CHILLICOTHE MUNICIPAL AIRPORT
CITY OF CHILLICOTHE, MISSOURI

MoDOT Project No. 17-015A-1

Project Description
Reconstruct Runway 14-32 and Connecting Taxiways
Install New Medium Intensity Runway Lighting (MIRL) System
Install New Runway 14 PAPI System
Install New Runway 14-32 REIL Systems
Install Lighted Holding Position Signs

ADDENDUM NO. 1

June 11, 2019

TO ALL PROSPECTIVE BIDDERS:

A. You are hereby notified of the following amendments to the Contract Documents/Specifications for the subject project.

1. Section 1, Notice to Bidders. This section has been updated to reflect the changes to the various contract pay items noted in this addendum. The following contract pay items have been revised as follows:

Item No.	Spec.	Item Description
46	L-108	Bare Counterpoise Wire (#6 AWG) **(Revised Per Add. No. 1)**
50	L-110	1" Electrical Duct and Trench **(Revised Per Add. No. 1)**

Updated Section 1 is included with this addendum for reference.

2. Section 17, Portland Cement Concrete (PCC) Pavement. Section 501-3.2, the following text was added to the third paragraph:

   For fixed-form concrete placement, the slump shall not exceed 4 inches. Separate mix designs shall be prepared for both slip-form concrete and fixed-form concrete. ***(Added Per Addendum No. 1)***

Updated Section 17 is included with this addendum for reference.

3. Section 26, Underground Power Cable for Airports. Section 108-5.1, the following bid item was revised:

   Bare Counterpoise Wire (#6 AWG) ***(Rev. Per Add. No. 1)***

Updated Section 26 is included with this addendum for reference.

4. Section 28, Airport Underground Electrical Duct Banks and Conduit. Section 110-5.1, the following bid item was revised:

   1" Electrical Duct and Trench *(Rev. Per Add. No. 1)*

   Updated Section 28 is included with this addendum for reference.

5. The Official Bid Form, Page PF-3 has been updated to reflect the changes to the various contract pay items noted in this addendum. The following contract pay items have been revised as follows:

Item No.	Spec.	Item Description
46	L-108	Bare Counterpoise Wire (#6 AWG) **(Revised Per Add. No. 1)**
50	L-110	1" Electrical Duct and Trench **(Revised Per Add. No. 1)**

   A revised "OFFICIAL BID FORM PER ADDENDUM NO 1" for Page PF-3 is included with this addendum for reference and use. PLEASE REPLACE THE ORIGINAL PAGE PF-3 WITH THIS UPDATED PAGE WHEN PREPARING YOUR BID.

B. You are hereby notified of the following amendments to the Construction Plans for the subject project.

1. Sheet 2, General Airport Layout Plan. This sheet has been revised as follows:

   A. Added Optional Locations on Airport Property for Disposal of Asphalt Millings.
   B. Revised General Note #3 to include Point of Contact for Locating FAA Runway 32 PAPI Circuit.
   C. Revised General Note #6 to include the Option for Disposal of Asphalt Millings on Airport Property and for Utilizing the Existing Concrete Pavement as Recycled Concrete Aggregate Base Course.

   Updated Sheet 2 is included with this addendum for reference.

2. Sheet 3, Safety Plan – Phase 1. This sheet has been revised as follows:

   A. Revised Plan Callout requiring the use of two (2) flaggers when crossing Runway 2-20.
   B. Revised Construction Phasing Note No. 2 to include two (2) flaggers and a power broom when crossing Runway 2-20.

   Updated Sheet 3 is included with this addendum for reference.

3. Sheet 7, Summary of Quantities & Typical Sections. This sheet has been revised as follows:

   A. Revise Bid Item #46 to "Bare Counterpoise Wire (#6 AWG)".
   B. Revise Bid Item #50 to "1" Electrical Duct and Trench".
   C. Added Optional Asphalt Milling Placement Detail.

   Updated Sheet 7 is included with this addendum for reference.

4. Sheet 11, Runway 14-32 Plan & Profile. This sheet has been revised to add missing leader arrows in profile view.

   Updated Sheet 11 is included with this addendum for reference.

5. Sheet 12, Runway 14-32 Plan & Profile. This sheet has been revised to add missing leader arrows in profile view.

   Updated Sheet 12 is included with this addendum for reference.

6. Sheet 30, Electrical Plan. This sheet has been revised to change 2" PVC Conduit reference to 1" PVC Conduit.

   Updated Sheet 30 is included with this addendum for reference.

7. Sheet 31, Electrical Plan. This sheet has been revised to change 2" PVC Conduit reference to 1" PVC Conduit and added the distance from the runway centerline to wind cone.

   Updated Sheet 31 is included with this addendum for reference.

8. Sheet 32, Electrical Plan. This sheet has been revised to change 2" PVC Conduit reference to 1" PVC Conduit.

   Updated Sheet 32 is included with this addendum for reference.

9. Sheet 33, Electrical Details. This sheet was a full revision to include all details for the installation of the Electrical Counterpoise System by the Equipotential Method (Option 1) or the Isolation Method (Option 2).

   Updated Sheet 33 is included with this addendum for reference.

10. Sheet 33A, Electrical Details. This sheet has been added to include all details for the installation of the Electrical Counterpoise System by the Equipotential Method (Option 1) or the Isolation Method (Option 2).

