequate power to operate all vibrators shall be available on the paver. The vibrators shall be automatically controlled so that they shall be stopped as forward motion ceases. The contractor shall provide an electronic or mechanical means to monitor vibrator status. The checks on vibrator status shall occur a minimum of two times per day or when requested by the Engineer.

Hand held vibrators may be used in irregular areas only, but shall meet the recommendations of ACI 309, Guide for Consolidation of Concrete.

e. **Concrete Saws.** The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions. The Contractor shall 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.

f. **Side Forms.** Straight side forms shall be made of steel and shall be furnished in sections not less than 10-feet (3 m) in length. Forms shall 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 shall be used for curves of 100-foot (31 m) radius or less. Forms shall 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 shall not be used. Built-up forms shall not be used, except as approved by the Engineer. The top face of the form shall not vary from a true plane more than 1/8-inch (3 mm) in 10-feet (3 m), and the upstanding leg shall not vary more than 1/4-inch (6 mm). The forms shall 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 Engineer.

g. **Pavers.** The paver shall 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 shall 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 shall be equipped with electronic or hydraulic horizontal and vertical control devices.

**501-4.2 FORM SETTING.** Forms shall be set sufficiently in advance of the concrete placement to insure continuous paving operation. After the forms have been set to correct grade, the underlying surface shall be thoroughly tamped, either mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place sufficiently to maintain the form in position for the method of placement.

Form sections shall be tightly locked and shall be free from play or movement in any direction. The forms shall not deviate from true line by more than 1/8 inch (3 mm) at any joint. Forms shall be so set that they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms shall be cleaned and oiled prior to the placing of concrete.
The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete.

501-4.3 CONDITIONING OF UNDERLYING SURFACE. The compacted underlying surface on which the pavement will be placed shall 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 shall be trimmed or graded to the plan grade elevation and profile by means of a properly designed machine. The grade of the underlying surface shall 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 shall be corrected by additional compaction and retested at the option of the Engineer before the concrete is placed except when stabilized subbases are being constructed. If damage occurs on a stabilized subbase, it shall be corrected full depth by the Contractor. If traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately before the placement of concrete. The prepared grade shall be moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from concrete. The underlying surface shall be protected so that it will be entirely free of frost when concrete is placed.

501-4.4 CONDITIONING OF UNDERLYING SURFACE, SIDE-FORM AND FILL-IN LANE CONSTRUCTION. The prepared underlying surface shall 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 shall be corrected and retested at the option of the Engineers. If damage occurs to a stabilized subbase, it shall be corrected full depth by the Contractor. A template shall be provided and operated on the forms immediately in advance of the placing of all concrete. The template shall be propelled only by hand and not attached to a tractor or other power unit. Templates shall 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 shall be such as will provide an accurate retest of the grade before placing the concrete thereon. All excess material shall be removed and wasted. Low areas shall be filled and compacted to a condition similar to that of the surrounding grade. The underlying surface shall 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 shall not be permitted.

The template shall be maintained in accurate adjustment, at all times by the Contractor, and shall be checked daily.

501-4.5 HANDLING, MEASURING, AND BATCHING MATERIAL. The batch plant site, layout, equipment, and provisions for transporting material shall assure a continuous supply of material to the work. Stockpiles shall be constructed in such a manner that prevents segregation and intermixing of deleterious materials.

Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall 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.

Batching plants shall 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 shall 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 shall be arranged to provide positive assurance that the cement content specified is present in each batch.
501-4.6 MIXING CONCRETE. The concrete may be mixed at the work site, in a central mix plant or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials, except water, are emptied into the drum. All concrete shall be mixed and delivered to the site in accordance with the requirements of ASTM C 94.

Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or nonagitating trucks. The elapsed time from the addition of cementitious material to the mix until the concrete is deposited in place at the work site shall not exceed 30 minutes when the concrete is hauled in nonagitating 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 Engineer.

501-4.7 LIMITATIONS ON MIXING AND PLACING. No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

   a. Cold Weather. Unless authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40 degrees F (4 degrees C) and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35 degrees F (2 degrees C).

   The aggregate shall be free of ice, snow, and frozen lumps before entering the mixer. The temperature of the mixed concrete shall not be less than 50 degrees F (10 degrees C) at the time of placement. Concrete shall not be placed on frozen material nor shall 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 degrees F (66 degrees C). The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might be detrimental to the materials.

   b. Hot Weather. During periods of hot weather when the maximum daily air temperature exceeds 85 degrees F (30 degrees C), the following precautions shall be taken.

   The forms and/or the underlying surface shall be sprinkled with water immediately before placing the concrete. The concrete shall be placed at the coolest temperature practicable, and in no case shall the temperature of the concrete when placed exceed 90 degrees F (35 degrees C). The aggregates and/or mixing water shall 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 shall be kept damp by applying a water-fog or mist with approved spraying equipment until the pavement is covered by the curing medium. If necessary, wind screens shall be provided to protect the concrete from an evaporation rate in excess of 0.2 psf per hour as determined in accordance with Figure 2.1.5 in ACI 305R, Hot Weather Concreting, which takes into consideration relative humidity, wind velocity, and air temperature.

   When conditions are such that problems with plastic cracking can be expected, and particularly if any plastic cracking begins to occur, the Contractor shall immediately take such additional measures as necessary to protect the concrete surface. Such measures shall 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 shall be immediately stopped.

c. **Temperature Management Program.** Prior to the start of paving operation for each day of paving, the contractor shall provide the engineer with a Temperature Management Program for the concrete to be placed to assure that uncontrolled cracking is avoided. As a minimum the program shall address the following items:

1. Anticipated tensile strains in the fresh concrete as related to heating and cooling of the concrete material.

2. Anticipated weather conditions such as ambient temperatures, wind velocity, and relative humidity.

3. Anticipated timing of initial sawing of joint.

501-4.8 PLACING CONCRETE. The Contractor has the option of placing the concrete with either side (fixed) forms or slip-forms. At any point in concrete conveyance, the free vertical drop of the concrete from one point to another or to the underlying surface shall not exceed 3-feet (1 m). Backhoes and Grading equipment shall not be used to distribute the concrete in front of the paver. Front end loaders will not be used unless the contractor demonstrates that they can be used without contaminating the concrete and base course and it is approved by the Engineer.

Hauling equipment or other mechanical equipment can be permitted on adjoining previously constructed pavement when the concrete strength reaches \[ \text{a flexural strength of 550 psi (3792 kPa) [a compressive strength of 3,500 psi], based on the average of four field cured specimens per 2,000 cubic yards (1 530 cubic meters) of concrete placed. Also, subgrade and subbase planers, concrete pavers, and concrete finishing equipment may be permitted to ride upon the edges of previously constructed pavement when the concrete has attained a minimum flexural strength of 400 psi.}\]

a. **Slip-Form Construction.** The concrete shall be distributed uniformly into final position by a self propelled slip-form paver without delay. The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose. The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration shall be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well defined edges. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms.

The plastic concrete shall 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 shall not exceed 9-inches (23 cm). The spacing of internal units shall be uniform and shall not exceed 18-inches (46 cm).

The term internal vibration means vibrating units located within the specified thickness of pavement section.

The rate of vibration of each vibrating unit shall be within 8000 to 12000 cycles per minute and the amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating unit for a distance of at least one foot. The frequency of vibration or amplitude shall vary proportionately with the rate of travel to result in a uniform density and air content. The paving machine shall be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.
The concrete shall be held at a uniform consistency. The slip-form paver shall be operated with as nearly a continuous forward movement as possible. And all operations of mixing, delivering, and spreading concrete shall 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 shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall 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.

**b. Side-Form Construction.** Side form sections shall be straight, free from warps, bends, indentations, or other defects. Defective forms shall be removed from the work. Metal side forms shall be used except at end closures and transverse construction joints where straight forms of other suitable material may be used.

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 shall also be metal.

Width of the base of all forms shall be equal to at least 80 percent of the specified pavement thickness.

Side forms shall 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 shall provide sufficient forms so that there will be no delay in placing concrete due to lack of forms.

Before placing side forms, the underlying material shall be at the proper grade. Side forms shall have full bearing upon the foundation throughout their length and width of base and shall be placed to the required grade and alignment of the finished pavement. They shall be firmly supported during the entire operation of placing, compacting, and finishing the pavement.

Forms shall be drilled in advance of being placed to line and grade to accommodate tie bars where these are specified.

Immediately in advance of placing concrete and after all subbase operations are completed, side forms shall be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing.

Side forms shall 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 shall be applied to the concrete immediately after the forms have been removed.

Side forms shall be thoroughly cleaned and oiled each time they are used and before concrete is placed against them.

Concrete shall be spread, screeded, shaped and consolidated by one or more self-propelled machines. These machines shall uniformly distribute and consolidate concrete without segregation so that the completed pavement will conform to the required cross section with a minimum of handwork.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to that of concrete delivery.
Concrete for the full paving width shall be effectively consolidated by internal vibrators without causing segregation. Internal type vibrators' rate of vibration shall be not less than 7,000 cycles per minute. Amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete more than one foot from the vibrating element. The Contractor shall furnish a tachometer or other suitable device for measuring and indicating frequency of vibration.

Power to vibrators shall be connected so that vibration ceases when forward or backward motion of the machine is stopped.

The provisions relating to the frequency and amplitude of internal vibration shall be considered the minimum requirements and are intended to ensure adequate density in the hardened concrete.

c.  **Consolidation Testing.** The provisions relating to the frequency and amplitude of internal vibration shall be considered the minimum requirements and are intended to ensure adequate density in the hardened concrete. If a lack of consolidation of the concrete is suspected by the Engineer, additional referee testing may be required. Referee testing of hardened concrete will be performed by cutting cores from the finished pavement after a minimum of 24 hours curing. Density determinations will be made based on the water content of the core as taken. ASTM C 642 shall be used for the determination of core density in the saturated-surface dry condition. Referee cores will be taken at the minimum rate of one for each 500 cubic yards of pavement, or fraction thereof.

The average density of the cores shall be at least 97 percent of the original mix design density, with no cores having a density of less than 96 percent of the original mix design density.

Failure to meet the above requirements will be considered as evidence that the minimum requirements for vibration are inadequate for the job conditions, and additional vibrating units or other means of increasing the effect of vibration shall be employed so that the density of the hardened concrete as indicated by further referee testing shall conform to the above listed requirements.

501-4.9 **STRIKE-OFF OF CONCRETE AND PLACEMENT OF REINFORCEMENT.** Following the placing of the concrete, it shall be struck off to conform to the cross section shown on the plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement shall be at the elevation shown on the plans. When reinforced concrete pavement is placed in two layers, the bottom layer shall 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 shall then be placed directly upon the concrete, after which the top layer of the concrete shall 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 shall 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.

Reinforcing steel, at the time concrete is placed, shall 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.

501-4.10 **JOINTS.** Joints shall be constructed as shown on the plans and in accordance with these requirements. All joints shall be constructed with their faces perpendicular to the surface of the pavement and finished or edged as shown on the plans. Joints shall not vary more than 1/2-inch (13 mm) from their designated position and shall be true to line with not more than 1/4-inch (6 mm) variation.
in 10-feet (3 m). The surface across the joints shall be tested with a 10-foot (3 m) straightedge as the joints are finished and any irregularities in excess of 1/4-inch (6 mm) shall be corrected before the concrete has hardened. All joints shall be so prepared, finished, or cut to provide a groove of uniform width and depth as shown on the plans.

a. **Construction.** Longitudinal construction joints shall be slip-formed or formed against side forms with or without keyways, as shown in the plans.

Transverse construction joints shall 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 shall be located at a planned contraction or expansion joint. If placing of the concrete is stopped, the Contractor shall remove the excess concrete back to the previous planned joint.

b. **Contraction.** Contraction joints shall be installed at the locations and spacing as shown on the plans. Contraction joints shall 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 shall be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish shall be according to the manufacturer's instructions. The groove shall be finished or cut clean so that spalling will be avoided at intersections with other joints. Grooving or sawing shall produce a slot at least 1/8-inch (3 mm) wide and to the depth shown on the plans.

c. **Expansion.** Expansion joints shall be installed as shown on the plans. The premolded filler of the thickness as shown on the plans, shall 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 shall be securely staked or fastened into position perpendicular to the proposed finished surface. A cap shall 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 shall be carefully withdrawn leaving the space over the premolded filler. The edges of the joint shall be finished and tooled while the concrete is still plastic. Any concrete bridging the joint space shall be removed for the full width and depth of the joint.

d. **Keyways.** Keyways (only female keys permitted) shall be formed in the plastic concrete by means of side forms or the use of keyway liners that are inserted during the slip-form operations. The keyway shall be formed to a tolerance of 1/4-inch (6 mm) in any dimension and shall be of sufficient stiffness to support the upper keyway flange without distortion or slumping of the top of the flange. The dimensions of the keyway forms shall not vary more than plus or minus 1/4-inch (6 mm) from the mid-depth of the pavement. Liners that remain in place permanently and become part of the keyed joint shall be made of galvanized, copper clad, or of similar rust-resistant material compatible with plastic and hardened concrete and shall not interfere with joint reservoir sawing and sealing.

e. **Tie bars.** Tie bars shall consist of deformed bars installed in joints as shown on the plans. Tie bars shall be placed at right angles to the centerline of the concrete slab and shall be spaced at intervals shown on the plans. They shall 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. These bars shall not be painted, greased, or enclosed in sleeves. When slip-form operations call for tie bars, two-piece hook bolts can be installed in the female side of the keyed joint provided the installation is made without distorting the keyed dimensions or causing edge slump. If a bent tie bar installation is used, the tie bars shall be inserted through the keyway liner only on the female side of the joint. In no case shall a bent tie bar installation for male keyways be permitted.
**f. Dowel bars.** Dowel bars or other load-transfer units of an approved type shall be placed across joints in the manner as shown on the plans. They shall 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 shall be rigid enough to permit complete assembly as a unit ready to be lifted and placed into position. A metal, or other type, dowel expansion cap or sleeve shall be furnished for each dowel bar used with expansion joints. These caps shall be substantial enough to prevent collapse and shall be placed on the ends of the dowels as shown on the plans. The caps or sleeves shall fit the dowel bar tightly and the closed end shall be watertight. The portion of each dowel painted with rust preventative paint, as required under paragraph 501-2.7 and shown on the plans to receive a debonding lubricant, shall be thoroughly coated with asphalt MC-70, or an approved lubricant, to prevent the concrete from bonding to that portion of the dowel. If free-sliding plastic-coated or epoxy-coated steel dowels are used, a lubrication bond breaker shall be used except when approved pullout tests indicate it is not necessary. Where butt-type joints with dowels are designated, the exposed end of the dowel shall be oiled.

Dowel bars at contraction joints may be placed in the full thickness of pavement by a mechanical device approved by the Engineer. The device shall be capable of installing dowel bars within the maximum permissible alignment tolerances. Dowels bars at longitudinal construction joints shall be bonded in drilled holes.

**g. Installation.** All devices used for the installation of expansion joints shall be approved by the Engineer.

The top of an assembled joint device shall be set at the proper distance below the pavement surface and the elevation shall be checked. Such devices shall be set to the required position and line and shall be securely held in place by stakes or other means to the maximum permissible tolerances during the pouring and finishing of the concrete. The premolded joint material shall be placed and held in a vertical position; if constructed in sections, there shall be no offsets between adjacent units.

Dowel bars and assemblies shall be checked for position and alignment. The maximum permissible tolerances on dowel bar alignment shall be in accordance with paragraph 501-5.2e(6). During the concrete placement operation, it is advisable to place plastic concrete directly on dowel assemblies immediately prior to passage of the paver to help maintain dowel position and alignment within maximum permissible tolerances.

When concrete is placed using slip-form pavers, dowels and tie bars shall be placed in longitudinal construction joints by bonding the dowels or tie bars into holes drilled into the hardened concrete. Holes approximately 1/8-inch to 1/4-inch (3 to 6 mm) greater in diameter than the dowel or tie bar shall be drilled with rotary-core drills that must be held securely in place to drill perpendicularly into the vertical face of the pavement slab. Rotary-type percussion drills may be used provided that spalling of concrete does not occur. Any damage of the concrete shall be repaired by the Contractor in a method approved by the Engineer. Dowels or tie bars shall be bonded in the drilled holes using an epoxy resin material. Installation procedures shall be adequate to insure that the area around dowels is completely filled with epoxy grout. Epoxy shall be injected into the back of the hole and displaced by the insertion of the dowel bar. Bars shall be completely inserted into the hole and shall not be withdrawn and reinserted creating air pockets in the epoxy around the bar. The Contractor shall furnish a template for checking the position and alignment of the dowels. Dowel bars shall not be less than 10-inches (25 cm) from a transverse joint and shall not interfere with dowels in the transverse direction.

**h. Sawing of Joints.** Joints shall be cut as shown on the plans. Equipment shall be as described in paragraph 501-4.1. The circular cutter shall be capable of cutting a groove in a straight line and shall produce a slot at least 1/8-inch (3 mm) wide and to the depth shown on the plans. The top portion of the
slot shall be widened by sawing to provide adequate space for joint sealers as shown on the plans. Sawing shall commence 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. Sawing shall be carried on both during the day and night as required. The joints shall be sawed at the required spacing, consecutively in sequence of the concrete placement. Curing compound, if being used as the cure type, shall be reapplied in the initial sawcut and maintained for the remaining cure period. Curing compound shall not be applied, and used as the cure method, to any final concrete face that is to receive a sealant. All slurry and debris produced in the sawing of joints shall be removed by vacuuming and washing.

501-4.11 FINAL STRIKE-OFF, CONSOLIDATION, AND FINISHING.

a. Sequence. The sequence of operations shall be the strike-off, floating and removal of laitance, straightedging, and final surface finish. The addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted.

b. Finishing at Joints. The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material; it shall be firmly placed without voids or segregation under and around all load-transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated as required in paragraph 501-4.8.a. After the concrete has been placed and vibrated adjacent to the joints, the finishing machine shall be operated in a manner to avoid damage or misalignment of joints. If uninterrupted operations of the finishing machine, to, over, and beyond the joints, cause segregation of concrete, damage to, or misalignment of the joints, the finishing machine shall be stopped when the screed is approximately 8-inches (20 cm) from the joint. Segregated concrete shall be removed from the front of and off the joint; and the forward motion of the finishing machine shall be resumed. Thereafter, the finishing machine may be run over the joint without lifting the screed, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

c. Machine Finishing. The concrete shall be spread as soon as it is placed, and it shall be struck off and screeded by a finishing machine. The machine shall go over each area as many times and at such intervals as necessary to give to proper consolidation and to leave a surface of uniform texture. Excessive operation over a given area shall be avoided. When side forms are used, the tops of the forms shall be kept clean by an effective device attached to the machine, and the travel of the machine on the forms shall be maintained true without lift, wobbling, or other variation tending to affect the precision finish. During the first pass of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed for its entire length. When in operation, the screed shall be moved forward with a combined longitudinal and transverse shearing motion, always moving in the direction in which the work is progressing, and so manipulated that neither end is raised from the side forms during the striking-off process. If necessary, this shall be repeated until the surface is of uniform texture, true to grade and cross section, and free from porous areas.

d. Hand Finishing. Hand finishing methods will not be permitted, except under the following conditions: in the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade; in areas of narrow widths or of irregular dimensions where operation of the mechanical equipment is impractical. Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used. A second screed shall be provided for striking off the bottom layer of concrete when reinforcement is used.

The screed for the surface shall be a least 2 feet (0.6 m) longer than the maximum width of the slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape, and shall be constructed
either of metal or of other suitable material covered with metal. Consolidation shall be attained by the use of suitable vibrators.

e. Floating. After the concrete has been struck off and consolidated, it shall be further smoothed and trued by means of a longitudinal float using one of the following methods:

(1) **Hand Method.** Long-handled floats shall not be less than 12-feet (3.6 m) in length and 6-inches (15 cm) in width, stiffened to prevent flexibility and warping. The float shall be operated from foot bridges spanning but not touching the concrete or from the edge of the pavement. Floating shall pass gradually from one side of the pavement to the other. Forward movement along the centerline of the pavement shall be in successive advances of not more than one-half the length of the float. Any excess water or laitance in excess of 1/8-inch (3 mm) thick shall be removed and wasted.

(2) **Mechanical method.** The Contractor may use a machine composed of a cutting and smoothing float(s), suspended from and guided by a rigid frame and constantly in contact with, the side forms or underlying surface. If necessary, long-handled floats having blades not less than 5-feet (1.5 m) in length and 6-inches (15 cm) in width may be used to smooth and fill in open-textured areas in the pavement. When the crown of the pavement will not permit the use of the mechanical float, the surface shall be floated transversely by means of a long-handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and laitance in excess of 1/8-inch (3 mm) thick shall be removed and wasted. Successive drags shall be lapped one-half the length of the blade.

f. **Straight-edge Testing and Surface Correction.** After the pavement has been struck off and while the concrete is still plastic, it shall be tested for trueness with a Contractor furnished 16-foot (5 m) straightedge swung from handles 3-feet (1 m) longer than one-half the width of the slab. The straightedge shall 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 shall 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 shall be removed from the surface of the pavement and wasted. Any depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the smoothness requirements of paragraph 501-5.2e(3). Straightedge testing and surface corrections shall 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 shall be confined to a minimum; they may be used only in emergencies and in areas not accessible to finishing equipment.