    New Sheet 33A is included with this addendum for reference.

C. A copy of the pre-bid meeting minutes and attendees list is included with this addendum.

D. **IMPORTANT NOTE:** All bidders submitting a proposal for this project must use the **OFFICIAL BID FORM, including the revised Page PF-3** which is included with this addendum. Please replace the original Page PF-3 with this updated version when preparing your bid.

E. All bidders must acknowledge receipt of this addendum in the space provided on page PF-5 of the Proposal Form. **Failure to acknowledge receipt of an addendum may be cause for rejection of the bid.**

SECTION 1
NOTICE TO BIDDERS

CITY OF CHILLICOTHE, MISSOURI
CHILLICOTHE MUNICIPAL AIRPORT
State Block Grant Project No. **17-015A-1**

Sealed bids subject to the conditions and provisions presented herein will be received until **2:00 p.m. (CDT)**, **Thursday, June 20th, 2019,** and then publicly opened and read at **the office of the City Clerk, City Hall, 715 Washington, Chillicothe, MO 64601**, for furnishing all labor, materials, equipment and performing all work necessary to

Reconstruct Runway 14-32 and Connecting Taxiways
Install New Medium Intensity Runway Lighting (MIRL) System
Install New Runway 14 PAPI System
Install New Runway 14-32 REIL Systems
Install Lighted Holding Position Signs

Copies of the bid documents including project drawings and technical specifications are on file and may be inspected at:

City Hall
715 Washington
Chillicothe, MO 64601

Lochner
16105 W. 113th Street
Suite 107
Lenexa, KS 66219

Drawings, specifications, official bid form, and other related contract information may be ordered online at www.drexeltech.com or by contacting Drexel Technologies, Inc. at 10840 W. 86th Street, Lenexa, KS 66214, phone (913) 371-4430, fax (913) 371-7128. Checks shall be made payable to "Drexel Technologies" and mailing costs are the responsibility of the purchaser. Drawings, specifications, official bid form, any addenda, and a plan holders list are available at www.drexeltech.com by clicking on "Enter Plan Room".

A prebid conference for this project will be held at **10:00 a.m. (CDT), Tuesday, June 4th, 2019, at the Chillicothe Municipal Airport, 13844 Liv 253, Chillicothe, MO 64601.**

Contract Work Items. This project will involve the following work items and estimated quantities. Prospective bidders are hereby advised that the quantities indicated herein are approximate and are subject to change.

ITEM NO.	SPEC.	ITEM DESCRIPTION	QTY.	UNIT
1	MOB	Mobilization	1	L.S.
2	TEMP	Temporary Marking, Lighting, & Barricades	1	L.S.
3	P-101	Saw Cut	362	L.F.
4	P-101	Pavement and Base Course Removal	36,578	S.Y.
5	P-101	Pavement Marking Removal	537	S.F.
6	P-101	Existing CMP Removal	616	L.F.
7	P-101	Existing Lighting System and Signs Removal	1	L.S.
8	P-101	Existing Underdrain System Removal	1	L.S.
9	P-152	Unclassified Excavation	6,202	C.Y.
10	P-152	Unsuitable Subgrade Removal and Replacement	500	C.Y.
11	P-155	Lime-Treated Subgrade (12")	37,534	S.Y.
12	P-156	Erosion Control Barrier (Silt Fence)	1,970	L.F.

ITEM NO.	SPEC.	ITEM DESCRIPTION	QTY.	UNIT
13	P-156	Erosion Control Barrier (Straw Wattle)	140	L.F.
14	TREC	Erosion Control Blanket (Type 2C)	11,000	S.Y.
15	PTM	Permanent Transition Mat	288	S.F.
16	P-154	Unsuitable Subgrade Removal and Replacement with Rock Base	1,000	C.Y.
17	P-208 P-209 P-219	Aggregate Base Course (6")	37,534	S.Y.
18	P-154 P-208 P-209 P-219	Aggregate Subbase Course (6")	37,534	S.Y.
19	P-501	P.C.C. Pavement (6")	36,520	S.Y.
20	P-620	Permanent Reflectorized Pavement Marking (White)(Solid)	13,550	S.F.
21	P-620	Permanent Reflectorized Pavement Marking (White)(Striated)	1,274	S.F.
22	P-620	Permanent Reflectorized Pavement Marking (Yellow)	1,425	S.F.
23	P-620	Permanent Non-Reflectorized Pavement Marking (Black)	7,128	S.F.
24	P-620	Temporary Non-Reflectorized Pavement Marking (White)(Solid)	3,200	S.F.
25	P-620	Temporary Non-Reflectorized Pavement Marking (White)(Striated)	1,274	S.F.
26	P-620	Temporary Non-Reflectorized Pavement Marking (Yellow)	1,425	S.F.
27	D-701	18" Pipe	96	L.F.
28	D-701	24" Pipe	88	L.F.
29	D-701	30" Pipe	112	L.F.
30	D-701	18" RCP End Section	2	Ea.
31	D-701	24" RCP End Section	2	Ea.
32	D-701	30" RCP End Section	2	Ea.
33	D-705	Conventional Underdrain (4") (Schedule 40)	7,718	L.F.
34	D-705	Conventional Underdrain (4") (Schedule 80)	117	L.F.
35	D-705	Non-Perforated Outlet Pipe (4") (Schedule 40)	768	L.F.
36	D-705	Non-Perforated Outlet Pipe (4") (Schedule 80)	456	L.F.
37	D-705	Underdrain Cleanout Riser	25	Ea.
38	D-705	Splash Pad	8	Ea.
39	D-705	Connect to Proposed Storm Pipe	10	Ea.
40	T-901	Permanent Seeding	12.6	Ac.
41	T-901	Temporary Seeding	12.6	Ac.
42	T-905	Placement of Topsoil (Obtained on Site)	1	L.S.
43	T-908	HydroMulch	10.3	Ac.
44	L-108	Install Cable in Duct (1/c, #8 AWG, 5kV L-824C)	16,520	L.F.
45	L-108	Install Cable in Duct (1/c, #6 AWG, 600V L-824C)	2,775	L.F.
46	L-108	**Bare Counterpoise Wire (#6 AWG) (Revised Per Add. No. 1)**	12,500	L.F.
47	L-109	Airfield Electrical Vault Modifications, Complete	1	L.S.
48	L-109	Furnish and Install 4 kW CCR	1	Ea.
49	L-109	Furnish and Install 7.5 kW CCR	1	Ea.
50	L-110	**1" Electrical Duct and Trench (Revised Per Add. No. 1)**	12,620	L.F.
51	L-110	1-2" PVC, Schedule 40, Concrete Encased Electrical Duct	295	L.F.

ITEM NO.	SPEC.	ITEM DESCRIPTION	QTY.	UNIT
52	L-110	2-2" PVC, Schedule 40, Concrete Encased Electrical Duct	192	L.F.
53	L-110	1-2" PVC, Schedule 80, Bore Duct Under Pavement	135	L.F.
54	L-115	L-867 Junction Box	10	Ea.
55	L-125	Retroreflective Markers	24	Ea.
56	L-125	M.I.R.L. (LED), Base Mounted (Red/Green Lens)	16	Ea.
57	L-125	M.I.R.L. (LED), Base Mounted (Clear/Yellow Lens)	33	Ea.
58	L-125	M.I.R.L. (LED), Base Mounted (Yellow/Yellow Lens)	2	Ea.
59	L-125	M.I.T.L. (LED), Base Mounted (Blue Lens)	42	Ea.
60	L-125	New 1 Module (LED) Lighted L-858R Sign (Size 1, Style 2)	2	Ea.
61	L-125	New 2 Module (LED) Lighted L-858R Sign (Size 1, Style 2)	2	Ea.
62	L-125	Furnish and Install REIL System	2	Ea.
63	L-125	Furnish and Install 4-Box PAPI System	1	Ea.

Contract Time. The owner has established a contract performance time of **One Hundred Fifty (150)** calendar days from the date of the Notice-to-Proceed with **Forty-Five (45)** calendar days allotted **for Phase 2.** All project work shall be substantially completed within the stated timeframe. This project is subject to liquidated damages as prescribed in the project manual.

Bid Security. No bid will be considered unless accompanied by a certified check or cashier's check on any bank or trust company insured by the Federal Deposit Insurance Corporation, payable to **City of Chillicothe**, for not less than five (5) percent of the total amount of the bid, or by a bid bond secured by an approved surety or sureties, payable to the owner, for not less than five (5) percent of the total amount of the bid.

Bonding Requirements. The successful bidder will be required to furnish separate performance and payment bonds each in an amount equal to 100% of the contract price at the time of contract execution.

Award of Contract. All proposals submitted in accordance with the instructions presented herein will be subject to evaluation. Bids may be held by the **City of Chillicothe** for a period not to exceed **One Hundred Twenty (120) Calendar Days** from the date of the bid opening for the purpose of conducting the bid evaluation.

Award of contract will be based on the lowest aggregate sum proposal submitted from those bidders that are confirmed as being responsive and responsible. If more than one base bid is listed in the Proposal Form, the bidder may bid on Base Bid No. 1 and/or Base Bid No. 2. The owner reserves the right to select any one of the combinations of the base bid(s) and alternate bid(s), which in the judgment of the owner, best serves the owner's interest. The right is reserved, as the **City of Chillicothe** may require, to reject any bid and all bids.

Award of contract is contingent upon the owner receiving Federal-funding assistance under the State Block Grant Program.

Notice-To-Proceed
It is the intent of the Owner to issue the Notice-To-Proceed (NTP) as soon as practical after the Award of Contract. The anticipated early NTP date is **April, 6th, 2020** and the late NTP date is **May 4, 2020**.

Federal Provisions. This project is subject to the following Federal provisions, statutes and regulations:

> **Equal Employment Opportunity - Executive Order 11246 and 41 CFR Part 60:** The Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Opportunity Construction Contract Specifications" set forth within the supplementary provisions. The successful Bidder shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, or national origin.

Notice of Requirement for Affirmative Action to Ensure Equal Employment Opportunity:

1. The Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Opportunity Construction Contract Specifications" set forth within the supplementary provisions.

2. The goals and timetables for minority and female participation, expressed in percentage terms for the contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

Timetables
Goals for minority participation for each trade: **10.0% (Livingston County)**
Goals for female participation in each trade: 6.9%.