501-4.12 **SURFACE TEXTURE.** The surface of the pavement shall 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 shall be corrected to the satisfaction of the Engineer.

a. **Brush or Broom Finish.** If the pavement surface texture is to be a type of brush or broom finish, it shall be applied when the water sheen has practically disappeared. The equipment shall operate transversely across the pavement surface, providing corrugations that are uniform in appearance and approximately 1/16-inch (2 mm) in depth.

b. **Burlap Drag Finish.** If a burlap drag is used to texture the pavement surface, it shall be at least 15 ounces per square yard (555 grams per square meter). To obtain a textured surface, the transverse threads of the burlap shall be removed approximately 1-foot (0.3 m) from the trailing edge. A heavy buildup of grout on the burlap threads produces the desired wide sweeping longitudinal striations on the
pavement surface. The corrugations shall be uniform in appearance and approximately 1/16-inch (2 mm) in depth.

c. Artificial Turf Finish. If artificial turf is used to texture the surface, it shall be applied by dragging the surface of the pavement in the direction of concrete placement with an approved full-width drag made with artificial turf. The leading transverse edge of the artificial turf drag will be securely fastened to a lightweight pole on a traveling bridge. At least 2-feet of the artificial turf shall be in contact with the concrete surface during dragging operations. A variety of different types of artificial turf are available and approval of any one type will be done only after it has been demonstrated by the Contractor to provide a satisfactory texture. One type that has provided satisfactory texture consists of 7,200 approximately 0.85-inches-long polyethylene turf blades per square foot. The corrugations shall be uniform in appearance and approximately 1/16-inch (2 mm) in depth.

The removal of all waste material and slurry generated from the grooving operation shall be continuous. The Contractor shall utilize a vacuum truck to continuously vacuum up all waste material and slurry during the grooving operations. The Contractor shall also maintain a bulk tanker on site to transfer the vacuumed materials into prior to disposal. The Contractor shall not, under any circumstances, deposit the waste materials or slurry generated by the grooving operations on the pavement or surrounding sod or grass areas. All waste material and slurry shall be contained in either the vacuum truck or bulk tanker. All waste material and slurry shall be disposed of off airport at a location approved by the Owner. No waste material or slurry shall be permitted to enter or be deposited into the storm or sanitary sewer system.

The Contractor shall thoroughly wash all grooves to ensure all grooves are clean and free to transfer runoff from the pavement without obstruction during grooving operations.

Prior to any grooving, all joints shall be sealed and approved by the Engineer.

501-4.14 CURING. Immediately after finishing operations are completed and marring of the concrete will not occur, the entire surface of the newly placed concrete shall 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, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2-hour during the curing period.

a. Impervious Membrane Method. The entire surface of the pavement shall 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 shall not be applied during rainfall. Curing compound shall be applied by mechanical sprayers under pressure at the rate of 1-gallon (4 liters) to not more than 150 square feet (14 square meters). The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application the compound shall 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 Engineer, a double application rate shall be used to insure coverage. The curing compound shall 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 shall be repaired immediately with additional compound or other approved means. Upon removal of side forms, the sides of the exposed slabs shall be protected immediately to provide a curing treatment equal to that provided for the surface.
b. Polyethylene Films. The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The units shall be lapped at least 18 inches (457 mm). The sheeting shall be placed and weighted to cause it to remain in contact with the surface and sides. The sheeting shall have dimensions that will extend at least twice the thickness of the pavement beyond the edges of the pavement. Unless otherwise specified, the sheeting shall be maintained in place for 7 days after the concrete has been placed. This sheeting will be on site to protect fresh pavement from unanticipated rain events that could mar the surface finish.

c. Waterproof Paper. The top surface and sides of the pavement shall be entirely covered with waterproofed paper. The units shall be lapped at least 18 inches (457 mm). The paper shall be placed and weighted to cause it to remain in contact with the surface covered. The paper shall have dimensions that will extend at least twice the thickness of the pavement beyond the edges of the slab. The surface of the pavement shall be thoroughly saturated prior to placing of the paper. Unless otherwise specified, the paper shall be maintained in place for 7 days after the concrete has been placed. This sheeting will be on site to protect fresh pavement from unanticipated rain events that could mar the surface finish.

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 7 days after the concrete has been placed.

(1) Curing in Cold Weather. The concrete shall be maintained at a temperature of at least 50 degrees F (10 degrees C) for a period of 72 hours after placing and at a temperature above freezing for the remainder of the curing time. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and any concrete injured by frost action shall be removed and replaced at the Contractor's expense.

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 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.

501-4.15 REMOVING FORMS. Unless otherwise specified, forms shall 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 shall be cured as outlined in one of the methods indicated in paragraph 501-4.14. Major honeycombed areas shall be considered as defective work and shall be removed and replaced in accordance with paragraph 501-5.2(f).

501-4.16 SEALING JOINTS. The joints in the pavement shall be sealed in accordance with Item [P-605].

501-4.17 PROTECTION OF PAVEMENT. The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor's employees and agents. This shall 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 shall be repaired or the pavement replaced at the Contractor's expense. The Contractor shall have available at all times, materials for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of rolled polyethylene sheeting at least 4-mils (0.1 mm) 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 shall stop and all available personnel shall begin covering the surface of the unhardened concrete with the protective covering.

501-4.18 OPENING TO TRAFFIC. The pavement shall not be opened to traffic until test specimens molded and cured in accordance with ASTM C 31 have attained a flexural strength of 550 pounds per square inch (3,792 kPa) when tested in accordance with ASTM C 78. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the concrete was placed. Prior to opening the pavement to construction traffic, all joints shall 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. The pavement shall be cleaned before opening for normal operations.

501-4.19 REPAIR, REMOVAL, REPLACEMENT OF SLABS.

a. General. New pavement slabs that are broken or contain cracks shall be removed and replaced or repaired, as specified hereinafter at no cost to the owner. Spalls along joints shall be repaired as specified. Removal of partial slabs is not permitted. Removal and replacement shall be full depth, shall be full width of the slab, and the limit of removal shall be normal to the paving lane and to each original transverse joint. The engineer 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 shall be 4-inch (100 mm) diameter, shall be drilled by the Contractor and shall 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 shall be at no expense to the owner. All epoxy resin used in this work shall conform to ASTM C 881, Type V.

b. Shrinkage Cracks. Shrinkage cracks, which do not exceed 4-inches in depth, shall be cleaned and then pressure injected with epoxy resin, Type IV, Grade 1, using procedures as approved. Care shall be taken to assure that the crack is not widened during epoxy resin injection. All epoxy resin injection shall take place in the presence of the Engineer. Shrinkage cracks, which exceed 4-inches (10 cm) in depth, shall 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 (600 mm) from either adjacent original transverse joint. The full slab shall be removed and replaced at no cost to the owner, when there are any full depth cracks, or cracks greater than 4-inches (10 cm) 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 (600 mm) either side of the joint shall be treated as specified hereinafter. Any crack extending more than 6-inches (600 mm) from the joint shall be treated as specified above in subparagraph “Slabs With Cracks Through Interior Area.”

(1) Full Depth Cracks Present, Original Joint Not Opened. When the original uncracked joint has not opened, the crack shall be sawed and sealed, and the original joint filled with epoxy resin as specified below. The crack shall be sawed with equipment specially designed to follow random cracks. The reservoir for joint sealant in the crack shall be formed by sawing to a depth of 3/4-inch (19 mm), plus or minus 1/16-inch (1.6 mm), and to a width of 5/8-inch (16 mm), plus or minus 1/8-inch (3.2 mm). Any equipment or procedure which causes raveling or spalling along the crack shall be modified or replaced to prevent such raveling or spalling. The joint sealant shall be a liquid sealant as specified. Installation of joint seal shall 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 shall 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 shall 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 shall 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 shall be treated as specified above for a parallel crack, and the cracked original joint shall 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 shall 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 keys or dowels present, all edges of the slab shall be cut full depth with a concrete saw. All saw cuts shall be perpendicular to the slab surface. If keys, dowels, or tie bars are present along any edges, these edges shall be sawed full depth 24-inches (150 mm) from the edge if only keys are present, or just beyond the end of the dowels or tie bars if they are present. These joints shall then be carefully sawed on the joint line to within 1-inch (25 mm) of the depth of the dowel or key.

The main slab shall be further divided by sawing full depth, at appropriate locations, and each piece lifted out and removed. Suitable equipment shall be used to provide a truly vertical lift, and approved safe lifting devices used for attachment to the slabs. The narrow strips along keyed or doweled edges shall be carefully broken up and removed using light, hand-held jackhammers, 30 LB (14 kg) or less, or other approved similar equipment.

Care shall be taken to prevent damage to the dowels, tie bars, or keys or to concrete to remain in place. The joint face below keys or dowels shall 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 1-inch (25 mm) when tested in a horizontal direction with a 12-foot (3.6 m) straightedge.

No mechanical impact breakers, other than the above hand-held equipment shall be used for any removal of slabs. If underbreak between 1-1/2 and 4-inches (37 and 100 mm) deep occurs at any point along any edge, the area shall 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 shall be removed and replaced. Where there are no dowels, tie bars, or keys on an edge, or where they have been damaged, dowels of the size and spacing as specified for other joints in similar pavement shall be installed by epoxy grouting them into holes drilled into the existing concrete using procedures as specified. Original damaged dowels or tie bars shall be cut off flush with the joint face. Protruding portions of dowels shall be painted and lightly oiled. All 4 edges of the new slab shall thus contain dowels or original keys or original tie bars.

Placement of concrete shall be as specified for original construction. Prior to placement of new concrete, the underlying material (unless it is stabilized) shall be re-compacted and shaped as specified in the appropriate SECTION of these specifications. The surfaces of all four joint faces shall be cleaned of all loose material and contaminants and coated with a double application of membrane forming curing compound as bond breaker. Care shall be taken to prevent any curing compound from contacting dowels or tie bars. The resulting joints around the new slab shall 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, shall be repaired by first making a vertical saw cut at least 1-inch (25 mm) outside the spalled area and to a depth of at least 2-inches (50 mm). Saw cuts shall be straight lines forming rectangular areas. The concrete between the saw cut and the joint, or crack, shall be chipped out to remove all unsound concrete and at least 1/2-inch (12 mm) of visually sound concrete. The cavity thus formed shall 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, shall be applied to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. The prime coat shall be applied in a thin coating and scrubbed into the surface with a stiff-bristle brush. Pooling of epoxy resin shall be avoided. The cavity shall be filled with low slump Portland cement concrete or mortar or with epoxy resin concrete or mortar. Concrete shall be used for larger spalls, generally those more than 1/2 cu. ft. (0.014 m3) in size, and mortar SHALL BE USED FOR THE SMALLER ONES. ANY SPALL LESS THAN 0.1 CU. FT. (0.003 m3) shall be repaired only with epoxy resin mortar or a Grade III epoxy resin. Portland cement concrete and mortar mixtures shall be proportioned as directed and shall be mixed, placed, consolidated, and cured as directed. Epoxy resin mortars shall 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 Engineer. The epoxy resin materials shall be placed in the cavity in layers not over 2-inches (50 mm) thick. The time interval between placement of additional layers shall be such that the temperature of the epoxy resin material does not exceed 140 degrees F (60 degrees C) at any time during hardening. Mechanical vibrators and hand tampers shall be used to consolidate the concrete or mortar. Any repair material on the surrounding surfaces of the existing concrete shall be removed before it hardens. Where the spalled area abuts a joint, an insert or other bond-breaking medium shall be used to prevent bond at the joint face. A reservoir for the joint sealant shall be sawed to the dimensions required for other joints, or as required to be routed for cracks. The reservoir shall 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 shall be removed and replaced as previously specified.

501.4.20 EXISTING CONCRETE PAVEMENT REMOVAL AND REPAIR.

All operations shall be carefully controlled to prevent damage to the concrete pavement and to the underlying material to remain in place. All saw cuts shall be made perpendicular to the slab surface.

a. Removal of Existing Pavement Slab.

When it is necessary to remove existing concrete pavement and leave adjacent concrete in place, [unless there are dowels or keys present,] the joint between the removal area and adjoining pavement to stay in place, [including dowels, tie bars or keys,] shall first be cut full depth with a standard diamond-type concrete saw. [If keys or dowels are present at this joint, the saw cut shall be made full depth 6-inches (150 mm) from the joint if only keys are present, or just beyond the end of dowels if dowels are present. The edge shall then be carefully sawed on the joint line to within 1-inch (25 mm) of the top of the dowel or key.] Next, a full depth saw cut shall be made parallel to the joint at least 24-inches (600 mm) from the joint and at least 12-inches (300 mm) from the end of any dowels. All pavement between this last saw cut and the joint line shall be carefully broken up and removed using hand-held jackhammers, 30 lb. (14 kg) 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 or keys are present, care shall be taken to produce an even, vertical joint face below the dowels or keys. If the Contractor is unable to produce such a joint face, or if underbreak or other distress occurs, the Contractor shall saw the dowels or keys flush with the joint. The Contractor shall 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 “Placing dowels and Tie-bars. All this shall be at no additional cost to the Owner.”] [Dowels of the size and spacing indicated shall be installed as shown on the drawings by epoxy resin
bonding them in holes drilled in the joint face as specified in paragraph "Placing Dowels and Tie Bars". The joint face shall be sawed or otherwise trimmed so that there is no abrupt offset in any direction greater than 1/2-inch (12 mm) and no gradual offset greater than 1-inch (25 mm) when tested in a horizontal direction with a 12-feet (3.6 m) straightedge.

b. Edge Repair.

The edge of existing concrete pavement against which new pavement abuts shall be protected from damage at all times. Areas that are damaged during construction shall be repaired at no cost to the Owner; repair of previously existing damage areas will be paid for as listed in the bid schedule will be considered a subsidiary part of concrete pavement construction.

(1) Spall Repair. Spalls shall be repaired where indicated and where directed. Repair materials and procedures shall be as previously specified in subparagraph "Repairing Spalls Along Joints."

(2) Underbreak Repair. All underbreak shall be repaired. First, all delaminated and loose material shall be carefully removed. Next, the underlying material shall be recompacted, without addition of any new material. Finally, the void shall be completely filled with paving concrete, thoroughly consolidated. Care shall be taken to produce an even joint face from top to bottom. Prior to placing concrete, the underlying material shall be thoroughly moistened. After placement, the exposed surface shall be heavily coated with curing compound.

(3) Underlying Material. The underlying material adjacent to the edge of an under the existing pavement which is to remain in place shall be protected from damage or disturbance during removal operations and until placement of new concrete, and shall be shaped as shown on the drawings or as directed. Sufficient material shall 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 shall be carefully removed and replaced with concrete as specified in paragraph "Underbreak Repair." The underlying material outside the joint line shall be thoroughly compacted and moist when new concrete is placed.

MATERIAL ACCEPTANCE

501-5.1 ACCEPTANCE SAMPLING AND TESTING. All acceptance sampling and testing, with the exception of coring for thickness determination, necessary to determine conformance with the requirements specified in this section will be performed by the Engineer. Concrete shall be accepted for strength and thickness on a lot basis.

A lot shall consist of:

{[cubic yards (cubic meters).}  
{[square yards (square meters).]}

[a day's production not to exceed 2,000 cubic yards (1,530 cubic meters).]  
[a day's production not to exceed [6,000] square yards (square meters).]

Testing organizations performing these tests shall meet the requirements of ASTM C 1077, including accreditation. The accreditation will include ASTM C 78. The Contractor shall 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).
a. Flexural Strength.

(1) Sampling. Each lot shall be divided into four equal sublots. One sample shall be taken for each sublot from the plastic concrete delivered to the job site. Sampling locations shall be determined by the Engineer in accordance with random sampling procedures contained in ASTM D 3665. The concrete shall be sampled in accordance with ASTM C 172.

(2) Testing. Two (2) specimens shall be made from each sample. Specimens shall be made in accordance with ASTM C 31 and the flexural strength of each specimen shall be determined in accordance with ASTM C 78. The flexural strength for each sublot shall be computed by averaging the results of the two test specimens representing that sublot.

Immediately prior to testing for flexural strength, the beam shall be weighed and measured for determination of a sample unit weight. Measurements shall be made for each dimension; height, depth, and length, at the mid-point of the specimen and reported to the nearest tenth of an inch. The weight of the specimen shall be reported to the nearest 0.1 pound. The sample unit weight shall be calculated by dividing the sample weight by the calculated volume of the sample. This information shall 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 C 31.

(3) Curing. The Contractor shall 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 degrees F (16 to 27 degrees 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 Engineer in accordance with paragraph 501-5.2b.

b. Pavement Thickness.

(1) Sampling. Each lot shall be divided into four equal sublots and one core shall be taken by the Contractor for each sublot. Sampling locations shall be determined by the Engineer in accordance with random sampling procedures contained in ASTM D 3665. Areas, such as thickened edges, with planned variable thickness, shall be excluded from sample locations.

Cores shall be neatly cut with a core drill. The Contractor shall furnish all tools, labor, and materials for cutting samples and filling the cored hole. Core holes shall be filled by the Contractor with a non-shrink grout approved by the Engineer within one day after sampling.

(2) Testing. The thickness of the cores shall be determined by the Engineer by the average caliper measurement in accordance with ASTM C 174.
(3) **Acceptance.** Acceptance of pavement for thickness shall be determined by the Engineer in accordance with paragraph 501-5.2c.

c. **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 Engineer 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 shall constitute a lot. Where one or two sublots have been produced, they shall be incorporated into the next lot or the previous lot and the total number of sublots shall be used in the acceptance criteria calculation, i.e., n=5 or n=6.

d. **Outliers.** All individual flexural strength tests within a lot shall be checked for an outlier (test criterion) in accordance with ASTM E 178, at a significance level of 5 percent. Outliers shall be discarded, and the PWL shall be determined using the remaining test values.

**501-5.2 ACCEPTANCE CRITERIA.**

a. **General.** Acceptance will be based on the following characteristics of the completed pavement:

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<table>
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<tbody>
<tr>
<td>(1)</td>
<td>Flexural strength</td>
</tr>
<tr>
<td>(2)</td>
<td>Thickness</td>
</tr>
<tr>
<td>(3)</td>
<td>Smoothness</td>
</tr>
<tr>
<td>(4)</td>
<td>Grade</td>
</tr>
<tr>
<td>(5)</td>
<td>Edge slump</td>
</tr>
<tr>
<td>(6)</td>
<td>Dowel bar alignment</td>
</tr>
</tbody>
</table>

Flexural strength and thickness shall 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).

Acceptance for flexural strength will be based on the criteria contained in accordance with paragraph 501-5.2e(1). Acceptance for thickness will be based on the criteria contained in paragraph 501-5.2e(2). Acceptance for smoothness will be based on the criteria contained in paragraph 501-5.2e(3). Acceptance for grade will be based on the criteria contained in paragraph 501-5.2e(4).

The Engineer may at any time, not withstanding 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 only on visual inspection. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the Engineer, and if it can be demonstrated in the laboratory, in the presence of the Engineer, 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 shall be based on PWL. The Contractor shall target production quality to achieve 90 PWL or higher.

c. **Pavement Thickness.** Acceptance of each lot of in-place pavement shall be based on PWL. The Contractor shall target production quality to achieve 90 PWL or higher.

d. **Percentage of Material Within Limits (PWL).** The percentage of material within limits (PWL) shall be determined in accordance with procedures specified in Section 110 of the General Provisions.
The lower specification tolerance limit (L) for flexural strength and thickness shall be:

**Lower Specification Tolerance Limit (L)**

<table>
<thead>
<tr>
<th>Property</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexural Strength</td>
<td>$0.93 \times \text{strength specified in paragraph 501-3.1}$</td>
</tr>
<tr>
<td>Thickness</td>
<td>Lot Plan Thickness in inches $- 0.50$ inches</td>
</tr>
</tbody>
</table>

**e. Acceptance Criteria.**

1. **Flexural Strength.** If the PWL of the lot equals or exceeds 90 percent, the lot shall be acceptable. Acceptance and payment for the lot shall be determined in accordance with paragraph 501-8.1.

2. **Thickness.** If the PWL of the lot equals or exceeds 90 percent, the lot shall be acceptable. Acceptance and payment for the lot shall be determined in accordance with paragraph 501-8.1.

3. **Smoothness.** As soon as the concrete has hardened sufficiently, the pavement surface shall be tested with a 16-foot (5 m) straightedge or other specified device. Surface smoothness deviations shall not exceed 1/4-inch (6 mm) from a 16-foot (5 m) straightedge placed in any direction, including placement along and spanning any pavement joint edge.

Areas in a slab showing high spots of more than 1/4-inch (6 mm) but not exceeding 1/2-inch (13 mm) in 16-feet (5 m) shall be marked and immediately ground down with an approved grinding machine to an elevation that will fall within the tolerance of 1/4-inch (6 mm) or less. Where the departure from correct cross section exceeds 1/2-inch (13 mm), the pavement shall be removed and replaced at the expense of the Contractor when so directed by the Engineer.

4. **Grade.** An evaluation of the surface grade shall be made by the Engineer for compliance to the tolerances contained below. Records shall be maintained showing all grade measurements.