These goals are applicable to all of the contractor's construction work (whether or not it is Federal or federally-assisted) performed in the covered area. If the contractor performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for such geographical area where the work is actually performed. With regard to this second area, the contractor is also subject to the goals for both its federally involved and non-federally involved construction.

The contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a), and its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from project to project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

3. The Contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs (OFCCP) within 10 working days of award of any construction subcontract in excess of $10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address, and telephone number of the subcontractor; employer identification number of the subcontractor; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the subcontract is to be performed.

4. As used in this notice and in the contract resulting from this solicitation, the "covered area" is the **Chillicothe Municipal Airport, City of Chillicothe, Livingston County, Missouri.**

Certification of Nonsegregated Facilities – 41 CFR Part 60: A certification of Nonsegregated Facilities must be submitted prior to the award of a federally-assisted construction contract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity Clause.

Contractors receiving federally assisted construction contract awards exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity Clause will be required to provide for the forwarding of the notice to prospective subcontractors for supplies and construction contracts where the subcontracts exceed $10,000 and are not exempt from the provisions of the Equal Opportunity Clause. The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001.

Disadvantaged Business Enterprise – 49 CFR Part 26: The requirements of 49 CFR Part 26, Regulations of the U.S. Department of Transportation, apply to this contract. It is the policy of MoDOT and the **City of Chillicothe** to practice nondiscrimination based on race, color, sex or national origin in the award or performance of this contract. All firms qualifying under this solicitation are encouraged to submit bids/proposals regardless of their business size or ownership. Awards of this contract will be conditioned upon satisfying the requirements of this section. These requirements apply to all bidders, including those who qualify as a DBE. The owner's award of this contract is condition upon the bidder satisfying the good faith effort requirements of 49 CFR §26.53. A DBE contract goal of **6.0** percent has been established for this contract. The *non-DBE* bidder shall subcontract

6.0 percent of the dollar value of the base bid(s), excluding any additive alternates, to disadvantaged business enterprises (DBE) or make good faith efforts to meet the DBE contract goal. *The bidder and any subcontractor who qualifies as a DBE who subcontracts work to another non-DBE firm must subtract the amount of the non-DBE contract from the total DBE work counted toward the goal, as defined in 49 CFR Part 26.55*.

The apparent successful competitor will be required to submit the following information as a condition of bid responsiveness: (1) the names and addresses of DBE firms that will participate in the contract; (2) a description of the work that each DBE firm will perform; (3) the dollar amount of the participation of each DBE firm participating; (4) written statement from bidder that attests their commitment to use the DBE firm(s) listed under (1) above to meet the owner's project goal; and (5) if the contract goal is not met, evidence of good faith efforts undertaken by the bidder, as described in Appendix A to 49 CFR Part 26.

The apparent successful competitor must provide written confirmation of participation from each of the DBE firms listed in their commitment with the proposal documents as a condition of bid responsiveness.

Davis-Bacon Act, as amended – 29 CFR Part 5: The Contractor is required to comply with wage and labor provisions and to pay minimum wages in accordance with the current schedule of wage rates established by the United States Department of Labor included in the supplementary provisions.

In addition, the contractor will also be required to comply with the wage and labor requirements and pay minimum wages in accordance with the schedule of wage rates established by the Missouri Division of Labor Standards included in the Supplementary Provisions.

The highest rate between the two (Federal and State) for each job classification shall be considered the prevailing wage.

Debarment, Suspension, Ineligibility and Voluntary Exclusion – 49 CFR Part 29: The bidder certifies, by submission of a proposal or acceptance of a contract, that neither it nor its principals are presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.

Foreign Trade Restriction – 49 CFR Part 30: The Bidder and Bidder's subcontractors, by submission of an offer and/or execution of a contract, is required to certify that it:

a. is not owned or controlled by one or more citizens of a foreign country included in the list of countries that discriminate against U.S. firms published by the Office of the United States Trade Representative (USTR);

b. has not knowingly entered into any contract or subcontract for this project with a person that is a citizen or national of a foreign country on said list, or is owned or controlled directly or indirectly by one or more citizens or nationals of a foreign country on said list; or

c. has not procured any product nor subcontracted for the supply of any product for use on the project that is produced in a foreign country on said list.

Buy American Certificate – Aviation Safety and Capacity Act of 1990: This contract is subject to the "Buy American Preferences" of the Aviation Safety and Capacity Act of 1990. Prospective Bidders are required to certify that steel and manufactured products have been produced in the United States and to clearly identify those items produced or manufactured outside of the United States.

Additional Provisions:
Modification to the project documents may only be made by written addendum by the Owner or Owner's authorized Representative.

The proposal must be made on the official bid form provided separate from the bound project manual. Bidders must supply all required information prior to the time of bid opening.

SECTION 17

ITEM P-501

PORTLAND CEMENT CONCRETE (PCC) PAVEMENT

DESCRIPTION

501-1.1 This work shall consist of pavement composed of Portland cement concrete (PCC), **with 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. Fine and Coarse aggregates to be used in all concrete shall be evaluated and tested by the Contractor for alkali-aggregate reactivity in accordance with both ASTM C1260 and ASTM C1567. Aggregate and mix proportion reactivity tests shall be performed for each project.

(1) Coarse and fine aggregate shall be tested separately in accordance with ASTM C1260. The aggregate shall be considered innocuous if the expansion of test specimens, tested in accordance with ASTM C1260, does not exceed 0.10% at 28 days (30 days from casting).

(2) Combined coarse and fine aggregate shall be tested in accordance with ASTM C1567, modified for combined aggregates, using the proposed mixture design proportions of aggregates, cementitious materials, and/or specific reactivity reducing chemicals. If lithium nitrate is proposed for use with or without supplementary cementitious materials, the aggregates shall be tested in accordance with Corps of Engineers (COE) Concrete Research Division (CRD) C662. If lithium nitrate admixture is used, it shall be nominal 30% ±0.5% weight lithium nitrate in water.

(3) If the expansion of the proposed combined materials test specimens, tested in accordance with ASTM C1567, modified for combined aggregates, or COE CRD C662, does not exceed 0.10% at 28 days, the proposed combined materials will be accepted. If the expansion of the proposed combined materials test specimens is greater than 0.10% at 28 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10% at 28 days, or new aggregates shall be evaluated and tested.

b. Fine aggregate. Fine aggregate shall conform to the requirements of ASTM C33. Grading of the fine aggregate, as delivered to the mixer, shall conform to the requirements of ASTM C33 and shall have a fineness modulus of not less than 2.50 nor more than 3.40. The soundness loss shall not exceed 10% when sodium sulfate is used or 15% when magnesium sulfate is used, after five cycles, when tested per ASTM C88.

The amount of deleterious material in the fine aggregate shall not exceed the following limits:

Limits for Deleterious Substances in Fine Aggregate for Concrete

Deleterious Material	ASTM	Percentage by Mass
Clay lumps and friable particles	ASTM C142	1.0
Material finer than 0.075mm (No. 200 sieve)	ASTM C117	3.0
Lightweight particles	ASTM C123 using a medium with a density of Sp. Gr. of 2.0	0.5
Total of all deleterious material		3.0

c. Coarse aggregate. Gradation, within the separated size groups, shall meet the coarse aggregate grading requirements of ASTM C33 when tested in accordance with ASTM C136. When the nominal maximum size of the aggregate is greater than one inch (25 mm), the aggregates shall be furnished in two size groups.

Aggregates delivered to the mixer shall consist of crushed stone, crushed or uncrushed gravel, air-cooled iron blast furnace slag, crushed recycled concrete pavement, or a combination. The aggregates should be free of ferrous sulfides, such as pyrite, that would cause "rust" staining that can bleed through pavement markings. Steel blast furnace slag shall not be permitted. The aggregate shall be composed of clean, hard, uncoated particles. Dust and other coating shall be removed from the aggregates by washing.

The percentage of wear shall be no more than **40%** when tested in accordance with ASTM C131.

The quantity of flat, elongated, and flat and elongated particles in any size group coarser than 3/8 sieve (9 mm) shall not exceed 8% by weight when tested in accordance with ASTM D4791. A flat particle is defined as one having a ratio of width to thickness greater than 5. An elongated particle is one having a ratio of length to width greater than 5.

The soundness loss shall not exceed 12% when sodium sulfate is used or 18% when magnesium sulfate is used, after five cycles, when tested per ASTM C88.

The amount of deleterious material in the coarse aggregate shall not exceed the following limits:

Limits for Deleterious Substances in Coarse Aggregate for Concrete

Deleterious Material	ASTM	Percentage by Mass
Clay lumps and friable particles	ASTM C142	1.0
Material finer than No. 200 sieve (0.075mm)	ASTM C117	1.0
Lightweight particles	ASTM C123 using a medium with a density of Sp. Gr. of 2.0	0.5
Chert (less than 2.40 Sp Gr.)	ASTM C123 using a medium with a density of Sp. Gr. of 2.0)	1.0
Total of all deleterious material		3.0

Table 1. Gradation for Coarse Aggregate
(ASTM C33)

Sieve Designations (Square Openings)		Percentage by Weight Passing Sieves
inch	**mm**	**#67 3/4 inch - No. 4**
2-1/2	60	**---**
2	50	**---**
1-1/2	38	**---**
1	25	**100**
3/4	19	**90-100**
1/2	13	**---**
3/8	9	**20-55**
No. 4	4.75	**0-10**
No. 8	2.36	**0-5**

(1) Aggregate susceptibility to durability (D) cracking. Coarse aggregate may be accepted from sources that have a 20 year service history for the same gradation to be supplied with no durability issues. Aggregates that do not have a record of 20 years of service without major repairs (less than 5% of slabs replaced) in similar conditions without D-cracking shall not be used unless it meets the following:

(a) Material currently being produced shall have a durability factor ≥ 95 using ASTM C666 procedure B. Coarse aggregates that are crushed granite, calcite cemented sandstone, quartzite, basalt, diabase, rhyolite or trap rock are considered to meet the D-cracking test but must meet all other quality tests. Aggregates meeting State Highway Department material specifications may be acceptable.

(b) The Contractor shall submit a current certification that the aggregate does not have a history of D-cracking and that the aggregate meets the state specifications for use in PCC pavement for use on interstate highways. Certifications, tests and any history reports must be for the same gradation as being proposed for use on the project. Certifications which are not dated or which are over one (1) year old or which are for different gradations will not be accepted. Test results will only be accepted when tests were performed by a State Department of Transportation (DOT) materials laboratory or an accredited laboratory.