   - **Lateral Deviation.** Lateral deviation from established alignment of the pavement edge shall not exceed plus or minus 0.10 foot (30 mm) in any lane.

   - **Vertical Deviation.** Vertical deviation from established grade shall not exceed plus or minus 0.04-foot (12 mm) at any point.

5. **Edge Slump.** When slip-form paving is used, not more than 15 percent of the total free edge of each 500 foot (150 m) segment of pavement, or fraction thereof, shall have an edge slump exceeding 1/4-inch (6 mm), and none of the free edge of the pavement shall have an edge slump exceeding 3/8-inch (10 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; i.e., 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 shall be limited to not more than 18-inches (457 mm) from the edge. When excessive edge slump cannot be corrected before the concrete has hardened, the area with excessive edge slump shall be removed and replaced at the expense of the Contractor when so directed by the Engineer.

6. **Dowel Bar Alignment.** Dowel bars and assemblies shall be checked for position and alignment. The maximum permissible tolerance on dowel bar alignment in each plane, horizontal and
vertical, shall not exceed 2 percent or 1/4-inch per foot (20 mm per meter) of a dowel bar. Vertical alignment of dowels shall be measured parallel to the designed 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, shall be measured to a level surface. Horizontal alignment shall be checked perpendicular to the joint edge.

f. Removal and Replacement of Concrete. Any area or section of concrete that is removed and replaced shall be removed and replaced back to planned joints. The Contractor shall replace damaged dowels and the requirements for doweled longitudinal construction joints in paragraph 501-4.10 shall apply to all contraction joints exposed by concrete removal. Removal and replacement shall be in accordance with paragraph 501-4.19 of this specification.

CONTRACTOR QUALITY CONTROL

501-6.1 QUALITY CONTROL PROGRAM. The Contractor shall develop a Quality Control Program in accordance with Section 100 of the General Provisions. The program shall address all elements that affect the quality of the pavement including but not limited to:

a. Mix Design
b. Aggregate Gradation
c. Quality of Materials
d. Stockpile Management
e. Proportioning
f. Mixing and Transportation
g. Placing and Consolidation
h. Joints
i. Dowel Placement and Alignment
j. Flexural or Compressive Strength
k. Finishing and Curing
l. Surface Smoothness

501-6.2 QUALITY CONTROL TESTING. The Contractor shall 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 shall include, but not necessarily be limited to, tests for aggregate gradation, aggregate moisture content, slump, and air content.

A Quality Control Testing Plan shall be developed as part of the Quality Control Program.

a. Fine Aggregate.
(1) Gradation. A sieve analysis shall be made at least twice daily in accordance with ASTM C 136 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 shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C 70 or ASTM C 566.

b. Coarse Aggregate.

(1) Gradation. A sieve analysis shall be made at least twice daily for each size of aggregate. Tests shall be made in accordance with ASTM C 136 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 shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C 566.

c. Slump.

Four slump tests shall be performed for each lot of material produced in accordance with the lot size defined in Section 501-5.1. One test shall be made for each sublot. Slump tests shall be performed in accordance with ASTM C 143 from material randomly sampled from material discharged from trucks at the paving site. Material samples shall be taken in accordance with ASTM C 172.

d. Air Content.

Four air content tests, shall be performed for each lot of material produced in accordance with the lot size defined in Section 501-5.1. One test shall be made for each sublot. Air content tests shall be performed in accordance with ASTM C 231 for gravel and stone coarse aggregate and ASTM C 173 for slag or other porous coarse aggregate, from material randomly sampled from trucks at the paving site. Material samples shall be taken in accordance with ASTM C 172.

e. Four unit weight and yield tests shall be made in accordance with ASTM C 138. The samples shall be taken in accordance with ASTM C 172 and at the same time as the air content tests.

501-6.3 CONTROL CHARTS. The Contractor shall maintain linear control charts for fine and coarse aggregate gradation, slump, and air content.

Control charts shall be posted in a location satisfactory to the Engineer and shall be kept up to date at all times. As a minimum, the control charts shall 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 shall 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 Engineer may halt production or acceptance of the material.

a. Fine and Coarse Aggregate Gradation. The Contractor shall record the running average of the last five gradation tests for each control sieve on linear control charts. Specification limits contained in Tables 1 and 2 shall be superimposed on the Control Chart for job control.

b. Slump and Air Content. The Contractor shall maintain linear control charts both for individual measurements and range (i.e. difference between highest and lowest measurements) for slump and air content in accordance with the following Action and Suspension Limits.
### CONTROL CHART LIMITS

<table>
<thead>
<tr>
<th>Control Parameter</th>
<th>Individual Measurements</th>
<th>Range Limit</th>
<th>Suspension Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Action Limit</td>
<td>Suspension Limit</td>
<td></td>
</tr>
<tr>
<td><strong>Slip Form:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slump</td>
<td>+0 to -1 inch (0-25mm)</td>
<td>+0.5 to -1.5 inch (13-38mm)</td>
<td>+/- 1.5 inch (38mm)</td>
</tr>
<tr>
<td>Air Content</td>
<td>+/- 1.2%</td>
<td>+/- 1.8%</td>
<td>+/- 2.5%</td>
</tr>
<tr>
<td><strong>Fixed Form:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slump</td>
<td>+ 0.5 to -1 inch (13-25mm)</td>
<td>+1 to -1.5 inch (25-38mm)</td>
<td>+/- 1.5 inch (38mm)</td>
</tr>
<tr>
<td>Air Content</td>
<td>+/- 1.2%</td>
<td>+/- 1.8%</td>
<td>+/- 2.5%</td>
</tr>
</tbody>
</table>

The individual measurement control charts shall use the mix design target values as indicators of central tendency.

**501-6.4 CORRECTIVE ACTION.** The Contractor Quality Control Program shall indicate that appropriate action shall be taken when the process is believed to be out of control. The Contractor Quality Control Program shall detail what action will be taken to bring the process into control and shall contain sets of rules to gauge when a process is out of control. As a minimum, a process shall be deemed out of control and corrective action taken if any one of the following conditions exists.

a. **Fine and Coarse Aggregate Gradation.** When two consecutive averages of five tests are outside of the Tables 1 or 2 specification limits, immediate steps, including a halt to production, shall be taken to correct the grading.

b. **Fine and Coarse Aggregate Moisture Content.** Whenever the moisture content of the fine or coarse aggregate changes by more than 0.5 percent, the scale settings for the aggregate batcher(s) and water batcher shall be adjusted.

c. **Slump.** The Contractor shall 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.

   d. **Air Content.** The Contractor shall 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 shall be calibrated to ensure that it is operating correctly and with good reproducibility.

### METHOD OF MEASUREMENT

**501-7.1** Portland cement concrete pavement shall be measured by the number of [cubic yards (cubic meters)] [square yards (square meters)] of either plain or reinforced pavement as specified in-place,
completed and accepted. Saw-cut grooving shall be measured by the number of square yards (square meters) of saw-cut grooving as specified in-place, completed and accepted.

**BASIS OF PAYMENT**

501-8.1 PAYMENT. Payment for accepted concrete pavement shall be made at the contract unit price \[ \text{per cubic yard (cubic meter)} \] \[ \text{per square yard (square meter)} \] adjusted in accordance with paragraph 501-8.1a, subject to the limitation that:

The total project payment for concrete pavement shall not exceed \[100\] percent of the product of the contract unit price and the total number of \[ \text{cubic yards (cubic meters)} \] \[ \text{square yards (square meters)} \] of concrete pavement used in the accepted work (See Note 2 under Table 3).

Payment shall be full compensation for all labor, materials, tools, equipment, and incidentals required to complete the work as specified herein and on the drawings, except for saw-cut grooving.

a. **Basis of Adjusted Payment.** The pay factor for each individual lot shall be calculated in accordance with Table 3. A pay factor shall be calculated for both flexural strength and thickness. The lot pay factor shall be the higher of the two values when calculations for both flexural strength and thickness are 100 percent or higher. The lot pay factor shall be the product of the two values when only one of the calculations for either flexural strength or thickness is 100 percent or higher. The lot pay factor shall be the lower of the two values when calculations for both flexural strength and thickness are less than 100 percent.

**TABLE 3. PRICE ADJUSTMENT SCHEDULE**

<table>
<thead>
<tr>
<th>Percentage of Material Within Specification Limits (PWL)</th>
<th>Lot Pay Factor (Percent of Contract Unit Price)</th>
</tr>
</thead>
<tbody>
<tr>
<td>96 – 100</td>
<td>106</td>
</tr>
<tr>
<td>90 – 95</td>
<td>PWL + 10</td>
</tr>
<tr>
<td>75 – 90</td>
<td>0.5PWL + 55</td>
</tr>
<tr>
<td>55 – 74</td>
<td>1.4PWL – 12</td>
</tr>
<tr>
<td>Below 55</td>
<td>Reject ²</td>
</tr>
</tbody>
</table>

¹ ALTHOUGH IT IS THEORETICALLY POSSIBLE TO ACHIEVE A PAY FACTOR OF 106 PERCENT FOR EACH LOT, ACTUAL PAYMENT IN EXCESS OF 100 PERCENT SHALL BE SUBJECT TO THE TOTAL PROJECT PAYMENT LIMITATION SPECIFIED IN PARAGRAPH 501-8.1.

² The lot shall be removed and replaced. However, the Engineer may decide to allow the rejected lot to remain. In that case, if the Engineer and Contractor agree in writing that the lot shall not be removed, it shall be paid for at 50 percent of the contract unit price AND THE TOTAL PROJECT PAYMENT LIMITATION SHALL BE REDUCED BY THE AMOUNT WITHHELD FOR THE REJECTED LOT.

For each lot accepted, the adjusted contract unit price shall be the product of the lot pay factor for the lot and the contract unit price. Payment shall be subject to the total project payment limitation specified in paragraph 501-8.1. Payment in excess of 100 percent for accepted lots of concrete pavement shall be used to offset payment for accepted lots of concrete pavement that achieve a lot pay factor less than 100 percent.
b. Payment. Payment shall be made under:

Item P-501-8.1a Portland Cement Concrete Pavement—[per cubic yard (cubic meter)] [per square yard (square meter)]

Item P-501-8.1 12-inch Thick Portland Cement Concrete Pavement -- Per Square Yard (Square Meter)

Item P-501-8.2 9-inch Thick Portland Cement Concrete Pavement -- Per Square Yard (Square Meter)

Item P-501-8.3 Buried Transition - Concrete -- Per Square Yard (Square Meter)

c. 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 shall be applied in accordance the following equation and schedule:

\[(\text{Sq yds in section}) \times (\text{original unit price per sq yds}) \times \text{PFm} = \text{reduction in payment for area within section}\]

<table>
<thead>
<tr>
<th>Average Profile Index (Inches per mile)</th>
<th>Pavement strength rating</th>
<th>Contract Unit Price Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>over 30,000 lb or less</td>
<td>Short Sections</td>
<td>PFM</td>
</tr>
<tr>
<td>0 - 7</td>
<td>0 - 15</td>
<td>0.00</td>
</tr>
<tr>
<td>7.1 - 9</td>
<td>10.1 - 11</td>
<td>0.02</td>
</tr>
<tr>
<td>9.1 - 11</td>
<td>11.1 - 12</td>
<td>0.04</td>
</tr>
<tr>
<td>11.1 - 13</td>
<td>12.1 - 13</td>
<td>0.06</td>
</tr>
<tr>
<td>13.1 - 14</td>
<td>13.1 - 14</td>
<td>0.08</td>
</tr>
<tr>
<td>14.1 - 15</td>
<td>14.1 - 15</td>
<td>0.10</td>
</tr>
<tr>
<td>15.1 &amp; up</td>
<td>15.1 &amp; up</td>
<td>corrective work required</td>
</tr>
</tbody>
</table>

501-8.2 PAYMENT FOR SAW-CUT GROOVING. Payment for saw-cut grooving shall be made at the contract unit price per square yard (square meter) for saw-cut grooving. Refer to P-402 Diamond Grooving of Runway Pavement for specification and payment.

TESTING REQUIREMENTS

ASTM C 31 Making and Curing Concrete Test Specimens in the Field

ASTM C 39 Compressive Strength of Cylindrical Concrete Specimens

ASTM C 70 Surface Moisture in Fine Aggregate

ASTM C 78 Test for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)

ASTM C 88 Test for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 131  Test for Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine
ASTM C 136  Sieve Analysis of Fine and Coarse Aggregates
ASTM C 138 of Concrete  Test for Density (Unit Weight), Yield, and Air Content (Gravimetric)
ASTM C 143  Test for Slump of Hydraulic Cement Concrete
ASTM C 172  Sampling Freshly Mixed Concrete
ASTM C 173 Method  Test for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 174 Cores  Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C 227  Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
ASTM C 231 Method  Test for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 289  Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
ASTM C 295  Petrographic Examination of Aggregates for Concrete
ASTM C 114  Chemical Analysis of Hydraulic Cement
ASTM C 535  Test for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 566  Total Evaporable Moisture Content of Aggregates by Drying
ASTM C 642  Test for Density, Absorption, and Voids in Hardened Concrete
ASTM C 666  Resistance of Concrete to Rapid Freezing and Thawing
ASTM C 1077 Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction And Criteria for Laboratory Evaluation
ASTM C 1260 Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM D 3665 Random Sampling of Paving Materials
ASTM D 4791 Test Method for Flat or Elongated Particles in Coarse Aggregate
ASTM E 178 Practice for Dealing With Outlying Observations
ASTM E 1274 Test for Measuring Pavement Roughness Using a Profilograph
AASHTO T 26  Quality of Water to be Used in Concrete

MATERIAL REQUIREMENTS

ASTM A 184  Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement

ASTM A 185  Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

ASTM A 497  Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement

ASTM A 615  Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

ASTM A 704  Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement

ASTM A 714  Specification for High-Strength Low-Alloy Welded and Seamless Steel Pipe

ASTM A 996  Specification for Rail-Steel and Axle Steel Deformed Bars for Concrete Reinforcement

ASTM C 33  Specification for Concrete Aggregates

ASTM C 94  Specification for Ready-Mixed Concrete

ASTM C 150  Specification for Portland Cement

ASTM C 171  Specification for Sheet Materials for Curing Concrete

ASTM C 260  Specification for Air-Entraining Admixtures for Concrete

ASTM C 309  Specification for Liquid Membrane-Forming Compounds for Curing Concrete

ASTM C 494  Specification for Chemical Admixtures for Concrete

ASTM C 595  Specification for Blended Hydraulic Cements

ASTM C 618  Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete

ASTM C 881  Specification for Epoxy-Resin Base Bonding System for Concrete

ASTM C 989  Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM D 1751 Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

ASTM D 1752 Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving And Structural Construction

ACI 305R Hot Weather Concreting

ACI 306R Cold Weather Concreting

ACI 309 Guide for Consolidation of Concrete

MIL-DTL-24441/20a (1999) Paint, Epoxy-Polyamide, Green Primer, Formula 150, Type III Department of Defense

END ITEM P-501
ITEM D-751  MANHOLES, CATCH BASINS, INLETS AND INSPECTION HOLES

DESCRIPTION

751-1.1 This item shall consist of construction of manholes, catch basins, inlets, and inspection holes, in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the Engineer. All structures, castings, etc. in the Runway and Taxiway safety areas shall comply with FAA Advisory Circular 150/5320-6, Latest Edition and shall be aircraft rated. All other structures shall conform to these specifications and plans.

751-1.2 SUBMITTALS. Shop drawing of each component shall be submitted to the Engineer for review and approval and shall be approved prior to ordering any materials for this item. This submittal shall include the proposed method of installation for all components. The submittal shall include data on all component parts of this item. The data shall be sufficient, in the opinion of the Engineer, to determine compliance with the contract documents. The Contractor's submittals shall be submitted to the Engineer 30 days prior to start up of construction. The complete submittal shall be reviewed, approved, signed and sealed by a licensed registered Professional Engineer for the state in which the project is located.

751-1.3 QUALIFICATIONS. The Engineer reserves the right to reject any and all equipment, materials, procedures, etc., which, in the Engineer's opinion, does not meet the system design and the standards and codes specified herein.

751-1.4 REFERENCED MATERIALS. Additional details pertaining to specific items covered in this section are contained in Federal Advisory Administration (FAA) Advisory Circulars (AC's), Latest Edition, listed below:

<table>
<thead>
<tr>
<th>Circular</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>150/5300-13</td>
<td>Airport Design (Latest Edition)</td>
</tr>
<tr>
<td>150/5320-6</td>
<td>Airport Pavement Design and Evaluation (Latest Edition)</td>
</tr>
<tr>
<td>150/5370-2</td>
<td>Operational Safety on Airports During Construction (Latest Edition)</td>
</tr>
<tr>
<td>150/5370-10</td>
<td>Standards for Specifying Construction of Airports (Latest Edition)</td>
</tr>
</tbody>
</table>

The Contractor is responsible for obtaining and using the latest Edition of the referenced FAA Advisory Circulars. This list is not all inclusive but is offered as a convenience to the Contractor.

MATERIALS

751-2.1 BRICK. The brick shall conform to the requirements of ASTM C 32, Grade SM.

751-2.2 MORTAR. Mortar shall consist of one part portland cement and two parts sand. The portland cement shall conform to the requirements of ASTM C 150, Type I. The sand shall conform to the requirements of ASTM C 144.

751-2.3 CONCRETE. Plain and reinforced concrete used in structures, connections of pipes with structures, and the support of structures or frames shall conform to the requirements of Item P-610. Concrete produced by a reputable local supplier of ready-mix or transit-mix concrete designed for a minimum compressive strength of 4,000 psi at 28 days, unless otherwise specified, may be used when approved by the Engineer. The Contractor shall submit the ready-mix or transit-mix design to the Engineer at least 30 days prior to startup of construction.
751-2.4 PRECAST CONCRETE PIPE MANHOLE RINGS. Precast concrete pipe manhole rings shall conform to the requirements of ASTM C 478. Unless otherwise specified, the risers and offset cone sections shall have an inside diameter of not less than 36-inches (90 cm) nor more than 48-inches (120 cm). The precast concrete pipe manhole rings shall be designed to withstand a 250 psi tire pressure when the structure is inside the runway, taxiway or apron safety area and an HS-20 loading when the structure is outside the runway, taxiway or apron safety area.

751-2.5 CORRUGATED METAL. Corrugated metal shall conform to the requirements of AASHTO M 36.

751-2.6 FRAMES, COVERS, AND GRATES. The castings shall conform to one of the following requirements:

- a. Gray iron castings shall meet the requirements of ASTM A 48, Class 30B and 35B.
- b. Malleable iron castings shall meet the requirements of ASTM A 47.
- c. Steel castings shall meet the requirements of ASTM A 27.
- d. Structural steel for grates and frames shall conform to the requirements of ASTM A 283, Grade D.
- e. Ductile iron castings shall conform to the requirements of ASTM A 536.
- f. Austempered ductile iron castings shall conform to the requirements of ASTM A 897.

All castings shall be designed to withstand a 250 psi tire pressure when the structure is inside the runway, taxiway or apron safety area and an HS-20 loading when the structure is outside the runway, taxiway or apron safety area.

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings, aircraft gear configuration and/or direct loading, specified.

Each frame and cover or grate unit shall be provided with fastening members to prevent it from being dislodged by traffic but which will allow easy removal for access to the structure.

The frame and cover or grate unit shall be cast flush with the top of the manhole slab. The frame and cover or grate unit manufacturer shall certify that the cover or unit is rated to exceed the requirements of the 250 psi tire pressure or HS-20 loading. Each cover shall have the word “Storm Drainage” or other approved designation cast on one piece.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A 123.

751-2.7 STEPS. The steps or ladder bars shall be gray or malleable cast iron or galvanized steel. The steps shall be the size, length, and shape shown on the plans and those steps that are not galvanized shall be given a coat of bituminous paint, when directed.

751-2.8 REINFORCING STEEL. All reinforcing steel shall be deformed bars of new billet steel meeting the requirements of ASTM A 615, Grade 60.
751-2.9 PRECAST CONCRETE STRUCTURES. Precast concrete structures shall be constructed on prepared or previously placed slab foundations and shall conform to the dimensions and locations shown on the contract drawings. All precast concrete sections necessary to build a completed structure shall be furnished. The different sections shall fit together readily and all joints shall be sealed with a butyl rubber gasket type sealant. The top of the upper precast concrete member shall be suitably formed and dimensioned to receive the metal frame and cover or grate, or other cap, as required.

751-2.10 SEALANTS. Joints between precast concrete sections shall be sealed with a butyl rubber gasket type sealant that meets all of the requirements of Federal Specification SS-S-210A, Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.

751-2.11 SUBMITTALS. Submittals of “Shop and Setting Drawings”, “Working Drawings”, “Catalogue Data” and “Certifications” for review shall be submitted in accordance with appropriate sections of the specifications. Submittals and Certifications required are as follows:

a. Certifications and Concrete Mix Design submittals in accordance with Item P-610, Structural Portland Cement Concrete.

b. Catalogue data and certifications that frames and covers meet the requirements specified.

c. Catalogue data and certification that ladders meet the requirements specified.

d. Certification that reinforcing steel meets the requirements specified.

e. Submittal of Strength Design Calculations, Shop Drawings and Certifications for Pre-cast units.

f. Shop Drawings when structure to be built is at variance with plans or hydraulic assist.