(2) Combined aggregate gradation. If substituted for the grading requirements specified for coarse aggregate and for fine aggregate and when approved by the Engineer, the combined aggregate grading shall meet the following requirements:

(a) The materials selected and the proportions used shall be such that when the Coarseness Factor (CF) and the Workability Factor (WF) are plotted on a diagram as described in d. below, the point thus determined shall fall within the parallelogram described therein.

(b) The CF shall be determined from the following equation:

CF = (cumulative percent retained on the 3/8 in. sieve)(100) / (cumulative percent retained on the No. 8 sieve)

(c) The WF is defined as the percent passing the No. 8 (2.36 mm) sieve based on the combined gradation. However, WF shall be adjusted, upwards only, by 2.5 percentage points for each 94 pounds (42 kg) of cementitious material per cubic meter yard greater than 564 pounds per cubic yard (335 kg per cubic meter).

(d) A diagram shall be plotted using a rectangular scale with WF on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram a parallelogram shall be plotted with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-40), (CF-45, WF-32.5), and (CF-45, WF-44.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, the grading of each size of aggregate used and the proportions selected shall be changed as necessary.

501-2.2 Cement. Cement shall conform to the requirements of ASTM **C150** Type **I**.

If aggregates are deemed innocuous when tested in accordance with paragraph 501-2.1.a.1 and accepted in accordance with paragraph 501-2.1.a.2, higher equivalent alkali content in the cement may be allowed if approved by the Engineer and FAA. If 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.

501-2.3 Cementitious materials.

a. Fly ash. *Fly ash shall meet the requirements of ASTM C618, Class F or N with the exception of loss of ignition, where the maximum shall be less than 6%. Class F or N for use in mitigating alkali-silica reactivity shall have a Calcium Oxide (CaO) content of less than 16% and a total available alkali content less than 3% per ASTM C311. Fly ash produced in furnace operations using liming materials or soda*

ash (sodium carbonate) as an additive shall not be acceptable. The Contractor shall furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the mix design, and shall furnish each additional report as they become available during the project. The reports can be used for acceptance or the material may be tested independently by the Engineer.

b. Slag cement (ground granulated blast furnace (GGBF)). Slag cement shall conform to ASTM C989, Grade 100 or Grade 120. Slag cement shall be used only at a rate between 25% and 55% of the total cementitious material by mass.

c. Raw or calcined natural pozzolan. Natural pozzolan shall be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and shall have a loss on ignition not exceeding 6%. Class N pozzolan for use in mitigating Alkali-Silica Reactivity shall have a total available alkali content less than 3%.

d. Ultrafine fly ash and ultrafine pozzolan. UltraFine Fly Ash (UFFA) and UltraFine Pozzolan (UFP) shall conform to ASTM C618, Class F or N, and the following additional requirements:

(1) The strength activity index at 28 days of age shall be at least 95% of the control specimens.

(2) The average particle size shall not exceed 6 microns.

501-2.4 Joint seal. The joint seal for the joints in the concrete pavement shall meet the requirements of **Item P-605** and shall be of the type specified in the plans.

501-2.5 Isolation joint filler. Premolded joint filler for isolation joints shall conform to the requirements of **ASTM D1751** and shall be where shown 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.

501-2.6 Steel reinforcement. Reinforcing shall consist of **welded wire fabric** conforming to the requirements of ASTM **ASTM A1064.**

501-2.7 Dowel and tie bars. Dowel bars shall be plain steel bars conforming to ASTM A615 and shall be free from burring or other deformation restricting slippage in the concrete. Before delivery to the construction site each dowel bar shall be epoxy coated per ASTM A1078. The dowels shall be coated with a bond-breaker recommended by the manufacturer. Dowel sleeves or inserts are not permitted. Grout retention rings shall be fully circular metal or plastic devices capable of supporting the dowel until the grout hardens.

Tie bars shall be deformed steel bars and conform to the requirements of ASTM A615. Tie bars designated as Grade 60 in ASTM A615 or ASTM A706 shall be used for construction requiring bent bars.

501-2.8 Water. Water used in mixing or curing shall be potable, clean, free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product, except that non-potable water, or water from concrete production operations, may be used if it meets the requirements of ASTM C1602.

501-2.9 Material for curing concrete. 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 C309, 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 C171.

c. White burlap-polyethylene sheeting for curing concrete shall conform to the requirements of ASTM C171.

d. Waterproof paper for curing concrete shall conform to the requirements of ASTM C171.

501-2.10 Admixtures. 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 C260 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. Water-reducing admixtures. Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D. ASTM C494, Type F and G high range water reducing admixtures and ASTM C1017 flowable admixtures shall not be used.

c. Other admixtures. The use of set retarding, and set-accelerating admixtures shall be approved by the Engineer. Retarding shall meet the requirements of ASTM C494, Type A, B, or D and set-accelerating shall meet the requirements of ASTM C494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

d. Lithium nitrate. The lithium admixture shall be a nominal 30% aqueous solution of Lithium nitrate, with a density of 10 pounds/gallon (1.2 kg/L), and shall have the approximate chemical form as shown below:

Constituent	Limit (Percent by Mass)
LiNO3 (Lithium Nitrate)	30 ±0.5
SO4 (Sulfate Ion)	0.1 (max)
Cl (Chloride Ion)	0.2 (max)
Na (Sodium Ion)	0.1 (max)
K (Potassium Ion)	0.1 (max)

Provide a trained manufacturer's representative to supervise the lithium nitrate admixture dispensing and mixing operations.