CONSTRUCTION METHODS

751-3.1 UNCLASSIFIED EXCAVATION.

a. The Contractor shall do all excavation for structures and structure footings to the lines and grades or elevations, shown on the plans, or as staked by the Engineer. The excavation shall 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 plans, shall be considered as approximate only; and the Engineer 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 shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the Engineer. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation, and excavation to final grade shall not be made until just before the concrete or reinforcing is to be placed.

c. The Contractor shall 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 shall 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 shall be removed by the Contractor after the completion of the structure. Removal shall be effected in a
manner that will not disturb or mar finished masonry. The cost of removal shall be included in the unit price bid for the structure.

e. After each excavation is completed, the Contractor shall notify the Engineer to that effect; and concrete or reinforcing steel shall be placed after the Engineer has approved the depth of the excavation and the character of the foundation material.

751-3.2 Brick Structures.

--- a. Foundations. A prepared foundation shall be placed for all brick structures after the foundation excavation is completed and accepted. Unless otherwise specified, the base shall consist of reinforced concrete mixed, prepared, and placed in accordance with the requirements of Item P-610.

--- b. Laying Brick. All brick shall be clean and thoroughly wet before laying so that they will not absorb any appreciable amount of additional water at the time they are laid. All brick shall be laid in freshly made mortar. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted. An ample layer of mortar shall be spread on the beds and a shallow furrow shall be made in it that can be readily closed by the laying of the brick. All bed and head joints shall be filled solid with mortar. End joints of stretchers and side or cross joints of headers shall be fully buttered with mortar and a shoved joint made to squeeze out mortar at the top of the joint. Any bricks that may be loosened after the mortar has taken its set, shall be removed, cleaned, and relaid with fresh mortar. No broken or chipped brick shall be used in the face, and no spalls or bats shall be used except where necessary to shape around irregular openings or edges; in which case, full bricks shall be placed at ends or corners where possible, and the bats shall be used in the interior of the course. In making closures, no piece of brick shorter than the width of a whole brick shall be used; and wherever practicable, whole brick shall be used and laid as headers.

--- c. Joints. All joints shall be slushed with mortar at every course, but slushing alone will not be considered adequate for making an acceptable joint. Exterior faces shall be laid up in advance of backing. Exterior faces shall be back plastered or pargeted with a coat of mortar not less than 3/8-inch (9 mm) thick before the backing is laid up. Prior to pargeting, all joints on the back of face courses shall be cut flush. Unless otherwise noted, joints shall be not less than 1/4-inch (6 mm) nor more than 1/2-inch (12 mm) wide and whatever width is adopted shall be maintained uniform throughout the work.

--- d. Pointing. Face joints shall be neatly struck, using the weather joint. All joints shall be finished properly as the laying of the brick progresses. When nails or line pins are used the holes shall be immediately plugged with mortar and pointed when the nail or pin is removed.

--- e. Cleaning. Upon completion of the work all exterior surfaces shall be thoroughly cleaned by scrubbing and washing down with water and, if necessary to produce satisfactory results, cleaning shall be done with a 5% solution of muriatic acid which shall then be rinsed off with liberal quantities of clean fresh water.

--- f. Curing and Cold Weather Protection. In hot or dry weather, or when directed by the Engineer, the brick masonry shall be protected and kept moist for at least 48 hours after laying the brick. Brick masonry work or pointing shall not be done when there is frost in the brick or when the air temperature is below 50 F (10 C) unless the Contractor has on the project ready to use, suitable covering and artificial heating devices necessary to keep the atmosphere surrounding the masonry at a temperature of not less than 60 F (15 C) for the duration of the curing period.

No brick products shall be used to adjust the elevation between the precast or cast-in-place concrete structure and the top and rim and cover or inlet. All adjustments shall be cast-in-place concrete meeting the requirements of P-610, Structural Portland Cement Concrete.
751-3.3 CONCRETE STRUCTURES. Concrete structures shall be built on prepared foundations, conforming to the dimensions and form indicated on the plans. The construction shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the Engineer before the concrete is poured.

All invert channels shall be constructed and shaped accurately so as to be smooth, uniform, and cause minimum resistance to flowing water. The interior bottom shall be sloped downward toward the outlet.

751-3.4 PRECAST CONCRETE PIPE STRUCTURES. Precast concrete pipe structures shall be constructed on prepared or previously placed slab foundations and shall conform to the dimensions and locations shown on the plans. All precast concrete pipe sections necessary to build a completed structure shall be furnished. The different sections shall fit together readily, and all jointing and connections shall be cemented with mortar. The top of the upper precast concrete pipe member shall be suitably formed and dimensioned to receive the metal frame and cover or grate, or other cap, as required. Provision shall be made for any connections for lateral pipe, including drops and leads that may be installed in the structure. The flow lines shall be smooth, uniform, and cause minimum resistance to flow. The metal steps that are embedded or built into the side walls shall be aligned and placed at vertical intervals of 12-inches (300 mm). When a metal ladder replaces the steps, it shall be securely fastened into position.

751-3.5 CORRUGATED METAL STRUCTURES. Corrugated metal structures shall be constructed on prepared foundations, conforming to the dimensions and locations as shown on the plans. The structures shall be prefabricated. Standard or special fittings shall be furnished to provide pipe connections or branches of correct dimensions. The connections or branches shall be of sufficient length to accommodate connecting bands. The fittings shall be welded in place to the metal structures. When indicated, the structures shall be placed on a reinforced concrete base. The top of the metal structure shall be designed so that either a concrete slab or metal collar may be attached to which can be fastened a standard metal frame and grate or cover. Steps or ladders shall be furnished as shown on the plans.

751-3.6 INLET AND OUTLET PIPES. Inlet and outlet pipes shall extend through the walls of the structures for a sufficient distance beyond the outside surface to allow for connections but shall be cut off flush with the wall on the inside surface, unless otherwise directed. For concrete or brick structures, the mortar shall be placed around these pipes so as to form a tight, neat connection.

751-3.7 PLACEMENT AND TREATMENT OF CASTINGS, FRAMES, AND FITTINGS. All castings, frames, and fittings shall be placed in the positions indicated on the plans or as directed by the Engineer, and shall 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 shall be in place and position before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

When frames or fittings are to be placed upon previously constructed masonry, the bearing surface or masonry shall be brought true to line and grade and shall 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 shall be set in mortar beds and anchored to the masonry as indicated on the plans or as directed and approved by the Engineer. All units shall set firm and secure.

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 shall be placed and fastened down.

751-3.8 INSTALLATION OF STEPS. The steps shall be installed as indicated on the plans or as directed by the Engineer. When the steps are to be set in concrete, they shall be placed and secured in position before the concrete is poured. When the steps are installed in brick masonry, they shall be placed as the masonry is being built. The steps shall not be disturbed or used until the concrete or mortar
has hardened for at least 7 days. After this period has elapsed, the steps shall be cleaned and painted, unless they have been galvanized.

When steps are required with precast concrete pipe structures, they shall 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.

When steps are required with corrugated metal structures, they shall be welded into aligned position at a vertical spacing of 12 inches (300 mm).

In lieu of steps, prefabricated ladders may be installed. In the case of brick or concrete structures, the ladder shall be held in place by grouting the supports in drilled holes. In the case of metal structures, the ladder shall be secured by welding the top support and grouting the bottom support into drilled holes in the foundation or as directed.

751-3.9 BACKFILLING.

a. After a structure has been completed, the area around it shall be filled with approved material, in horizontal layers not to exceed 8-inches (200 mm) in loose depth, and compacted to the density required in Item P-152. Each layer shall be deposited all around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the Engineer.

b. Backfilling shall not be placed against any structure until permission is given by the Engineer. In the case of concrete, such permission shall not be given until the concrete has been in place 7 days, or until tests made by the laboratory under supervision of the Engineer 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. When required, the Engineer may direct the Contractor to add, at his own expense, sufficient water during compaction to assure a complete consolidation of the backfill. The Contractor shall be responsible for all damage or injury done to ducts, structures, property or persons due to improper placing or compacting of backfill. The cost of all backfill and compaction efforts shall be included in the unit price bid for the manhole, catch basin, inlet or inspection hole.

cd. Backfill shall not be measured for direct payment. Performance of this work shall be considered on obligation of the Contractor covered under the contract unit price for the structure involved.

751-3.10 CLEANING AND RESTORATION OF SITE. After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as ordered by the Engineer. The Contractor shall restore all disturbed areas to their original condition.

After all work is completed, the Contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

751-3.11 MANHOLE ADJUSTMENTS. The Contractor shall adjust the tops of existing manholes in areas to be paved to the new elevations shown on the contract drawings. The Contractor shall be responsible for determining the exact height adjustment required to raise the top of each inlet or manhole to the new elevation. The existing top elevation of each inlet or manhole to be adjusted shall be determined in the field and added or subtracted from the proposed top elevation. The Contractor shall not use brick products to adjust inlet or manhole tops.
The Contractor shall remove the existing top section or ring and cover from the inlet, manhole structure or manhole access. The Contractor shall then install precast concrete sections or grade rings of the required dimensions to adjust the inlet or manhole top to the new proposed elevation. Finally, the Contractor shall reinstall the inlet or manhole top section or ring and cover on top and check the new top elevation.

The Contractor shall install steps in the new precast concrete sections or grade rings as required to match the spacing of the steps in the existing structure being adjusted. The new steps shall be aligned with the existing steps.

The Contractor shall construct a concrete slab around the top of adjusted structures located in graded areas that are not to be paved. The concrete slab shall conform to the dimensions shown on the contract drawings.

**751-3.12 INSPECTION.** Prior to final approval of the manholes, catch basins, inlets and inspection holes, the Engineer, accompanied by the Contractor, shall make a through inspection, by an appropriate method, of the entire installation. Any indication of defects in material or workmanship shall be further investigated and corrected. Defects due to the Contractor’s negligence shall be corrected by the Contractor without additional compensation and as directed by the Engineer.

**751-3.13 REMOVAL OF WATER.** If water is encountered in the excavated areas, the Contractor shall dewater the area and obtain optimum moisture content prior to placing concrete, structure or subbase. Performance of the work described in this section is not payable directly, but shall be considered as a subsidiary obligation of the Contractor and included in the contract price for the pay items of work involved.

**STORM CHAMBER DETENTION SYSTEM**

**751-4.1 TRAINING** The contractor shall also provide 4.0 hours of Manufacturers’ Operation and Maintenance training of the system for the Duluth Airport Authority Staff. The contractor must coordinate the training two weeks prior to the training session.

**751-4.2 FINAL ACCEPTANCE** The contractor shall clean the system prior to final acceptance.

**WATER QUALITY UNIT**

**751-5.1 SCOPE** The contractor shall provide all labor, equipment and materials necessary to construct WATER QUALITY UNIT in place as per plan sheets C513 – C514.

This specification describes 36- through 60-inch (900 to 1500 mm) Storm Water Quality Units for use in on-site point source storm water treatment applications.

**751-5.2 REQUIREMENTS** Storm Water Quality Units shall have smooth interior and annular exterior corrugations. The unit shall have at least three containment zones, each zone separated from the next by use of a weir or baffle plate. Weir and baffle plates shall be welded at all interfaces between the plate and water quality unit. First weir plate shall incorporate a saw tooth design and shall be reinforced with stiffeners positioned horizontally on the downstream side of the plate to be retained. Storm Water Quality Units shall provide adequate clean-out and inspection access.

**751-5.3 JOINT PERFORMANCE** Connections for the bypass line and the unit shall utilize the same joint quality as specified for the main storm sewer pipe. Couplers for the bypass line may be either split couplers, in-line bell couplers, snap couplers, bell-bell couplers, or welded bell couplers.
751-5.4 MATERIAL PROPERTIES Virgin material for pipe & fittings used to produce Storm Water Quality Units shall be high density polyethylene conforming with the minimum requirements of cell classification 424420C for 4- through 10-inch (100 to 250 mm) diameters, and 435400C for 12- through 60-inch (300 to 1500mm) diameters as defined and described in the latest version of ASTM D3350. The virgin pipe material shall be evaluated using the notched constant ligament-stress (NCLS) test as specified in Sections 9.5 and 5.1 of AASHTO M294 and ASTM F2306, respectively. All smooth baffle and weir plates shall be high density polyethylene.

751-5.5 INSTALLATION Installation shall be in accordance with the Manufacturer’s installation guidelines, utilizing a class I (ASTM D2321) structural backfill material or flowable fill (CLSM –Controlled Low Strength Material). Contact your local Manufacturer’s representative for the latest installation instructions.

751-5.6 PERFORMANCE Water Quality Units shall remove a minimum of 80% of the first flush total suspended solids (TSS) based on flow rates and corresponding sieve sizes. Water Quality units shall be installed “offline” to prevent re-suspension of solids in high flow situations. Offline installation shall be constructed utilizing a by-pass structure. Flow through the unit shall be controlled by an orifice fabricated on the outlet end of the structure.

751-5.7 TRAINING The contractor shall also provide 4.0 hours of Manufacturers’ Operation and Maintenance training of the system for the Duluth Airport Authority Staff. The contractor must coordinate the training two weeks prior to the training session.

751-5.8 FINAL ACCEPTANCE The contractor shall clean the system prior to final acceptance.

METHOD OF MEASUREMENT

751-6.1 Manholes, catch basins, inlets, and inspection holes shall be measured by the unit, completed in place and accepted. All required excavation, sheeting and bracing, all required backfilling, restoration of all surfaces, all required connections and dewatering shall be included as part of the unit completed.

BASIS OF PAYMENT

751-7.1 The accepted quantities of manholes, catch basins, inlets, and inspection holes will be paid for at the contract unit price per each in place when completed. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials; furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the item as shown on the plans; and for all labor equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

- Item D-751-7.1 REMOVE MANHOLES OR CATCH BASINS -- Per Each
- Item D-751-7.2 INSTALL NEW MANHOLE/CATCHBASIN, 4' DIA -- Per Each
- Item D-751-7.3 INSTALL NEW MANHOLE/CATCHBASIN, 5' DIA -- Per Each
- Item D-751-7.4 INSTALL NEW MANHOLE/CATCHBASIN, 6' DIA -- Per Each
- Item D-751-7.5 INSTALL NEW MANHOLE/CATCHBASIN, 7' DIA -- Per Each
Item D-751-7.6 INSTALL NEW 42” DIA. END SECTION -- Per Each
Item D-751-7.7 RECONSTRUCT MANHOLES OR CATCH BASINS -- Per Each
Item D-751-7.8 STORM CHAMBER DETENTION SYSTEM -- Per LUMP SUM
Item D-751-7.9 STORM DRAINAGE FRAME AND COVER, AS SPECIFIED -- Per Each
Item D-751-7.10 WATER QUALITY UNIT -- Per LUMP SUM
Item D-751-7.11 ADJUST EXISTING STORM OR SANITARY MH CASTING -- Per Each

MATERIAL REQUIREMENT

ASTM A 27 Steel Castings, Carbon, for General Application
ASTM A 47 Ferritic Malleable Iron Castings
ASTM A 48 Gray Iron Castings
ASTM A 123 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 283 Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars
ASTM A 536 Ductile Iron Castings
ASTM A 897 Austempered Ductile Iron Castings
ASTM C 32 Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 144 Aggregate for Masonry Mortar
ASTM C 150 Portland Cement
ASTM C 478 Precast Reinforced Concrete Manhole Sections
AASHTO M 36 Zinc Coated (Galvanized) Corrugated Iron or Steel Culverts and Underdrains

END OF ITEM D-751
ITEM L-105 ALTERATIONS, REMOVAL AND DEMOLITION

GENERAL

105-1.1 DEFINITIONS. Alterations shall mean any change or rearrangement in the component parts, including structural, mechanical, electrical systems, or internal or external arrangements of an existing structure.

Removal shall mean the dismantling of existing materials, components, equipment, and utilities. Removed items shall be handled, prepared for storage, transported to storage areas as specified.

Demolition shall mean the dismantling and disposal of existing materials, components, equipment, and utilities which cannot or will not be reused or which will have no salvage value, or which cannot be reused due to unrepairable damage caused by age, non-demolition related reasons, etc. All demolished items not designated to be turned over to the Owner shall be disposed of in a safe manner and at a location acceptable to the Owner.

All items to be turned over to the Owner shall be properly enclosed or boxed to protect the items from damage and transported by the Contractor to a location on the Owner's property, designated by the Engineer and/or the Owner.

The installation and/or removal of lighting equipment may be critical to airport operations; therefore, the Contractor shall follow the work schedule established in the plans and specifications or as directed by the Engineer. The system shall be installed in accordance with the National Electrical Code and/or local code requirements.

The Contractor shall provide temporary wiring as required to reconnect existing circuits to provide guidance for aircraft to pass through the construction areas on those taxiways/runways which must remain open. The Contractor shall check all temporary circuits before dark each day to assure that they are operational. In the event of failure, the Contractor shall immediately take steps to restore operation. The cost of temporary and reconnected lighting shall be absorbed in the various work items.

105-1.2 CONDITION OF EXISTING FACILITIES. The Contractor shall verify the areas, conditions, and features necessary to tie into existing construction. This verification shall be done prior to submittal of shop drawings, fabrication or erection, construction or installation. The Contractor shall be responsible for the accurate tie-in of the new work to existing facilities.

Special attention is called to the fact that there may be piping, fixtures or other items in the existing systems which must be removed or relocated in order to perform the alteration work. All conduit, wiring, boxes, etc., that do not comply with these specifications shall be removed or corrected to comply with these specifications. All unused conduit not removed shall be identified and a pull line shall be installed. The work shall include all removal and relocation required for completion of the alterations and the new construction.

Whenever the scope of work requires connection to an existing circuit, the circuit's insulation resistance shall be tested, in the presence of the Owner and Engineer. The Contractor shall record the results on the forms included in these specifications. When the circuit is returned to its final condition, the circuit's insulation resistance shall be checked again in the presence of the Owner and Engineer. The Contractor shall record the results on the forms included in these specifications. The second reading shall be equal to or greater than the first reading or the Contractor shall make the necessary repairs to the circuit to bring the second reading above the first reading. All repair costs including a complete replacement of the cable, if necessary, shall be borne by the Contractor. All test results shall be submitted in the Operation
and Maintenance Manuals as described in Item L-106, Submittals, Record Documents and Maintenance Manuals.

105-1.3 OCCUPANCY AND USE OF EXISTING FACILITIES. The Owner will occupy and use the facilities within the areas of work during the entire construction period. The Contractor shall be required to plan and coordinate his activities in order to provide all necessary controls for the abatement of dust, noise, and inconvenience to the Owner personnel during all phases of the work.

105-1.4 VACATING OCCUPIED AREAS. The Owner will remove all portable items of furniture, equipment, and fixtures prior to the start of work.

105-1.5 SAFETY REQUIREMENTS. The Contractor shall conduct alterations and removal operations in a manner that will ensure the safety of persons in accordance with the requirements of CFR 29 PART 1926 and 1910.

105-1.6 CLASSIFICATION OF REMOVED/DEMOLISHED ITEMS. Existing materials and equipment indicated to be removed will be classified as “salvageable” and shall remain the property of the Owner or will be classified as “debris” and shall be disposed of legally off the airport.

Reusable salvaged items:

Salvaged materials and equipment shall be reused in the work as described on the contract drawings, unless noted otherwise.

Items classified as debris shall be legally disposed of off the airport property. The cost of such disposal shall be included in the cost of other items of work.

Retained salvaged items:

Salvaged materials and equipment to be retained by the Owner but not reused in the work shall be turned over to the Owner at a site at the facility to be determined by the Owner. Retained salvaged items shall be stored on Owner property where indicated by the Owner.

105-1.7 TEMPORARY PROTECTION. The Contractor shall provide and maintain the following requirements.

Protection of persons and property shall be provided throughout the progress of the work in accordance with these specifications.

Provide temporary enclosures and partitions prior to starting alterations and removal of work. Such items shall protect existing materials, equipment, and other remaining building or system components from damage by weather and construction operations.

Provide temporary enclosures to isolate space utilized by equipment during construction, from dirt, dust, noise, and unauthorized entry.

Provide temporary exits, entrances, and protected passages where work prevents the use of existing facilities.

Provide weathertight temporary enclosures over and around openings to be made in existing exterior construction prior to the start of work. The Contractor shall maintain such temporary enclosures until new construction will protect the interior of existing facilities from the elements.
Provide temporary exterior wall construction which will be designed and fabricated to resist an applied horizontal wind pressure of not less than 130 mph.

Provide temporary exterior roof construction which will be capable of supporting an applied vertical live load of not less than 200 psf, uniformly distributed over the entire roof area.

Design and fabricate temporary enclosures to maintain temperatures inside the existing facilities within a range of plus-or-minus 5 degrees F of normal operating conditions.

Provide temporary jet blast structures which will withstand the jet blast with a safety factor of 2.

**EXECUTION**

105-2.1 DISCONNECTING UTILITIES. Prior to the start of work, the necessary utilities serving each area of alteration or removal will be shut off by the Owner and shall be disconnected and sealed by the Contractor, as required. Lockout/Tag/Try procedures shall be utilized in accordance with Item L-104, General Electrical Safety Requirements and Temporary Airfield Lighting.

105-2.2 TEMPORARY UTILITY SERVICES. The Contractor shall install temporary utility services in satisfactory operating condition before disconnecting existing utilities. Such temporary services shall be maintained during the period of construction and removed only after new permanent services have been tested and are in operation.

105-2.3 REMOVAL WORK. The Contractor shall not disturb the existing construction beyond that indicated or necessary for installation of new work. Temporary shoring and bracing for support of building components to prevent settlement or other movement shall be as indicated and as required to protect the work.

The Contractor shall provide protective measures to control accumulation and migration of dust and dirt in all areas of work, particularly those adjacent to occupied areas. The Contractor shall remove dust, dirt, and debris from the areas of work daily.

105-2.4 SALVAGEABLE MATERIALS AND EQUIPMENT. The Contractor shall remove all salvageable materials and equipment in a manner that will cause the least possible damage thereto. Removed items which are to be retained by the Owner shall be carefully handled, stored, and protected.

The Contractor shall provide identification tags on all items boxed or placed in containers, indicating the type, size, and quantity of materials.

105-2.5 BUILDINGS AND STRUCTURES. The Contractor shall perform removal operations in existing buildings as indicated and as otherwise required to complete the work.

Existing concrete shall be demolished, removed, and disposed of. Square, straight edges shall be provided where existing concrete adjoins new work and at other locations where indicated. Existing steel reinforcement shall be protected where indicated; otherwise, it shall be cut off flush with face of concrete.

The Contractor shall dismantle steel components at field connections and in a manner that will prevent bending or damage.

The use of flame-cutting torches will be permitted only when other methods of dismantling are not practical, and when approved in writing by the Owner and/or Engineer.

105-2.6 ELECTRICAL EQUIPMENT AND FIXTURES. Wiring systems and components shall be
salvaged. Loose items shall be boxed and tagged for identification.

All unused conduit not removed shall have a pull string installed and shall be noted on the record drawings.

Primary, secondary, control, communication, and signal circuits shall be disconnected at the point of attachment to their distribution system.

The Contractor shall remove and salvage electrical fixtures. Incandescent lamps, mercury-vapor lamps, and fluorescent lamps shall be salvaged, boxed and tagged for identification, and protected from breakage.

The Contractor shall remove and salvage switches, receptacles, fixtures, transformers, constant current regulators, meters, instruments, plates, circuit breakers, panelboards, outlet boxes, and similar items. These items shall be boxed, and tagged for identification according to type and size.

The Contractor shall remove and dispose of conductors and conduits not used in the finished work and shown to be demolished on the plans.

**DEMOLITION**

105-3.1 DEMOLITION OPERATIONS. Demolition operations shall be conducted to ensure the safe passage of persons to and from facilities occupied and used by the Owner and to prevent damage by falling debris or other cause to adjacent buildings, structures, and other facilities.

The sequence of operations shall be such that maximum protection from inclement weather will be provided for materials and equipment located in partially dismantled structures.

105-3.2 MAINTAINING TRAFFIC. Demolition operations and removal of debris to disposal areas shall be conducted to ensure minimum interference with runways, taxiways, aprons, roads, streets, walks, and other facilities occupied and used by the Owner.

Streets, walks, runways, taxiways and other facilities occupied and used by the Owner shall not be closed or obstructed without written permission from the Owner.

105-3.3 REFERENCE STANDARDS REQUIREMENTS. Demolition operations shall be conducted to ensure the safety of persons in accordance with ANSI A 10.6 Safety Requirements for Demolition.

Demolition shall be conducted in accordance with OSHA, State and local requirements.

**DISPOSAL OF DEMOLISHED MATERIALS**

105-4.1 GENERAL. The Contractor shall dispose of debris, rubbish, scrap, and other non-salvageable materials resulting from demolition operations. Demolished materials shall not be stored or disposed of on Airport property.

105-4.2 REMOVAL FROM OWNER PROPERTY. Materials classified as debris shall be transported from Owner property and legally disposed of at no additional cost to the Owner. Permits and fees for disposal shall be paid by the Contractor.

**ALTERATION WORK**

105-5.1 GENERAL. Cutting, patching, repairing, and other alteration work shall be done by tradesman
skilled in the particular trade or work required.

Where required to patch or extend existing construction, or both, such alteration work shall match existing exposed surface materials in finish, color, texture, and pattern.

Salvaged items for reuse shall be as approved by the Engineer and Owner.

**METHOD OF MEASUREMENT**

105-6.1 This item includes all materials, labor, transportation incidentals and services required for the building demolition as shown on the plans. It is the intent of the demolition pay item that all equipment, devices, fixtures, wiring, materials, systems and appurtenances, etc. which are no longer required as a result of the project to be removed shall be measured by the lump sum.

105-6.2 This item includes all materials, labor, transportation incidentals and services required for the airfield electrical demolition as shown on the plans. It is the intent of the demolition pay item that all equipment, devices, fixtures, wiring, materials, systems and appurtenances, etc. which are no longer required as a result of the project to be removed shall be measured by the lump sum.

**BASIS OF PAYMENT**

105-7.1 Payment will be made at the contract price for the required building demolition. This price shall be full compensation for furnishing all material, equipment and for all preparation, removal of the salvageable materials or debris and equipment and for all labor, equipment, tools and incidentals necessary to complete this item.

105-7.2 Payment will be made at the contract price for required airfield electrical demolition. This item includes all materials, labor, transportation, incidentals and services required for the demolition as shown on the plans. This item includes any temporary wiring, fixtures, etc. required to maintain the existing airfield lighting systems to the satisfaction of the Owner and Engineer. It is the intent of the demolition pay item that all equipment, devices, fixtures, wiring, materials, systems and appurtenances, etc. which are no longer required as a result of the project be removed.

Payment will be made under:

- Item L-105-7.1 Remove Guidance Sign and Foundation – Per Each.
- Item L-105-7.2 Remove Electrical Handhole -- Per Each.
- Item L-105-7.3 Remove Base Mounted Airfield Edge Light – Per Each.
- Item L-105-7.4 Remove Light and Foundation (Street) -- Per Each.
- Item L-105-7.5 Remove Light and Foundation (Sidewalk) -- Per Each.

**END OF ITEM L-105**
ITEM L-108 UNDERGROUND POWER CABLE FOR AIRPORTS

DESCRIPTION

108-1.1 This item shall consist of furnishing and installing power cables direct buried and furnishing and/or installing power cables within conduit or duct banks in accordance with these specifications at the locations shown on the plans. It includes excavation and backfill of trench for direct-buried cables only. Also included are the installation of counterpoise wires, ground wires, ground rods and connections, cable splicing, cable marking, cable testing, and all incidentals necessary to place the cable in operating condition as a completed unit to the satisfaction of the Engineer. This item shall not include the installation of duct banks or conduit, trenching and backfilling for duct banks or conduit, or furnishing or installation of any cable for FAA facilities. Requirements and payment for trenching and backfilling for the installation of underground conduit and duct banks is covered under Item L-110 "Airport Underground Electrical Duct Banks and Conduits."

108-1.2 REFERENCED Additional information pertaining to the items covered in this section are contained in the Federal Aviation Administration (FAA) Advisory Circulars (AC's), latest edition, listed below:

- 150/5345-7 Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
- 150/5345-26 Specification for L-823 Plug and Receptacle, Cable Connectors
- 150/5345-53 Airport Lighting Equipment Certification Program
- 150/5370-10 Standard for Specifying Construction of Airports
- 150/5370-2 Operational Safety on Airports During Construction
- 150/5370-10 Standard for Specifying Construction of Airports

The contractor is responsible for obtaining and using the latest edition of the referenced FAA Advisory Circulars. This list is not all inclusive but is offered as a convenience to the Contractor.

All new electrical systems should be tested to compare their compatibility to installed equipment. Operational tests shall be performed to ensure no increase in electromagnetic interference (EMI) occurs over the original findings.

EQUIPMENT AND MATERIALS

108-2.1 GENERAL.

a. Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) specifications shall be approved under the Airport Lighting Equipment Certification Program described in Advisory Circular (AC) 150/5345-53, current version.

b. All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification, when
The Contractor shall submit the manufacturer's certificate of compliance and the applicable specification sections to the Engineer for approval before the equipment and material are ordered.

c. Manufacturer's certifications shall not relieve the Contractor of the Contractor's responsibility to provide materials in accordance with these specifications and acceptable to the Engineer. Materials supplied and/or installed that do not materially comply with these specifications shall be removed, when directed by the Engineer and replaced with materials, which do comply with these specifications, at the sole cost of the Contractor.

d. All materials and equipment used to construct this item shall be submitted to the Engineer for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify pertinent products or models applicable to this project. Indicate all optional equipment and delete non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment for which they apply on each submittal sheet. Markings shall be boldly and clearly made with arrows or circles (highlighting is not acceptable). Contractor is solely responsible for delays in project accruing directly or indirectly from late submissions or resubmissions of submittals. The Contractor's submittals shall be in accordance with Item L-106, Submittals, Record Documents and Maintenance Manuals.

e. The data submitted shall be sufficient, in the opinion of the Engineer, to determine compliance with the plans and specifications. [The Contractor's submittals shall be neatly bound in a properly sized 3-ring binder, tabbed by specification section.] The Contractor's submittals shall be submitted to the Engineer within fifteen (15) days of the notice to proceed. Submittals shall comply with Section L-106. The Engineer reserves the right to reject any and all equipment, materials or procedures, which, in the Engineer’s opinion, does not meet the system design and the standards and codes, specified herein.

f. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least [twelve (12) months] from final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner’s discretion, with no additional cost to the Owner. The Contractor shall be responsible to maintain an insulation resistance of 50 megohms minima, (1000 V megger) with isolation transformers connected in new circuits and new segments of existing circuits through the end of the contract warranty period.

108-2.2 CABLE. Underground cable for airfield lighting facilities (runway and taxiway lights and signs) shall conform to the requirements of AC 150/5345-7, Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits. Conductor sizes noted above shall not apply to leads furnished by manufacturers on airfield lighting transformers and fixtures.

Wire for electrical circuits up to 600 volts shall comply with Specification L-824 and/or Federal Specification J-C-30 and shall be type THWN-2.

Cable type, size, number of conductors, strand and service voltage shall be as specified on the plans.

108-2.3 BARE COPPER WIRE FOR (COUNTERPOISE, BARE COPPER WIRE GROUND AND GROUND RODS). Wire for counterpoise or ground installations for airfield lighting systems shall be bare No. 6 AWG solid, single conductor for counterpoise wire and 600V insulated, XHHW insulation. No. 6 AWG stranded single conductor for ground wire conforming to ASTM B 3 and ASTM B 8, and shall be [bare copper wire] [tinned copper] conforming to the requirements of ASTM D 33.
Ground rods shall be [solid stainless steel] [copper] or [copper-clad steel]. The ground rods shall be of the length and diameter specified on the plans, but in no case shall they be less than 8-10-feet (240305 cm) long nor less than 5/8 3/4-in (15 19 mm) in diameter.

108-2.4 CABLE CONNECTIONS. In-line connections of underground primary cables shall be of the type called for on the plans, and shall be one of the types listed below. No separate payment will be made for cable connections.

   a. The Cast Splice. A cast splice, employing a plastic mold and using epoxy resin equivalent to that manufactured by Minnesota Mining and Manufacturing Company, “Scotchcast” Kit No. 82--B, or as manufactured by Hysol® Corporation, “Hyseal Epoxy Splice” Kit No. E1135, or equivalent, is used for potting the splice is acceptable.

   b. The Field-attached Plug-in Splice. Figure 3 of AC 150/5345-26, Specification for L-823 Plug and Receptacle, Cable Connectors, employing connector kits, is acceptable for field attachment to single conductor cable. It shall be the Contractor’s responsibility to determine the outside diameter of the cable to be spliced and to furnish appropriately sized connector kits and/or adapters and heat shrink tubing with integral sealant.


   d. The Taped or Heat-Shrinked Splice. Taped splices employing field-applied rubber, or synthetic rubber tape covered with plastic tape is acceptable. The rubber tape should meet the requirements of ASTM D 4388 and the plastic tape should comply with Mil Spec. MIL-I-24391 or Fed. Spec. A-A-55809. Heat shrinkable tubing shall be heavy-wall, self-sealing tubing rated for the voltage of the wire being spliced and suitable for direct-buried installations. The tubing shall be factory coated with a thermoplastic adhesive-sealant that will adhere to the insulation of the wire being spliced forming a moisture- and dirt-proof seal. Additionally, heat shrinkable tubing for multi-conductor cables, shielded cables, and armored cables shall be factory kits designed for the application. Heat shrinkable tubing and tubing kits shall be manufactured by Tyco Electronics/ Raychem Corporation, Energy Division, or approved equivalent.

   In all the above cases, connections of cable conductors shall be made using crimp connectors using a crimping tool designed to make a complete crimp before the tool can be removed. All L-823/L-824 splices and terminations shall be made in accordance with the manufacturer’s recommendations and listings.

   All connections of counterpoise, grounding conductors and ground rods shall be made by the exothermic process or approved equivalent, except the base can ground clamp connector shall be used for attachment to the base can. All exothermic connections shall be made in accordance with the manufacturer's recommendations and listings.

108-2.5 SPlicer QUALIFICATIONS. Every airfield lighting cable splicer shall be qualified in making cable splices and terminations on cables rated above 5,000 volts AC. The Contractor shall submit to the Engineer proof of the qualifications of each proposed cable splicer for the cable type and voltage level to be worked on. Cable splicing/terminating personnel shall have a minimum of three (3) years continuous experience in terminating/splicing medium voltage cable.

108-2.6 CONCRETE. Concrete for cable markers shall conform to Specification Item P-610, “Structural Portland Cement Concrete.”

108-2.7 FLOWABLE BACKFILL. Flowable material used to backfill trenches for power cable trenches shall conform to the requirements of Item P-153 “Controlled Low Strength Material”.
108-2.8 CABLE IDENTIFICATION TAGS. Cable identification tags shall be made from a non-corrosive material with the circuit identification stamped or etched onto the tag. The tags shall be of the type as detailed on the plans.

108-2.9 TAPE. Electrical tapes shall be Scotch Electrical Tapes – number Scotch 88 (1-1/2" wide) and Scotch 130C linerless rubber splicing tape (2" wide), as manufactured by the Minnesota Mining and Manufacturing Company, or approved equivalent.

108-2.10 ELECTRICAL COATING. Scotchkote™ shall be as manufactured by Minnesota Mining and Manufacturing Company, or approved equivalent.

108-2.11 EXISTING CIRCUITS. Whenever the scope of work requires, connection to an existing circuit, the circuit’s insulation resistance shall be tested, in the presence of the Engineer. The test shall be performed in accordance with this item and prior to any activity affecting the respective circuit. The Contractor shall record the results on forms acceptable to the engineer. When the work affecting the circuit is complete, the circuit’s insulation resistance shall be checked again, in the presence of the Engineer. The Contractor shall record the results on forms acceptable to the engineer. The second reading shall be equal to or greater than the first reading or the Contractor shall make the necessary repairs to the circuit to bring the second reading above the first reading. All repair costs including a complete replacement of the L-823 connectors, L-830 transformers and L-824 cable, if necessary, shall be borne by the Contractor. All test results shall be submitted in the Operation and Maintenance (O&M) Manual.

108-2.12 TEMPORARY CIRCUITING. Refer to Item L-104 General Electrical Safety Requirements and Temporary Airfield Lighting for requirements. Basis for payment shall be as included in this section.

CONSTRUCTION METHODS

108-3.1 GENERAL. The Contractor shall install the specified cable at the approximate locations indicated on the plans. Unless otherwise shown on the plans, all cable required to cross under pavements expected to carry aircraft loads shall be installed in concrete encased duct banks. Wherever possible, cable shall be run without splices, from connection to connection.

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 shall 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 Engineer or shown on the plans.

In addition to connectors being installed at individual isolation transformers, L-823 cable connectors for maintenance and test points shall be installed at locations shown on the plans. Cable circuit identification markers shall 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.

Provide not less than 3 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 1 ft 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 Engineer.

108-3.2 INSTALLATION IN DUCT BANKS OR CONDUITS. This item includes the installation of the cable in duct banks 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 shall be in accordance with the latest National Electric Code, or the code of the local agency or authority having jurisdiction.

The Contractor shall make no connections or splices of any kind in cables installed in conduits or duct banks.

Unless otherwise designated in the plans, where ducts are in tiers, use the lowest ducts to receive the cable first, with spare ducts left in the upper levels. Check duct routes prior to construction to obtain assurance that the shortest routes are selected and interferences are avoided.

Duct banks or conduits shall be installed as a separate item in accordance with Item L-110, “Airport Underground Electrical Duct Banks and Conduit.” The Contractor shall run a flexible mandrel, 1/4-inch less than the conduit size, 2 wire brushes, and a rag through duct banks or conduit prior to installation of cable to insure that the duct bank or conduit is open, continuous and clear of debris. Mandrel size shall be compatible with conduit size. The Contractor shall 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 shall be kept closed except when installing cables. Cleaning of ducts, base cans, manholes, etc. is incidental to the pay item of the item being cleaned. All raceway systems left open, after initial cleaning, for any reason shall be recleaned at the Contractor’s expense. All accessible points shall be kept closed when not installing cable. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the Engineer of any blockage in the existing ducts. The cable shall 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 shall be sealed with moisture-seal tape providing moisture-tight mechanical protection with minimum bulk, or alternately, heat shrinkable tubing before pulling into the conduit and it shall be left sealed until connections are made. Where more than one cable is to be installed in a conduit, all cable shall be pulled in the conduit at the same time. The pulling of a cable through duct banks or conduits may be accomplished by hand winch or power winch with the use of cable grips or pulling eyes. Maximum pulling tensions shall be governed by cable manufacturer’s recommendations. A non-hardening lubricant recommended for approved for use with the type of cable being installed shall be used where pulling lubricant is required.

The Contractor shall submit to the engineer, a cable installation plan for all cable pulls. Cable installation plan shall include:

a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.

b. List of cable installation equipment.

c. Lubricant manufacturer’s application instructions.

d. Procedure for resealing cable ends to prevent moisture from entering cable.

e. Cable pulling tension calculations of all cable pulls.

f. Cable percentage conduit fill.

g. Cable sidewall thrust pressure.

h. Cable minimum bend radius and minimum diameter of pulling wheels used.
i. Cable jam ratio.

j. Maximum allowable pulling tension on each different type and size of conductor.

k. Maximum allowable pulling tension on pulling device.

Contractor shall submit pulling tension values to the Engineer prior to any cable installation. If required by the Engineer, pulling tension values for cable pulls shall be monitored by a dynamometer in the presence of the Engineer. Cable pull tensions shall be recorded by the Contractor and reviewed by the Engineer. Cables exceeding the maximum allowable pulling tension values shall be removed and replaced by the Contractor at the Contractor's expense.

The manufacturer's minimum bend radius or the NEC requirements whichever is more restrictive shall apply. Cable installation, handling and storage shall be per manufacturer's recommendations. During cold weather, particular attention shall be paid to the manufacturer's minimum installation temperature. Cable shall not be installed when the temperature is at or below the manufacturer's minimum installation temperature. At the Contractor's option, the Contractor may submit a plan, for review by the Engineer, 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.

Cable shall not be dragged across base can or manhole edges, pavement or earth. When cable must be coiled, lay cable out on a canvas tarp or use other appropriate means to prevent abrasion to the cable jacket.

108-3.3 INSTALLATION OF DIRECT-BURIED CABLE IN TRENCHES. Unless otherwise specified, the Contractor shall not use a cable plow for installing the cable. Cable shall be unreeled uniformly in place alongside or in the trench and shall be carefully placed along the bottom of the trench. The cable shall not be unreeled and pulled into the trench from one end. Slack cable sufficient to provide strain relief shall be placed in the trench in a series of S curves. Sharp bends or kinks in the cable shall not be permitted. Where cables must cross over each other, a minimum of 3 in vertical displacement shall be provided with the topmost cable depth at or below the minimum required depth below finished grade.

Primary airfield lighting cables installed shall have cable circuit identification markers attached on both sides of each L-823 connector and on each airport lighting cable entering or leaving cable access points, such as manholes, handholes, pull boxes, junction boxes, etc. Markers shall be of sufficient length for imprinting the cable circuit identification legend on one line, using letters not less than ¼ in in size. The cable circuit identification shall match the circuits noted on the construction plans.

a. Trenching. Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored. Trenches for cables may be excavated manually or with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of surface is disturbed. Graders shall not be used to excavate the trench with their blades. The bottom surface of trenches shall be essentially smooth and free from coarse aggregate. Unless otherwise specified, cable trenches shall be excavated to a minimum depth of 18 in below finished grade, except as follows:

(1) When off the airport or crossing under a roadway or driveway, the minimum depth shall be 36 in unless otherwise specified.

(2) Minimum cable depth when crossing under a railroad track, shall be 42 in unless otherwise specified.

Dewatering necessary for cable installation, erosion and turbidity control, in accordance with Federal, State, and Local requirements is incidental to its respective pay items as part of Item L-108. The cost of
all excavation regardless of type of material encountered, shall be included in the unit price bid for the L-108 Item.