501-2.11 Epoxy-resin. All epoxy-resin materials shall be two-component materials conforming to the requirements of ASTM C881, Class as appropriate for each application temperature to be encountered, except that in addition, the materials shall meet the following requirements:

a. Material for use for embedding dowels and anchor bolts shall be Type IV, Grade 3.

b. Material for use as patching materials for complete filling of spalls and other voids and for use in preparing epoxy resin mortar shall be Type III, Grade as approved.

c. Material for use for injecting cracks shall be Type IV, Grade 1.

d. Material for bonding freshly mixed Portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete shall be Type V, Grade as approved.

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 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. General. No concrete shall be placed until the mix design has been submitted to the Engineer for review and the Engineer has taken appropriate action. The Engineer's review shall not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

501-3.2 Proportions. The laboratory preparing the mix design shall be accredited in accordance with ASTM C1077. The mix design for all Portland cement concrete placed under P-501 shall be stamped or sealed by the responsible professional Engineer of the laboratory. Concrete shall be proportioned to achieve a 28-day **compressive** strength that meets or exceeds the acceptance criteria contained in paragraph 501-5.2 for a **compressive** strength of **4,400** psi per ASTM C78. The mix shall be developed using the procedures contained in the Portland Cement Association's (PCA) publication, "Design and Control of Concrete Mixtures".

The minimum cementitious material shall be adequate to ensure a workable, durable mix. The minimum cementitious material (cement plus fly ash, or slag cement) shall be **564** pounds per cubic yard. The ratio of water to cementitious material, including free surface moisture on the aggregates but not including moisture absorbed by the aggregates shall not be more than **0.45** by weight.

Compressive strength test specimens shall be prepared in accordance with ASTM C192 and tested in accordance with ASTM C**39**. The mix determined shall be workable concrete having a maximum allowable slump between one and two inches (25mm and 50 mm) as determined by ASTM C143. For slip-form concrete, the slump shall be between 1/2 inch (12 mm) and 1-1/2 inch (38 mm). For fixed-form concrete placement, the slump shall not exceed 4 inches. Separate mix designs shall be prepared for both slip-form concrete and fixed-form concrete (***Added Per Addendum No.1***). At the start of the project, the Contractor shall determine a maximum allowable slump for slip-form pavement which will produce in-place pavement to control the edge slump. The selected slump shall be applicable to both pilot and fill-in lanes.

Cylinders

a. Fabricate all cylinders for each mixture from the same batch or blend of batches. Fabricate and cure all cylinders in accordance with ASTM C192, using 6 × 12 inch (150 × 300 mm) single-use cylinder forms.

b. Cure test cylinders from each mixture for 3, 7, 14, and 28-day compressive strength tests; six (6) cylinders to be tested per age.

c. Test cylinders in accordance with ASTM C39.

d. Using the average strength for each w/c at each age, plot all results from each of the three mixtures on separate graphs for w/c versus:

3-day compressive strength

7-day compressive strength

14-day compressive strength

28-day compressive strength

e. From these graphs select a w/c that will produce a mixture giving a 28-day compressive strength equal to the required strength determined in accordance with the next paragraph.

f. Using the above selected w/c, select from the graphs the expected 3, 7, 14, 28-day compressive strengths for the mixture.

g. From the above expected strengths for the selected mixture determine the following Correlation Ratios:

(1) Ratio of the 14-day compressive strength of the selected mixture to the 28-day compressive strength of the mixture (for acceptance).

(2) Ratio of the 7-day compressive strength of the selected mixture to the 28-day compressive strength of the mixture (for Contractor Quality Control control).

h. If there is a change in materials, additional mixture design studies shall be made using the new materials and new Correlation Ratios shall be determined.

i. No concrete pavement shall be placed until the Engineer has approved the Contractor's mixture proportions. The approved water-cementitious materials ratio shall not exceed the maximum value specified.

Before 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 **compressive** strength obtained from the concrete at seven (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 mix design shall be submitted to the Engineer at least 30 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.

If a change in sources is made, or admixtures added or deleted from the mix, a new mix design must be submitted to the Engineer for approval.

The results of the mix design shall include a statement giving the maximum nominal coarse aggregate size and the weights and volumes of each ingredient proportioned on a one cubic yard (meter) basis. Aggregate quantities shall be based on the mass in a saturated surface dry condition. The recommended

mixture proportions shall be accompanied by test results demonstrating that the proportions selected will produce concrete of the qualities indicated. Trial mixtures having proportions, slumps, and air content suitable for the work shall be based on methodology described in PCA's publication, Design and Control of Concrete Mixtures, modified as necessary to accommodate **compressive** strength.