The Contractor shall excavate all cable trenches to a width not less than 6 in. Unless otherwise specified on the plans, all cables in the same location and running in the same general direction shall be installed in the same trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 in below the required cable depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4 in sieve. Flowable backfill material may alternatively be used. The Contractor shall ascertain the type of soil or rock to be excavated before bidding. All such rock removal shall be performed and paid for under Item P-152.

Duct bank or conduit markers temporarily removed for trench excavations shall be replaced as required.

It is the Contractor’s responsibility to locate existing utilities within the work area prior to excavation. Where existing active cables cross proposed installations, the Contractor shall insure that these cables are adequately protected. Where crossings are unavoidable, no splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:

(1) Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred.

(2) Trenching, etc., in cable areas shall then proceed, with approval of the Engineer, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair or replacement.

b. Backfilling. After the cable has been installed, the trench shall be backfilled. The first layer of backfill in the trench shall be 3 in deep, loose measurement, and shall be either earth or sand containing no mineral aggregate particles that would be retained on a 1/4 in sieve. This layer shall not be compacted. The second layer shall be 5 in deep, loose measurement, and shall contain no particles that would be retained on a 1 in sieve. The remaining 3rd and subsequent layers of backfill shall not exceed 8 in of loose measurement and be excavated or imported material and shall not contain stone or aggregate larger than 4 in 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 Engineer. If necessary to obtain the desired compaction, the backfill material shall be moistened or aerated as required.

Trenches shall not contain pools of water during backfilling operations. The trench shall be completely backfilled and tamped level with the adjacent surface, except that when turf is to be established over the trench, the backfilling shall be stopped at an appropriate depth consistent with the type of turfing operation to be accommodated. A proper allowance for settlement shall also be provided. Any excess excavated material shall be removed and disposed of in accordance with the plans and specifications.

Underground electrical warning (caution) tape shall be installed in the trench above all direct-buried cable. Contractor shall submit a sample of the proposed warning tape for acceptance by the Engineer. If not shown on the plans, the warning tape shall be located 6 in above the direct-buried cable or the
counterpoise wire if present. A 4-6 in wide polyethylene film detectable tape, with a metalized foil core, shall be installed above all direct buried cable or counterpoise. The tape shall be of the color and have a continuous legend as indicated on the plans. The tape shall be installed 8 in minimum below finished grade.

c. Restoration. Where soil and sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by work shall be restored to its original condition. The restoration shall include the [sodding] [topsoiling] [fertilizing] [liming] [seeding] [sprigging] and [mulching] as shown on the plans. Refer to specifications T-901 Seeding, T-904 Sodding and T-908 Mulching. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. When trenching is through paved areas, restoration shall be equal to existing conditions and compaction shall meet the requirements of Item P-152 Excavation and Embankment. Restoration shall be considered incidental to the pay item of which it is a component part.

108-3.4 CABLE MARKERS FOR DIRECT-BURIED CABLE. The location of direct buried circuits shall be marked by a concrete slab marker, 2 feet (60 cm) square and 4-6 in (100 - 150 mm) thick, extending approximately 1 in (25 mm) above the surface. Each cable run from a line of lights and signs to the equipment vault shall be marked at approximately every 200 feet (60 m) along the cable run, with an additional marker at each change of direction of cable run. All other direct-buried cable shall be marked in the same manner. Cable markers shall be installed directly above the cable. The Contractor shall impress the word “CABLE” and directional arrows on each cable marking slab. The letters shall be approximately 4 in (100 mm) high and 3 in (75 mm) wide, with width of stroke 1/2 in (12 mm) and 1/4 in (6 mm) deep.

The location of each underground cable connection, except at lighting units, or isolation transformers, or power adapters shall be marked by a concrete marker slab placed above the connection. The Contractor shall impress the word “SPLICE” on each slab. The Contractor also shall impress additional circuit identification symbols on each slab as directed by the Engineer. All cable markers and splice markers shall be painted international orange. Paint shall be specifically manufactured for uncured exterior concrete. Furnishing and installation of cable markers is incidental to the respective cable pay item.

108-3.5 SPLICING. Connections of the type shown on the plans shall be made by experienced personnel regularly engaged in this type of work and shall be made as follows:

a. Cast Splices. These shall be made by using crimp connectors for jointing conductors. Molds shall be assembled, and the compound shall be mixed and poured in accordance with manufacturer's instructions and to the satisfaction of the Engineer.

b. Field-attached Plug-in Splices. These shall be assembled in accordance with manufacturer's instructions. These splices shall be made by plugging directly into mating connectors. In all cases the joint where the connectors come together shall be wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 in (37 mm) on each side of the joint.

c. Factory-Molded Plug-in Splices. These shall be made by plugging directly into mating connectors. In all cases, the joint where the connectors come together shall be wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 in (37 mm) on each side of the joint.

d. Taped or Heat-Shranked Splices. A taped splice shall be made in the following manner:

Bring the cables to their final position and cut so that the conductors will butt. Remove insulation and jacket allowing for bare conductor of proper length to fit compression sleeve connector with 1/4 in (6 mm) of bare conductor on each side of the connector. Prior to splicing, the two ends of the cable insulation shall be penciled using a tool designed specifically for this purpose and for cable size and type. Do not use emery paper on splicing operation since it contains metallic particles. The copper conductors shall be
thoroughly cleaned. Join the conductors by inserting them equidistant into the compression connection sleeve. Crimp conductors firmly in place with crimping tool that requires a complete crimp before tool can be removed. Test the crimped connection by pulling on the cable. Scrape the insulation to assure that the entire surface over which the tape will be applied (plus 3 in (75 mm) on each end) is clean. After scraping wipe the entire area with a clean lint-free cloth. Do not use solvents.

Apply high-voltage rubber tape one-half lapped over bare conductor. This tape should be tensioned as recommended by the manufacturer. Voids in the connector area may be eliminated by highly elongating the tape, stretching it just short of its breaking point. Throughout the rest of the splice less tension should be used. Always attempt to exactly half-lap to produce a uniform buildup. Continue buildup to 1-1/2 times cable diameter over the body of the splice with ends tapered a distance of approximately 1 in (25 mm) over the original jacket. Cover rubber tape with two layers of vinyl pressure-sensitive tape one-half lapped. Do not use glyptol or lacquer over vinyl tape as they react as solvents to the tape. No further cable covering or splice boxes are required.

Heat shrinkable tubing shall be installed following manufacturer’s instructions. Direct flame heating shall not be permitted unless recommended by the manufacturer. Cable surfaces within the limits of the heat-shrink application shall be clean and free of contaminates prior to application.

108-3.6 BARE COUNTERPOISE WIRE INSTALLATION FOR LIGHTNING PROTECTION AND GROUNDING. If shown on the plans or included in the job specifications, bare counterpoise copper wire shall be installed for lightning protection of the underground cables. Counterpoise wire shall be installed in the same trench for the entire length of buried cable, conduits and duct banks that are installed to contain airfield cables. Where the cable or duct/conduit trench runs parallel to the edge of pavement, the counterpoise shall be installed in a separate trench located half the distance between the pavement edge and the cable or duct/conduit trench. In trenches not parallel to pavement edges, counterpoise wire shall be installed continuously a minimum of 4 in above the cable, conduit or duct bank, or as shown on the plans if greater. Additionally, counterpoise wire shall be installed at least 8 in below the top of subgrade in paved areas or 10 in below finished grade in unpaved areas. This dimension may be less than 4 in where conduit is to be embedded in existing pavement. Counterpoise wire shall not be installed in conduit.

The counterpoise wire shall be routed around to each light fixture base, mounting stake, or junction/access structures. The counterpoise wire shall also be exothermically welded to ground rods installed as shown on the plans but not more than 500 ft (150 m) apart around the entire circuit.

The counterpoise system shall be continuous and terminate at outside the transformer vault or at separate from the power source. It shall be securely attached to the vault or equipment external ground ring or other made electrode grounding system. The connections shall be made as shown on the plans and in the specifications.

If shown on the plans or in the specifications, a separate equipment (safety) ground system shall be provided in addition to the counterpoise wire using one of the following methods:

(1) A ground rod installed at and securely attached to each light fixture base, mounting stake if painted, and to all metal surfaces at junction/access structures.

(2) Install an insulated equipment ground conductor internal to the conduit system and securely attached it to each light fixture base and to all metal surfaces at junction/access structures. This equipment ground conductor shall also be exothermically welded to ground rods installed not more than 500 feet (150 m) apart around the circuit.
a. **Counterpoise Wire Installation Above Multiple Conduits and Duct Banks.** Counterpoise wires shall be installed above multiple conduits/duct banks for airfield lighting cables, with the intent being to provide a complete cone of protection over the airfield lighting cables. When multiple conduits and/or duct banks for airfield cable are installed in the same trench, the number and location of counterpoise wires above the conduits shall be adequate to provide a complete cone of protection measured 22 ½ degrees each side of vertical.

Where duct banks pass under pavement to be constructed in the project, the counterpoise shall be placed above the duct bank. Reference details on the construction plans.

b. **Counterpoise Wire Installation at Existing Duct Banks.** When airfield lighting cables are indicated on the plans to be routed through existing duct banks, the new counterpoise wiring shall be terminated at ground rods at each end of the existing duct bank where the cables being protected enter and exit the duct bank. The new counterpoise conductor shall be bonded to the existing counterpoise system.

### 108-3.7 EXOTHERMIC BONDING.

Bonding of ground and counterpoise wire shall be by the exothermic welding process. Only personnel experienced in and regularly engaged in this type of work shall make these connections.

Contractor shall demonstrate to the satisfaction of the Engineer, the welding kits, materials and procedures to be used for welded connections prior to any installations in the field. The installations shall comply with the manufacturer’s recommendations and the following:

a. All slag shall be removed from welds.

b. For welds at light fixture base cans, all galvanized coated surface areas and “melt” areas, both inside and outside of base cans, damaged by exothermic bond process shall be restored by coating with a liquid cold-galvanizing compound conforming to U.S. Navy galvanized repair coating meeting Mil. Spec. MIL-P-21035. Surfaces to be coated shall be prepared and compound applied in accordance with manufacturer’s recommendations.

c. All buried copper and weld material at weld connections shall be thoroughly coated 6 mil of 3M “Scotchkote,” or approved equivalent, or coated with coal tar Bitumastic® material to prevent surface exposure to corrosive soil or moisture.

### 108-3.8 TESTING.

The Contractor shall furnish all necessary equipment and appliances for testing the airport electrical systems and underground cable circuits before and after installation. The Contractor shall perform all tests in the presence of the Engineer. The Contractor shall demonstrate the electrical characteristics to the satisfaction of the Engineer. All costs for testing are incidental to the respective item being tested. For phased projects, the tests must be completed by phase and results meeting the specifications below must be maintained by the Contractor throughout the entire project as well as during the ensuing warranty period.

Earth resistance testing methods shall be submitted to the Engineer for approval. Earth resistance testing results shall be recorded on an approved form and testing shall be performed in the presence of the Engineer. All such testing shall be at the sole expense of the Contractor. Should the counterpoise or ground grid conductors be damaged or suspected of being damaged by construction activities the Contractor shall test the conductors for continuity with a low resistance ohmmeter. The conductors shall be isolated such that no parallel path exists and tested for continuity.

The Engineer shall approve of the test method selected. All such testing shall be at the sole expense of the Contractor.
After installation, the Contractor shall test and demonstrate to the satisfaction of the Engineer the following:

a. That all affected lighting power and control circuits (existing and new) are continuous and free from short circuits.

b. That all affected circuits (existing and new) are free from unspecified grounds.

c. That the insulation resistance to ground of all new non-grounded series circuits or cable segments is not less than 50 megohms.

d. That the insulation resistance to ground of all non-grounded conductors of new multiple circuits or circuit segments is not less than 50 megohms.

e. That all affected circuits (existing and new) are properly connected in accordance with applicable wiring diagrams.

f. That all affected circuits (existing and new) are operable. Tests shall 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.

g. That 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 shall be used, as described by ANSI/IEEE Standard 81, to verify this requirement.

Two copies of tabulated results of all cable tests performed shall be supplied by the Contractor to the Engineer. Where connecting new cable to existing cable, ground resistance tests shall be performed on the new cable prior to connection to the existing circuit.

There are no approved “repair” procedures for items that have failed testing other than complete replacement.

Refer to Item L-131 for additional testing requirements.

108-3.9 CABLE INSTALLATION REPORTS. Submit copies of the information described below in 8-1/2-inch by 11-inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each cable pull. Sections shall be separated by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

a. Site layout drawing with all cable pulls numerically identified.

b. A list of all equipment used, with calibration certifications.

c. The manufacturer of and quantity of lubricant used on pull.

d. The cable manufacturer and type of cable. The dates of cable pulls, time of day, and ambient temperature.

e. The length of cable pulls and calculated cable pulling tensions.

f. The actual cable pulling tensions encountered during pull.
METHOD OF MEASUREMENT

108-4.1 Trenching shall be measured by the linear feet (meters) of trench, including the excavation, backfill, and restoration, completed, measured as excavated, and accepted as satisfactory.

When specified, separate measurement shall be made for trenches of various specified widths.

The cost of all excavation, backfill, dewatering and restoration regardless of the type of material encountered shall be included in the unit price bid for the work.

108-4.2 Cable or counterpoise wire installed in trench, duct bank or conduit shall be measured by the number of linear feet (meters) of cable or counterpoise wire installed in trenches, duct bank or conduit, including ground rods and grounding connectors, and trench marking tape ready for operation, and accepted as satisfactory by the Engineer. Separate measurement shall be made for each cable or counterpoise wire installed in trench, duct bank or conduit. The measurement for this item [shall] [shall not] include additional quantities required for slack.

BASIS OF PAYMENT

108-5.1 Payment will be made at the contract unit price for trenching, cable and bare counterpoise wire installed in trench (direct-buried), or cable and equipment ground installed in duct bank or conduit, in place by the Contractor and accepted by the Engineer. This price shall be full compensation for furnishing all materials and for all preparation and installation of these materials, and for all labor, equipment, tools, and incidentals, including ground rods and ground connectors and trench marking tape, necessary to complete this item.

Payment will be made under:

Item L-108-5.1 Trenching for direct-buried cable -- per linear foot (meter)

Item L-108-5.2 [No. 8 AWG] [No. 6 AWG] L-824C Cable, installed in trench, duct bank or conduit -- per linear foot (meter)

Item L-108-5.3 Bare Counterpoise Wire, installed in trench, duct bank or conduit, including ground rods and ground connectors -- per linear foot (meter)

Item L-108-5.4 Bare or insulated equipment ground, installed in duct bank or conduit, including ground rods and ground conductors -- per linear foot (meter)

<table>
<thead>
<tr>
<th>Item L-108-5.1</th>
<th>1/C No. 8 AWG, 5kV, L-824C Cable, Series Lighting Cable Installed in Duct Bank or Conduit -- Per Linear Foot (meter)</th>
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<td>1/C No. 6 AWG, Bare Copper Counterpoise Wire Installed In Trench, Including Ground Rods And Grounding Connectors -- Per Linear Foot (meter)</td>
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<td>Item L-108-5.3</td>
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Item L-108-5.5 1/C #4 Equipment Ground -- Per Linear Foot (meter)

MATERIAL REQUIREMENTS

AC 150/5345-7 Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26 Specification for L-823 Plug and Receptacle Cable Connectors
FED SPEC J-C-30 Cable and Wire, Electrical Power, Fixed Installation (cancelled; replaced by A-A-59544 Cable and Wire, Electrical (Power, Fixed Installation))
FED SPEC A-A-55809 Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic Soft or Annealed Copper Wire
ASTM B 3 Rubber tapes, Nonmetallic Semiconducting and Electrically Insulating
ASTM D 4388

REFERENCE DOCUMENTS

NFPA No. 70 National Electrical Code (NEC)
MIL-S-23586C Sealing Compound, Electrical, Silicone Rubber
NN Building Industry Consulting Service International (BICSI)

END OF ITEM L-108
SPECIAL PROVISIONS
Job Number: 12-4401
(Duluth International Airport)
(February 10, 2012)

CITY of DULUTH
PROJECT SPECIFICATIONS

Duluth International Airport-New Passenger Terminal
Bid Package 2C-Sitework & Apron
Concessions and Furnishings
Issue for Bid

City of Duluth, MN
411 West 1st St.
Duluth, MN 55802

Bid # 12-4401

Opening Date: 02/8/12
Time: 2:00 pm
Place: City Hall, Room 400, Duluth MN
I HEREBY CERTIFY THAT THIS PLAN, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

_________________________________       _________________________________
Signature                                       Typed or Printed Name

_________________________________       _________________________________
Date                                             License No.
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Request for Bids form
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(February 10, 2012)

SP-3
The following forms and regulations/rules/statutes and interpretations, which are incorporated by reference in this contract, are available on the World Wide Web at the sites listed below. The City of Duluth will use its best efforts to ensure that the most recent, applicable forms and regulations/rules/statutes and interpretations are included on the web sites provided; however, if you are the successful bidder, prior to signing the contract, you are responsible for comparing the versions of the forms and regulations/rules/statutes and interpretations attached to the contract which you are signing with the versions on the web to ensure conformity.

THE VERSIONS OF THE FORMS AND REGULATIONS/RULES/STATUTES and INTERPRETATION ATTACHED TO THE CONTRACT WILL BE CONTROLLING. HARD COPIES OF ALL FORMS ARE AVAILABLE AT THE ENGINEERING DIVISION, EXCEPT THE NON-COLLUSION AND AFFIRMATIVE ACTION POLICY STATEMENT, WHICH ARE AVAILABLE AT THE CITY OF DULUTH PURCHASING DEPARTMENT.

Item listing from web:

<table>
<thead>
<tr>
<th>FORM</th>
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<tr>
<td>Affidavit of Non-Collusion (required by awarded contractor only)</td>
<td><a href="http://www.duluthmn.gov/engineering/construction_documents.cfm">www.duluthmn.gov/engineering/construction_documents.cfm</a></td>
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<tr>
<td>Bidder's Label for submitting project bids</td>
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<td><a href="http://www.dol.gov/whd/forms/WH347.pdf">www.dol.gov/whd/forms/WH347.pdf</a></td>
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<td><a href="http://www.duluthmn.gov/engineering/construction_documents.cfm">www.duluthmn.gov/engineering/construction_documents.cfm</a></td>
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<tr>
<td>Debarment/Suspension Notice 12-13-2011</td>
<td><a href="http://www.dot.state.mn.us/pre-letting/prov/order/suspension.pdf">www.dot.state.mn.us/pre-letting/prov/order/suspension.pdf</a></td>
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<td>IC-134 form</td>
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<tr>
<td>IC-134 on-line submittal (click: Submit Contractor Affidavit; r-side of screen)</td>
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<td>MN Statutes 177.41 to 177.44</td>
<td><a href="http://www.revisor.mn.gov/statutes/?id=177">www.revisor.mn.gov/statutes/?id=177</a></td>
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<tr>
<td>Notice to Bidders Prompt Payment to Subs</td>
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</tr>
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<td>One-Call Instructions</td>
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<td>Purchasing Division General Specifications</td>
<td><a href="http://www.duluthmn.gov/engineering/construction_documents.cfm">www.duluthmn.gov/engineering/construction_documents.cfm</a></td>
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<td>Request to Sublet TP-21834 (5-12-09)</td>
<td><a href="http://www.duluthmn.gov/engineering/construction_documents.cfm">www.duluthmn.gov/engineering/construction_documents.cfm</a></td>
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<tr>
<td>Statement of Compliance Form (12-10)</td>
<td><a href="http://www.dot.state.mn.us/const/labor/forms.html">www.dot.state.mn.us/const/labor/forms.html</a></td>
</tr>
<tr>
<td>Supplemental General Conditions Part II 4/15/11</td>
<td><a href="http://www.duluthmn.gov/engineering/construction_documents.cfm">www.duluthmn.gov/engineering/construction_documents.cfm</a></td>
</tr>
</tbody>
</table>
NOTICE TO ALL BIDDERS:


SP-4 **SCOPE OF WORK** The project scope consists of: Bid Package 2C, which includes building demolition, grading, concrete paving, bituminous paving, and lighting; building concessions and furnishings.

SP 5 **TYPE ‘C’ LIGHT WITH FOUNDATION**

SP-5.1 Lighting pole shall be a Kim Lighting Model No. KSS30-5180/SA, or approved equal, with a standard color finish to be confirmed before placing order. Pole shall come complete with breakaway banner arm and all necessary adapters, and arms to connect the proposed Phillips Master Elite 210 watt 277 volt -Clear fixture, or approved equal.

Busman HEBAA fuseholders/fuses, or approved equal, shall be provided and installed in the base of each light pole.

SP-5.2 Measurement will be made by each unit of entrance lighting unit Type ‘C’ installed with foundation provided and installed.

SP 5.3 Payment for TYPE ‘C’ LIGHT WITH FOUNDATION shall be made under Item SP 5.3.

SP-6 **PROGRAMMABLE CIRCUIT BREAKER, SQUARE D TYPE NF POWERLINK OR APPROVED EQUAL**

SP-6.1 Lighting circuits 23 and 24 shall have breakers installed in the existing panel as indicated on the plan sheets. Breakers shall be bolt-on programmable circuit breakers and compatible with the existing NF Power link Panel. The contractor shall be responsible for sizing the breaker to be adequate for the circuit as shown on the plan sheets.

SP-6.2 Measurement will be made by lump sum for all breakers to be provided and installed in existing electrical panel to complete the Lighting Circuits 23 and 24.

SP 6.3 Payment for PROGRAMMABLE CIRCUIT BREAKER, SQUARE D TYPE NF POWERLINK OR APPROVED EQUAL shall be made under Item SP 6.3.

SP-7 **ENTRANCE AND EXIT GATES W/ DETECTOR LOOPS W/FOUNDATIONS**

SP-7.1 The contractor shall provide all labor, equipment and materials necessary to supply, and install AMANO McGANN AMG-1700 SERIES with AL-12 GATES and two XML-PVC-2 Detector Loops. The gate operator shall be equipped with an AL-12 gate arm and an illumination kit. The PARKING GATE shall have a minimum 6” foundation that extends 2’ on each side of the operator (or until foundation is adjacent to curb and gutter whichever is less) and anchor bolt system as recommended by the manufacturer. An expansion joint shall be installed per Detail 7 on Sheet C207 if the foundation is adjacent to concrete curb and gutter.

The contractor shall also install a bollard on each side of the gate operator to protect the operator from damage. For bollard details see Sheet C211, Detail 7 (Two bollards per operator).

SP-7.2 Measurement will be made by each unit of entrance and exit gate w-detector loop, foundation, and bollards provided and installed.
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SP 7.3 Payment for ENTRANCE AND EXIT GATES W/ DETECTOR LOOPS W/FOUNDATIONS shall be made under Item SP 7.3.

SP-8 PROVIDE AND INSTALL PARKING STOPS

SP-8.1 The contractor shall provide all labor, equipment and materials necessary to provide and install rubber wheel stops. The wheels stops shall be Barco Products Part Number: 06FY1770(YL), or approved equal. The contractor shall provide shop drawings and confirm color of parking stops before ordering.

SP-8.2 Measurement will be made by each unit of parking stops provided and installed.

SP 8.3 Payment for PROVIDE AND INSTALL PARKING STOPS shall be made under Item SP 8.3.

SP-9 BUILDING DEMOLITION

SP-9.1 The contractor shall provide all labor, equipment and materials necessary to complete all work associated with the following specifications:

02221 – Building Demolition; 01732 – Selective Demolition

The contractor shall provide review the specifications thoroughly and provide the required signed submittals.

SP-9.2 Measurement will be made by lump sum.

SP-9.3 Payment for BUILDING DEMOLITION shall be made under Item 9.3.

SP-10 REMOVE VALVE AND CAP WATER LINE

SP-10.1 The contractor shall provide all labor, equipment and materials necessary to remove the existing 8" valve, cap the 8" ductile iron pipe, and provide concrete blocking to meet the City of Duluth Standard Detail W-2.

SP-10.2 Measurement will be made by each unit of valve and water line capped provided and installed.

SP 10.3 Payment for REMOVE VALVE AND CAP WATER LINE shall be made under Item SP 10.3.

SP-11 BUILDING UTILITY COORDINATION AND DEMOLITION (UTILITY ALLOWANCE)

SP-11.1 The contractor shall include a $35,000.00 allowance to be used to pay for work done by Minnesota Power, Qwest or any other utility company that will be required to transition from the existing terminal to the new terminal building or as directed by the engineer.

SP-11.2 Measurement will be made by the actual amount of the invoice from the utility company. Any portion of the allowance amount not needed for reimbursement for work done by the utility company will not be paid to the Contractor.

SP-11.3 Payment for BUILDING UTILITY COORDINATION AND DEMOLITION (UTILITY ALLOWANCE) shall be made under Item SP 11.3.

SP-12 TRAFFIC CONTROL ALLOWANCE

SP-12.1 The contractor shall include a $50,000.00 allowance to be used to pay for traffic control measures.
SP-12.2 The contractor shall submit a detailed traffic control plan for each phase of construction. The contractor shall furnish, install, and maintain all traffic control devices required in their submitted and approved traffic control plan.

SP-12.3 Measurement will be made by each unit of traffic control device provided and installed.

SP-12.4 Payment for TRAFFIC CONTROL ALLOWANCE shall be made under Item 12.4.

SP-13 (1903) INCREASED OR DECREASED QUANTITIES
The provisions of Mn/DOT 1903 regarding overruns and underruns shall not apply to any of the items of work under this Contract.

SP-14 COMMERCIAL VEHICLE GATE W/ DETECTOR LOOPS, PROXIMITY ACCESS TAGS, AND FOUNDATION

SP-14.1 The contractor shall provide all labor, equipment and materials necessary to supply, and install AMANO McGANN AMG-1700 SERIES with AL-12 GATES, and two XML-PVC-2 Detector Loops. The gate operator shall be equipped with an AL-12 gate arm and an illumination kit. The PARKING GATE shall have a minimum 6” foundation that extends 2’ on each side of the operator (or until foundation is adjacent to curb and gutter whichever is less) and anchor bolt system as recommended by the manufacturer. An expansion joint shall be installed per Detail 7 on Sheet C207 if the foundation is adjacent to concrete curb and gutter.

The contractor shall also install a bollard on each side of the gate operator to protect the operator from damage. For bollard details see Sheet C211, Detail 7 (Two bollards per operator).

The gate operator shall be equipped to be initiated by an internally mounted tag that operates on the FCC 915 MHZ frequency band.

1. Fixed RFID Reader:

   The fixed reader should be a fully integrated, self-contained 915 MHz wireless RFID reader specifically targeted at high performance applications in parking, security access, electronic vehicle registration (EVR) and traffic management.

   It should be capable of reading any two of the following standard protocols:
   - Super eGo®
   - eGo® (ISO 18000 6B)
   - American Trucking Associations (ATA)
   - Interagency Group (IAG)

   The fixed reader must be capable of reading read half-frame and full-frame ATA tags and Wiegand formatted tags and identification cards. The unit shall operate with beam or battery powered tags. Unit parameters shall include the following:

   Fixed Reader requirements:
   - Read range up to 17 feet
   - Capable of buffering up to 500 tag reads
   - Frequency Range – 911.75 to 919.75 MHz FCC-authorized in Canada and United States
   - Communications Interface – RS-232 or RS422 with Wiegand-compatible host interface
   - RF Control – By sense input or host command
   - I/O Control – Input: Two independent dry contact closures for sense circuits. Outputs: Two independent form C contacts
   - Approximate Weight – 4.3 kg (9.5 lb.)
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- Enclosure – The reader shall be a self-contained device environmentally sealed in a tamper-proof housing
- Operating Temperature: -40 to +55 °C (-40°F to +131°F)
- Humidity – 100% condensing
- Vibration – 0.5Grms, 10 to 500 Hz
- Standards – Shall comply with the requirements of Underwriters Laboratories UL-1950 Standard for Safety of Information Technology Equipment
- Verified to Part 15 of the FCC rules for a Class A digital device and comply with the requirements of Underwriters Laboratories UL-1950, Standard for Safety of Information Technology Equipment.
- Capable of being mounted indoors or outdoors on pole or wall mount

2. Internally Mounted Tags:

The contractor shall supply 250 of the internally mounted tags that meet the following requirements:

- Internally Mounted Tag One operates on the FCC approved 915 MHz frequency band and supports eGo protocol.
- Packaged in the form of a flexible sticker.
- The tag should be suited for transportation, trucking and port operations, parking, mCommerce, security-access, vehicle registration and other wireless identification applications
- Read distance of up to 17 feet with licensed eGo readers.
- Non battery
- Fully compliant with ANSI INCITS 256-2001 and ISO 18000-6B.
- Contains 1024-bits of total memory. This includes a 64-bit ID, 880-bits of user memory formatted and locked as required by application and includes 128 bits of user memory that are factory programmable.
- Attached by a semi-permanent adhesive to the interior of a non-metallic windshield 0.190 to 0.230in in thickness (standard windshields).
- Tag is not damaged when exposed to water washing of the backside of the sticker.
- Tag is not damaged when exposed to commonly spilled beverages, mild cleaning solutions or vinyl plasticizers.
- Capable of unlimited reads and 100,000 write transactions.
- Linear, horizontal polarization.
- The tag's lamination layers are not significantly damaged by extreme exposure to sunlight.
- Operating Temperature range of –40 to +85 degrees Celsius (-40 to +185°F).
- Storage Temperature range of –50 to +95 Celsius (-58 to +203°F).
- Dimensions should be approximately 2 x 3 inches; and thickness approximately .05 inch.

SP-14.2 Measurement will be made by each unit of commercial vehicle gate w/ detector loops, proximity access tags, foundation and 700 linear feet of Belden 9842 Multi-conductor – Low Capacitance Computer Cable communication cable (or approved equal) provided and installed.

SP 14.3 Payment for COMMERCIAL VEHICLE GATE W/ DETECTOR LOOPS, PROXIMITY ACCESS TAGS, AND FOUNDATION shall be made under Item SP 14.3.

SP-15 EXIT PAY STATION

SP-15.1 The contractor shall provide all labor, equipment and materials necessary to supply, and install the Exit Pay Station.

SP-15.2 The Exit Pay Station shall be installed to collect payment for parking in unattended exits of the parking facility. The features shall allow the processing of transient parkers to exit the parking facility using bank notes, coins, and credit card; calculate variable rate or flat fees; process lost tickets, print receipts, and void and vault validated tickets. The exit pay station shall operate as a stand-alone system or on-line to the system Server for...
collection of revenue transactions. It shall read the Airport’s existing magnetic stripe access tickets and interface with the existing Amano McGann credit card processing and report generating system.

SP-15.3 The exit pay station shall be located in the exit lanes of the facility for easy access by parking patrons from their vehicle. The patron shall insert the entry ticket into the exit pay station, guided by instructions displayed on the touch screen color monitor and guidance lights on the front panel of the exit pay station. The exit pay station shall automatically calculate the patron’s parking fee based on date and time encoded on the ticket, accept payment, tender any change due, issue a customer receipt, validate and vault the ticket, and vend the gate.

SP-15.4 Accepted at a minimum:
1. Entry Ticket dispensed by existing ticket dispensers
2. Entry Ticket validated with magnetic encoder
3. Credit Card
4. Lost Ticket

SP-15.5 Features:
1. Grace Time Control:
   a. Grace time is the amount of time allocated to the patron to exit the facility without having to pay. Free exit shall be granted via programming to patrons who are compelled to leave within a short period of time
   b. When the entry ticket time falls within the grace time period, the exit pay station shall accept the patron’s ticket, void and vault the ticket and vend the gate.
   c. The parking fee will calculate from actual time of entry once the Grace period has been exceeded.
2. Complementary Time Control:
   a. Complementary time is additional free time allocated to the patron for exit lane processing for long wait times due to high volume mass-exiting of a facility.
   b. Programmed Complementary time period shall be a programmable time subtracted from the duration of the patron's stay, or a minimum fee.
3. Daylight Savings Time: Exit pay station shall automatically adjust its clock upon the beginning and end of daylight savings time.
4. Off-line Credit Card Control:
   a. Off-line with the system server, the exit pay station shall continue to accept payment in note and coin.
   b. Credit card transactions shall be denied until communications with the system server are re-established.
5. Ticket/Card Reader Unit:
   a. Shall read all accepted tickets, management cards and credit cards,
   b. Erase encoding from all vaulted tickets;
   c. Print and vault all paid tickets with transaction data including at a minimum month, day, year, time of payment, fee and calculated rate.
6. Coin Acceptor shall accept and sort U.S.$ .05, .10, .25 and 1.00 coins and recycle coins for change.
7. Bank Note Acceptor shall allow 4-way note insertion and accept U.S.$1.00, $5.00, $10.00, $20.00 notes.
8. Credit Card: Exit pay station shall read all major credit cards (consult financial processor for availability), and process credit cards real time via the system server.
9. Bank note vault shall store all notes collected by the bank note acceptor.
10. Coin vault shall store overflow coins.

11. Receipt/Report Printer shall have the capacity to print approximately 500 receipts per roll.

12. Front Panel shall include a touch screen graphic monitor to display all user information and include operational buttons to select and respond to program prompts. User operation shall include at a minimum:
   a. Cancel
   b. Lost Ticket
   c. Receipt
   d. Help (intercom)

13. Patron guidance lights shall light when appropriate and indicate to the patron where to insert tickets, credit card, notes and coin.

14. Invalid Operation Indication: If an unreadable, invalid or expired ticket or credit card is inserted, it shall be returned to the patron accompanied by a voice announcement and display message informing the patron of the reason for the denial. If applicable, ticket or credit card shall be returned to patron.

15. Ticket Box shall have the capacity to store a minimum of 1500 vaulted tickets.

16. Voice Guide shall deliver verbal instructions to the patron and include at a minimum instruction for payment, fee, alarm and receipt.

17. Validation Accounts:
   a. Store ID’s (validation accounts) shall be assignable to participating merchants that will be validating parking patron’s valid entry tickets with a magnetic encoder.
   b. Each Store ID shall be programmable in the exit pay station with its own unique ID.
   c. Validations at a minimum shall be by time, fee, percent, flat fee, and surcharge.
   d. Exit pay station shall read the Store ID encoded on the ticket and automatically apply the discount or surcharge to the parking fee.

18. Taxes:
   a. Only one tax rate shall apply.
   b. Tax shall be programmable to apply before or after validation is applied.
   c. Each calculation mode shall have the capability to apply a programmable tax (0.00% – 99.99%).
   d. Unit shall be programmable to include or exclude tax.
   e. The tax total shall be reported in each total of T/GT.
   f. The amount of tax can be split into up to four separate taxes when sent to the facility management PC.

19. Cancellation of a Transaction:
   a. A transaction may be cancelled at any time prior to completed payment of the parking fee.
   b. Partial amount tendered shall be refunded in coins (if applicable).
   c. Once full parking fee payment is completed or credit card approval process has started, transaction cancellation cannot be performed and refunds shall not be available.

20. Out of Change:
   a. The unit shall be programmable to stop operation.
   b. Display a closed message to the patron.
   c. Issue a claim check for the amount of change due the patron.

21. Bank Note Full Operation: the unit can be programmed as “Out of Service” or to continue to accept coins.
22. Reports shall include at a minimum:
   a. T-Total/subtotal
   b. GT-Total/subtotal
   c. Hopper Total/subtotal
   d. Coin Vault Total/subtotal
   e. Note Vault Total/subtotal
   f. System Parameters
   g. Journal Record
   h. Error Log
   i. Alarm record

23. Security: Exit Pay Station should contain at a minimum:
   a. Concealed hinges.
   b. Multiple locks to access the front cabinet door.
   c. Lock to access the drawer of bank note vault.
   d. Lock to access the coin hoppers door.
   e. Each coin hopper’s security box.
   f. Lock to access the coin vault.
   g. Lock to access the bank note vault.
   h. Password protection via Management Cards.

24. Events and alarms shall include but not be limited to the following:
   a. Receipt paper out
   b. Coin empty
   c. Door alarm
   d. Coin vault full
   e. Bank Note vault full
   f. Door open
   g. Out of Change – Operation stopped
   h. Note reader error
   i. Bank note vault error
   j. Shutter error
   k. Magnetic reader error
   l. CPU error
   m. Coin validator error
   n. Credit card server error
   o. Credit card processing error
   p. Time out error

25. Management cards shall be user-programmable and each programmable with varying levels of security management. Varying security level functions include at a minimum money management, inventory, subtotal and fill.

26. Exit pay station shall include an electronic shutter system activated by the start of a transaction that shall reduce damage to the unit that may be caused by weather (rain, dust, snow) or vandalism.

SP-15.6 Rate Structures:

1. The exit pay station shall have at a minimum three calculation modes:
   a. Day-Night Zone mode
   b. Regressive Zone mode
   c. Block Pattern mode
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1. Day-Night Zone calculation mode:
   a. Fee shall depend on the actual time a time zone is entered.
   b. A minimum of 3 systems of time zone structures.
   c. A minimum of 12 rates shall be programmable.

3. Regressive Zone calculation mode:
   a. Fee shall depend on the length of time parked.
   b. A minimum of 3 systems of time zone structures.
   c. Each system can have up to 12 patterns for parking time.
   d. A minimum of 12 rates shall be programmable.

2. Block Pattern calculation mode:
   a. Combining the Day-Night Zone mode and the Regressive Zone mode can set the fee.
   b. A minimum of 5 systems of time zone structures.
   c. Each system can be separated into up to 6 time zones.
   d. Each zone can have up to 10 patterns for parking time.
   e. A minimum of 8 rates shall be programmable.

SP-15.7 Construction: The cabinet shall be constructed of heavy-gauge, all-weather steel welded construction and a powder-coated paint finish for maximum protection against corrosion. The color shall match the existing equipment installed on-site.

The exit pay station shall have a minimum 6” foundation that extends 2’ on each side of the operator (or until foundation is adjacent to curb and gutter whichever is less) and anchor bolt system as recommended by the manufacturer. An expansion joint shall be installed per Detail 7 on Sheet C207 if the foundation is adjacent to concrete curb and gutter.

The contractor shall also install a bollard on each side of the gate operator to protect the operator from damage. For bollard details see Sheet C211, Detail 7 (Two bollards per operator).

SP-15.8 Measurement will be made by each unit of exit pay station provided and installed. Power and communications cable conduit all materials, equipment and labor necessary to connect the exit pay station to the Revenue Control Booth to create a working system shall be included in the unit price of the item.

SP 15.9 Payment for EXIT PAY STATION shall be made under Item SP 15.9.

SP-16 PRIVATE UTILITY LOCATING SERVICE

SP-16.1 The contractor shall retain a certified utility locating service to locate all private (DAA owned) utilities within the project limits.

SP-16.2 Measurement of the item PRIVATE UTILITY LOCATING SERVICE will be on a lump sum basis.

SP-16.3 Payment for PRIVATE UTILITY LOCATING SERVICE shall be made under Item SP 16.3.
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes lightning protection for buildings and associated structures and requirements for lightning protection system components.

1.3 SYSTEM DESCRIPTION
   A. Protect entire building and outlying electro/mechanical equipment.

1.4 SUBMITTALS
   A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
   B. Product Data for each component specified.
   C. Shop Drawings detailing lightning protection system. Include air terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway and data on how concealment requirements will be met.
   D. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by Nationally Recognized Testing Laboratory (NRTL) or trade association. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
   E. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.
   F. Field inspection reports indicating compliance with specified requirements.

1.5 QUALITY ASSURANCE
   A. Installer Qualifications: Engage an experienced installer who is Underwriters Laboratories listed.
B. Listing and Labeling: Provide products specified in this Section that are Underwriters Laboratories listed and labeled.  
   1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

C. Comply with NFPA 70, as amended by state and local codes.

D. Comply with NFPA 780.

E. Comply with UL 96 and UL 96A.

F. Provide UL Master Label to owner.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
   1. Approved Lightning Protection Co., Inc.
   2. Harger Lightning Protection, Inc.
   4. Thompson Lightning Protection Co.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. System Materials: Copper, with solid air terminals, except as otherwise indicated.

B. Air Terminals for Single-Ply Membrane Roof Mounting: Units with bases especially designed for single-ply membrane roof materials.

C. Ground Rods: Copper-clad steel with a minimum of 27 percent of rod weight in copper cladding.
   1. Diameter: 3/4 inch (19 mm).
   2. Length: 10 feet (3 m).

D. Arresters, Protectors and Antenna-Discharge Units: Comply with UL 1449.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces, areas, and conditions, with Installer present, for compliance with installation tolerances and other conditions affecting performance of lightning protection. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install lightning protection as indicated, according to manufacturer's written instructions.

B. Comply with UL 96A, and NFPA 780.

C. Conform to the most stringent requirements when more than one standard is specified.

D. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops. Where concealed, run conductors in nonmetallic raceway - Schedule 40 minimum.

E. Conceal system conductors.

F. Conceal conductors from normal view from exterior locations at grade within 200 feet (60 m) of building.

G. Provide notification at least 48 hours before concealing lightning protection components.

H. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.

I. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's installation instructions.

J. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to lightning protection components.

K. Bond ground terminals to counterpoise conductor.

L. Bond grounded metal bodies on building within 12 feet (4 m) of ground to counterpoise conductor.

M. Bond grounded metal bodies on building within 12 feet (4 m) of roof to counterpoise conductor.

N. Bond grounded metal bodies on building within 12 feet (4 m) of roof to interconnecting loop at eave level or above.
O. Bond lightning protection components to grounded metal bodies on building at every 60 feet (18 m) with intermediate-level interconnection loop conductors.

P. Install lightning arresters, protectors and antenna discharge units on all incoming electrical and telecommunication services and antenna lead-ins.

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture, unless moisture is permanently excluded from the junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. UL Inspection: Apply for inspection by UL as required for UL master labeling of system. Provide additional components as required to obtain UL Master Label at no additional cost to owner.

END OF SECTION 16670
MATCHLINE
SEE SHEET M110
DULUTH AIRPORT AUTHORITY
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APPOLD DESIGN
2432 East First Street, Duluth MN 55812
TEL: (218) 591-5079
1. PROVIDE EXTERNAL NEMA 3R ELECTRICAL DISCONNECT & STARTER.

2. FAN SHALL HAVE AL HOUSING & SHALL BE PROVIDED W/ DRAIN TRAP, VENTED CURB EXTENSION, EXTERNAL WIRING IN FLEXIBLE CONDUIT & BE UL 762 RATED FOR GREASE LADEN VAPORS. INTERLOCK CONTROL W/ LOCAL MANUAL USER SWITCH IN KITCHEN

### FAN SCHEDULE

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<tr>
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### NOTES:

1. ALL UNIT SHALL BE DDC CONTROLLED AND INTEGRATED IN EXISTING BMS.

2. MINIMUM CFM SETTING SHALL BE SCHEDULED VALUE OR VAV BOX MINIMUM CAPACITY, WHICHER IS GREATER.

### VAV TERMINAL UNIT SCHEDULE

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### TYPICAL SUPPLY DIFFUSER CONNECTION

- SUPPORT IN ACERO STEEL
- SUPPORT IN ACERO STEEL
- SUPPORT IN ACERO STEEL
- SUPPORT IN ACERO STEEL

### DETAIL OF CAULKING OF DUCT PIERCING WALLS OR FLOORS WHERE FIRE DAMPERS ARE NOT REQUIRED

### METHOD OF HANGING DUCTWORK

- SUPPORT IN ACERO STEEL
- SUPPORT IN ACERO STEEL
- SUPPORT IN ACERO STEEL
- SUPPORT IN ACERO STEEL

### FIRE PENETRATION THRU ROOF SLAB

- SUPPORT IN ACERO STEEL
- SUPPORT IN ACERO STEEL
- SUPPORT IN ACERO STEEL
- SUPPORT IN ACERO STEEL
2. PROVIDE PLENUM RETURN INLET SMOKE DETECTORS FOR ALL FPB'S WITH PRIMARY AIR MAXIMUM OVER 2000 CFM. DETECTOR SHALL BE HARDWIRED TO FAN TO SHUT DOWN UPON DETECTION AND ALARM BMS.

1. ALL FPB WITH PRIMARY AIR MAXIMUM OVER 2000 CFM SHALL HAVE PERFORATED, DOUBLE-WALL HOUSING.

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### VAV TERMINAL UNIT SCHEDULE

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<th>UNIT NO.</th>
<th>AREA/ROOM</th>
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### FAN POWERED TERMINAL UNIT SCHEDULE

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### NOTES:

1. PROVIDE INTEGRAL DISCONNECT SWITCH.
2. FINAL FILTER SHALL BE ELECTRONIC DYNAMIC AIR TYPE ANGLE FILTER AND BE LOCATED UPSTREAM OF AIR COILS.
3. PROVIDE AUXILIARY DRAIN PAN PIPING CONNECTION WITH DRAIN.
4. PROVIDE VFD WITH INTEGRAL DISCONNECT SWITCH.
5. PROVIDE EXPLOSION PROOF MOTOR.
6. PROVIDE WALL SLEEVE WITH INTEGRAL BACKDRAFT DAMPER (U.N.O W/ MOTORIZED DAMPER ON DRAWINGS).
7. PROVIDE PRE-FAB ROOF CURB & ISOLATION DAMPER.
8. PROVIDE SOUND ATTENUATING WIND BAND, BYPASS DAMPER, SIDE INTAKE, SPARK RESISTANT CONSTRUCTION & UL 705 LISTING.

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### GENERAL KITCHEN EQUIPMENT NOTES:

1. **Self-Serve Order Interface**
   - Verify power requirements with the owner.

2. **Menu Board**
   - Verify power requirements with the owner.

3. **Ice Maker**
   - 120/11.8 kW, Direct LP-2B (11)

4. **Walk-In Freezer**
   - 120/120 A, Direct LP-2B (13)

5. **Freezer System Coil**
   - 208/18.7 A, Direct LP-2B (15/17)

6. **Freezer System Condenser**
   - 208/311.7 A, 2.5 HP, Direct LP-2B (19/21/23)

7. **Reach-In Refrigerator, 2-sec.**
   - 120/110.0 A, 1/2 HP, Recept. LP-2B (25)

8. **Disposer W/ Spray Rinse**
   - 208/36.6 A, 2 HP, Direct LP-2B (27/29/31)

9. **Microwave Oven**
   - 120/11.8 kW, Recept. RB-2D (1)

10. **Exhaust Hood**
    - 120/10.1 kW, Direct RB-2D (3)

11. **Fire Protection System**
    - Direct LP-2B (12)

12. **Half-Size Convection Oven**
    - 120/15.0 A, 1/3 HP, Recept. RP-2D (5)

13. **Conveyor Toaster**
    - 120/115.0 A, Recept. RP-2D (9)

14. **Sandwich Grill**
    - 208/13.45 kW, Recept. RP-2D (11/13)

15. **Soup Well**
    - 120/11.0 kW, Recept. RP-2D (2,4)

16. **Ice Maker, Undercabinet**
    - 120/16.0 A, Recept. RP-2D (6)

17. **Blender**
    - 120/111.5 A, 2 HP, Recept. RP-2D (8)

18. **Coffee Grinder**
    - 120/19.0 A, 3/4 HP, Recept. RP-2D (10)

19. **Airpot Brewer**
    - 120/208/1 4.6 kW, Direct RP-2D (12/14)

20. **Serving Counter**
    - A: 120/1(7) 20.0 A, Direct RP-2D (24, 26, 28, 30, 32), RPC-1A (11, 13)

21. **P.O.S. Keyboard**
    - 120/15.0 A, Service by Item #57A (Panel RPC-1A, CKT 11, 13)

22. **P.O.S. Printer**
    - 120/15.0 A, Service by Item #57A (Panel RPC-1A, CKT 11, 13)

23. **Bakery Display**
    - 120/10.61 A, Service by Item #57A (Panel RP-2D, CKT 24)

24. **Espresso Grinder**
    - 120/13.0 A, Service by Item #57A (Panel RP-2D, CKT 26)

25. **Undercounter Refrigerator, 1-sec.**
    - 120/13.9 A, 1/6 HP, Service by Item #57A (Panel RP-2D, CKT 28)

26. **Espresso Machine**
    - 208/14.5 kW, Service by Item #57B (Panel RP-2D, CKT 20/22)

27. **Refrigerated Display**
    - 120/17.2 A, 1/2 HP, Recept. RP-2D (17)

28. **Walk-In Refrigerator**
    - 120/120.0 A, Direct LP-2B (33)

29. **Refrigeration System Coil**
    - 120/11.8 A, Direct LP-2B (35)

30. **Refrigeration System Condenser**
    - 208/35.3 A, 1 HP, Direct LP-2B (37/39/41)

31. **Soda Carbonator**
    - 120/17.0 A, 1/3 HP, Recept. RP-2D (19)

32. **Beer System**
    - 120/114.0 A, 1/3 HP, Recept. RP-2D (21)

33. **Back Bar Refrigerator, 2-sec.**
    - 120/16.5 A, 1/4 HP, Recept. RP-2D (23)

34. **Back Bar Refrigerator, 3-sec.**
    - 120/16.5 A, 1/4 HP, Recept. RP-2D (25)

35. **Blender**
    - 120/115.0 A, 3 HP, Recept. RP-2D (27)

36. **Glass Washer**
    - 120/208/1 18.0 A, Direct RP-2D (29/31)

### PLAN NOTES:

- **Electrical Connection Schedule**
- **Electrical Legend**
- **Emergency Shut Down System Detail**
- **Enlarged Second Floor Plan - Concession Area**
- **Enlarged Elec. RM Plan and PLR**
- **Partial 3rd Floor Power Plan**
MATCHLINE
SEE SHEET E110

E117

MATCHLINE
SEE SHEET E111

MATCHLINE
SEE SHEET E110

DULUTH AIRPORT AUTHORITY

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### Panel Distribution: RDP-1A

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<th>Phase C</th>
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### Panel Distribution: RP-2A - FLR 2, 208/120V,3PH,4W+GND

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### Panel Distribution: RP-1A - FLR 1, 208/120V,3PH,4W+GND

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### Panel Distribution: RP-1A - Existing Panel

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<tr>
<td>Panel 2</td>
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### Panel Distribution: RP-1A - FLR 2, 208/120V,3PH,4W+GND

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</tr>
<tr>
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### Panel Distribution: RP-1A - FLR 2, 208/120V,3PH,4W+GND

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<th>Phase B</th>
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<th>Quantity</th>
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<tbody>
<tr>
<td>CA-100</td>
<td>Yaskawa</td>
<td>N02762</td>
<td>2</td>
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<tr>
<td>BLDC Motor</td>
<td>Yaskawa</td>
<td>N02762</td>
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</tr>
<tr>
<td>Brake</td>
<td>Siemens</td>
<td>2EB420M00</td>
<td>1</td>
</tr>
<tr>
<td>Inverter</td>
<td>Mitsubishi</td>
<td>2SIV30600S00N</td>
<td>2</td>
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<tr>
<td>Controller</td>
<td>Mitsubishi</td>
<td>2SIC30600R00N</td>
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<tr>
<td>Transformer</td>
<td>Mitsubishi</td>
<td>2SIT30600D10S</td>
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<td>Encoders</td>
<td>Siemens</td>
<td>2G1350004S00N</td>
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<td>Filter</td>
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<td>2SIF30600D10S</td>
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<td>Transformer</td>
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<tr>
<td>Motor</td>
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<td>Siemens</td>
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<td>Transformer</td>
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### Table 3

<table>
<thead>
<tr>
<th>400 VOLT MOTOR CONTROLLER / FEEDER / DEVICE SCHEDULE</th>
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<tr>
<td>Device</td>
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<tr>
<td>------------</td>
</tr>
<tr>
<td>CA-100</td>
</tr>
<tr>
<td>BLDC Motor</td>
</tr>
<tr>
<td>Brake</td>
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<tr>
<td>Filter</td>
</tr>
<tr>
<td>Transformer</td>
</tr>
</tbody>
</table>

**Notes:**
1. All devices are labeled with the appropriate model number for easy identification.
2. The equipment is designed for 400 volt operation.
3. The control system is integrated with the motor controller for efficient operation.
4. Regular maintenance is required to ensure optimal performance.
<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Mounting</th>
<th>Lamp Qty</th>
<th>Lamp Type</th>
<th>Total Fixture VA</th>
<th>Volts</th>
</tr>
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<tbody>
<tr>
<td>F1</td>
<td>Low Profile linear fluorescent 4' architectural strip fixture with integral ballast. Provide length as required for fixtures shown in restrooms.</td>
<td>Suspended/Recessed/Cove</td>
<td>1</td>
<td>F28T5</td>
<td>Approx. 9VA/LF</td>
<td>277</td>
</tr>
<tr>
<td>F1A</td>
<td>Low Profile linear fluorescent 4' architectural strip fixture with integral ballast.</td>
<td>Suspended/Recessed</td>
<td>1</td>
<td>F54T5HO</td>
<td>60</td>
<td>277</td>
</tr>
<tr>
<td>F1B</td>
<td>Low Profile linear fluorescent 2' architectural strip fixture with integral ballast.</td>
<td>Suspended/Recessed</td>
<td>1</td>
<td>F14T5</td>
<td>20</td>
<td>277</td>
</tr>
<tr>
<td>F2</td>
<td>Suspended Cylinder, two level metal halide, Down light. See note 8 on this drawing.</td>
<td>Suspended</td>
<td>150</td>
<td>MH60</td>
<td>277</td>
<td></td>
</tr>
<tr>
<td>F2A</td>
<td>Suspended Cylinder, two level metal halide, Down light. See note 8 on this drawing.</td>
<td>Suspended</td>
<td>170</td>
<td>MH80</td>
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<tr>
<td>F2C</td>
<td>Open Appearance rectangular can light 4&quot;X8&quot;</td>
<td>Recessed</td>
<td>24</td>
<td>2W CFL</td>
<td>100</td>
<td>277</td>
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<tr>
<td>F2D</td>
<td>Open Appearance square can light 6&quot; X 6&quot;</td>
<td>Recessed</td>
<td>142</td>
<td>2W CFL</td>
<td>50</td>
<td>277</td>
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<tr>
<td>F3</td>
<td>Direct/indirect lay-in 2'x4' architectural lighting fixture.</td>
<td>Recessed</td>
<td>3</td>
<td>F28T5</td>
<td>100</td>
<td>277</td>
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<tr>
<td>F3C</td>
<td>Direct/indirect lay-in 2'x4' architectural lighting fixture.</td>
<td>Recessed</td>
<td>2</td>
<td>F28T5</td>
<td>70</td>
<td>277</td>
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<tr>
<td>F3B</td>
<td>Direct/indirect asymmetric lay-in 2'x4' architectural lighting fixture w/ perforated side basket.</td>
<td>Recessed</td>
<td>2</td>
<td>F28T5</td>
<td>60</td>
<td>277</td>
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<tr>
<td>F4</td>
<td>Pendant, Indirect canopy lighting</td>
<td>Pendent</td>
<td>1</td>
<td></td>
<td>1150</td>
<td>277</td>
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<tr>
<td>F5</td>
<td>Wall mounted security metal halide fixture</td>
<td>Surface</td>
<td>1</td>
<td></td>
<td>170</td>
<td>277</td>
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<tr>
<td>F6</td>
<td>Pole mounted metal halide fixture, pole mounted 60' AFG.</td>
<td>Pole mounted.</td>
<td>Millerbernd Pole Model #UWLA 600, base &quot;A&quot;, prime paint finish, type 2 brackets for poles attached to building and type 4R for the poles located at the apron. For building attached poles, contractor shall coordinate with architectural and structural drawings for special attachment.</td>
<td>11000</td>
<td>MH1100</td>
<td>277</td>
</tr>
</tbody>
</table>
| F7   | Halogen TV Camera lights | 1 | | 750 | HAL.
<p>| F8   | Similar to fixture &quot;F1&quot; except 120V | Suspended | 1 | F28T5 | 35 | 120 |
| F9   | 4' Fluorescent fixture with acrylic diffuser | 1 | F28T5 | 35 | 277 |</p>
<table>
<thead>
<tr>
<th>POLE #</th>
<th>CIRCUIT DESCRIPTION</th>
<th>PHASE A</th>
<th>PHASE B</th>
<th>PHASE C</th>
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<td>30</td>
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</table>

**NOTES**
- **LOAD:** Connected Load (VA)
- **TRIP:** Trip Amperage
- **CIRCUIT BREAKER PANEL:** Bus Size: 200A, Panelboard: PP-1A
- **SERVICE:** 480/277V, 3PH, 4W + GND
<table>
<thead>
<tr>
<th>No.</th>
<th>Circuit Description</th>
<th>Phase A</th>
<th>Phase B</th>
<th>Phase C</th>
<th>Remarks</th>
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<tr>
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<tr>
<td>2</td>
<td>60A</td>
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</tr>
<tr>
<td>3</td>
<td>200A</td>
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<td>250A</td>
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<td>5</td>
<td>300A</td>
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**Notes:**
- PROVIDE CONTROLLABLE CIRCUIT BREAKER
- BUS SIZE: 400A
- SERVICE: 480/277V, 3PH, 4W + GND
- PANELBOARD: LP-2A
- PANEL DISTRIBUTION: DPP-ELEV
- PANEL DISTRIBUTION: DPP-1A
- PANEL DISTRIBUTION: RDP-1A
- PANELBOARD: LP-APRON
- PANELBOARD: LP-1A

**Author:**

**Contact Information:**
- TEL: (218) 591-5079
- FAX: (218) 722-9306

**Address:**
- 501 Lake Avenue South, Suite 300,
- Duluth, MN 55802
- www.rsh.com

**Consultants:**
- Landscaping Consultants:
- Baggage Handling Systems Consultants:
- M/E/P/FP Engineers:
- SJA Architects
- Interior Architects:
- MBJ Consulting Eng.
<table>
<thead>
<tr>
<th>POL #</th>
<th>CIRCUIT DESCRIPTION</th>
<th>PHASE A</th>
<th>PHASE B</th>
<th>PHASE C</th>
<th>NOTES</th>
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<tbody>
<tr>
<td>1</td>
<td>2 - CIRCUITS ASSOCIATED WITH ALTERNATE-PRICE SEPARATE</td>
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<tr>
<td>2</td>
<td>21.5 kVA</td>
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<td>29.2 kVA</td>
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<td>3</td>
<td>75.5 Amps</td>
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**Main Device**: 150A CIRCUIT BREAKER PANEL

**Service**: 208/120V, 3PH, 4W + GND

**Panelboard**: RP-1A

**Bus Size**: 225A

<table>
<thead>
<tr>
<th>PANELBOARD: RP-1A</th>
<th>PANELBOARD: RP-1B</th>
<th>PANELBOARD: RP-1C</th>
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</thead>
<tbody>
<tr>
<td>SERVICE: 208/120V</td>
<td>SERVICE: 208/120V</td>
<td>SERVICE: 208/120V</td>
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<tr>
<td>PANEL TYPE: RP-1A</td>
<td>PANEL TYPE: RP-1B</td>
<td>PANEL TYPE: RP-1C</td>
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<tr>
<td>PANEL DATA:</td>
<td>PANEL DATA:</td>
<td>PANEL DATA:</td>
</tr>
<tr>
<td>PHASE A</td>
<td>PHASE B</td>
<td>PHASE C</td>
</tr>
<tr>
<td>---------</td>
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<td>---------</td>
</tr>
<tr>
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<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

---

**Telephone**: (312) 201-7400 / **Fax**: (312) 201-0031

**Duluth MN 55802**

**SJA Architects**

**MJU Consulting Eng.**

**Codentum Associates Inc.**

**RMP Associates Inc.**

**APPLIED DESIGN**

---

**PPS Schedules**

**E406**

**Bid Package 2C**
<table>
<thead>
<tr>
<th>CKT</th>
<th>LOAD:</th>
<th>NOTES</th>
<th>CIRCUIT BREAKER PANEL</th>
<th>PANELBOARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEM.</td>
<td>31.9 Amps</td>
<td>TRIP/CONNECTED LOAD (VA)</td>
<td>MAIN DEVICE: 200A</td>
<td>ELEV-1A</td>
</tr>
<tr>
<td>DEM.</td>
<td>28.0 Amps</td>
<td></td>
<td>BUS SIZE: 200A</td>
<td>ELEV-1B</td>
</tr>
<tr>
<td>DEM.</td>
<td>76.7 Amps</td>
<td></td>
<td>PANELBOARD:ERP-1C - PNL W/TVSS, 200% NEUTRAL &amp; ISO GRD</td>
<td>ELEV-1C</td>
</tr>
<tr>
<td>DEM.</td>
<td>27.6 kVA</td>
<td></td>
<td>BUS SIZE: 480/277V, 3PH, 4W + GND</td>
<td>ELEV-1D</td>
</tr>
<tr>
<td>DEM.</td>
<td>22.4 Amps</td>
<td></td>
<td>MAIN DEVICE: 200A</td>
<td>ELEV-1E</td>
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<tr>
<td>DEM.</td>
<td>16.0 kVA</td>
<td></td>
<td>BUS SIZE: 60A</td>
<td>ELEV-1F</td>
</tr>
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**TOTAL CONNECTED LOADS:**

| 5,150 | 5,590 | 3,000 | 5,560 | 4,650 | 3,660 |
### PLUMBING SYMBOLS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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### PLUMBING ABBREVIATIONS

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<th>Abbreviation</th>
<th>Description</th>
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### DULUTH INTERNATIONAL AIRPORT

#### 5528 PLUMBING DRAWING LIST

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<tr>
<th>Sheet No.</th>
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#### NOTE:

No sheet line numbers have been edited since print.
Interior Architects: SJA ARCHITECTS
11 E Superior Street Suite 340, Duluth MN 55802
TEL: (218) 724-8578 / FAX: (218) 724-8717

Structural Engineers: MBJ CONSULTING ENG.
501 Lake Avenue South, Suite 300, Duluth MN 55802
TEL: (218) 722-1056 / FAX: (218) 722-9306

M/E/P/FP Engineers: COSENTINI ASSOCIATES INC.
1 South Wacker Drive, 37th Floor, Chicago IL 60606
TEL: (312) 201-7400 / FAX: (312) 201-0031

Baggage Handling Systems Consultants: BNP ASSOCIATES INC.
101 East Ridge Office Park, Suite 103, Danbury CT 06810
TEL: (203) 792-3000 / FAX: (203) 792-4900

Landscaping Consultants: APPOLD DESIGN
2432 East First Street, Duluth MN 55812
TEL: (218) 591-5079
**PLUMBING MATERIALS SPECIFICATION**

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**DOMESTIC WATER HEATER SCHEDULE**

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**PUMP SCHEDULE**

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**MIXING VALVE SCHEDULE**

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**GREASE INTERCEPTOR SCHEDULE**

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**DRAIN SCHEDULE**

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**Legend:**
- [ ] Director Existing Equipment
- [ ] Director Existing Equipment to be Changed

**Foodservice Equipment Schedule**

**NEW PASSENGER TERMINAL**

**Foodservice Equipment Consultants:**
- [ ] Foodservice Equipment Consultants

**Interior Architects:**
- [ ] Interior Architects

**Landscaping Consultants:**
- [ ] Landscaping Consultants

**ME/P/FP Engineers:**
- [ ] ME/P/FP Engineers

**(authorities and contact information are not visible in the image)**