The submitted mix design shall be stamped or sealed by the responsible professional Engineer of the laboratory and shall include the following items as a minimum:

a. Coarse, fine, and combined aggregate gradations and plots including fineness modulus of the fine aggregate.

b. Reactivity Test Results.

c. Coarse aggregate quality test results, including deleterious materials.

d. Fine aggregate quality test results, including deleterious materials.

e. Mill certificates for cement and supplemental cementitious materials.

f. Certified test results for all admixtures, including lithium nitrate if applicable.

g. Specified **compressive** strength, slump, and air content.

h. Recommended proportions/volumes for proposed mixture and trial water-cementitious materials ratio, including actual slump and air content.

i. Compressive strength summaries and plots, including all individual cylinder breaks.

j. Correlation ratios for acceptance testing and Contractor Quality Control testing, when applicable.

k. Historical record of test results documenting production standard deviation, when applicable.

501-3.3 Cementitious materials.

a. Fly ash. When fly ash is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between 20 and 30% by weight of the total cementitious material. If fly ash is used in conjunction with slag cement the maximum replacement rate shall not exceed 10% by weight of total cementitious material.

b. Slag cement (ground granulated blast furnace (GGBF)). Slag cement may be used. The slag cement, or slag cement plus fly ash if both are used, may constitute between 25 to 55% of the total cementitious material by weight. If the concrete is to be used for slipforming operations and the air temperature is expected to be lower than 55°F (13°C) the percent slag cement shall not exceed 30% by weight.

c. Raw or calcined natural pozzolan. Natural pozzolan may be used in the mix design. When pozzolan is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between 20 and 30% by weight of the total cementitious material. If pozzolan is used in conjunction with slag cement the maximum replacement rate shall not exceed 10% by weight of total cementitious material.

d. Ultrafine fly ash (UFFA) and ultrafine pozzolan (UFP). UFFA and UFP may be used in the mix design with the Engineer's approval. When UFFA and UFP is used as a partial replacement for

cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between seven (7) and 16% by weight of the total cementitious material.

501-3.4 Admixtures.

a. Air-entraining admixtures. Air-entraining admixtures are to be added in such a manner that will ensure uniform distribution of the agent throughout the batch. The air content of freshly mixed air-entrained concrete 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 **5.0%**.

b. Air content shall be determined by testing in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag and other highly porous coarse aggregate.

b. Water-reducing admixtures. Water-reducing admixtures 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 C494.

c. Other admixtures. 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.

d. Lithium nitrate. Lithium nitrate shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements in accordance with paragraph 501-2.10d.

501-3.5 Concrete mix design laboratory. The Contractor's laboratory used to develop the concrete mix design shall be accredited in accordance with ASTM C1077. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for developing the concrete mix design must be listed on the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the Engineer prior to start of construction

CONSTRUCTION METHODS

501-4.1 Equipment. Equipment necessary for handling materials and performing all parts of the work shall be approved by the Engineer, but does not relieve the Contractor of the responsibility for the proper operation of equipment and maintaining the equipment in good working condition. The equipment 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 C94.

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.

(2) Central plant mixer. Central plant mixers shall conform to the requirements of ASTM C94. 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 C94.

(4) Nonagitator trucks. Nonagitating hauling equipment shall conform to the requirements of ASTM C94.

(5) Transfer and spreading equipment. Equipment for transferring concrete from the transporting equipment to the paving lane in front of the paver shall be specially manufactured, self-propelled transfer equipment which will accept the concrete outside the paving lane and will transfer and spread it evenly across the paving lane in front of the paver and strike off the surface evenly to a depth which permits the paver to operate efficiently.

c. Finishing equipment. The standard method of constructing concrete pavements shall be with an approved slip-form paving equipment designed and operated to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine so that the end result is a dense and homogeneous pavement which is achieved with a minimum of hand finishing. The paver-finisher shall be a heavy duty, self-propelled machine designed specifically for paving and finishing high quality concrete pavements. It shall weigh at least 2,200 lbs per foot (3274 kg/m) of paving lane width and powered by an engine having at least 6.0 horsepower per foot of lane width.

On projects requiring less than 500 square yard (418 sq m) of cement concrete pavement or requiring individual placement areas of less than 500 square yard (418 sq m), or irregular areas at locations inaccessible to slip-form paving equipment, concrete pavement may be placed with approved placement and finishing equipment using stationary side forms. Hand screeding and float finishing may only be used on small irregular areas as allowed by the 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 inch (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 American Concrete Institute (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 309R, 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. Early-entry saws may be used, subject to demonstration and approval of the Engineer.

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 ensure 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 from different sources shall be stockpiled, weighed and batched separately at the concrete batch plant.

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 C94.

Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or non-agitating trucks. The elapsed time from the addition of cementitious material to the mix until the concrete is deposited in place at the work site shall not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 90 minutes when the concrete is hauled in truck mixers or truck agitators. Retempering concrete by adding water or by other means will not be permitted. With transit mixers additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements provided the addition of water is performed within 45 minutes after the initial mixing operations and provided the water/cementitious ratio specified in the approved mix design is not exceeded, and approved by the 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°F (4°C) and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F (2°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°F (10°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°F (66°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°F (30°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°F (32°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. When necessary, wind screens shall be provided to protect the concrete from an evaporation rate in excess of 0.2 psf (0.98 kg/m^2 per hour) per hour. When conditions are such that problems with plastic cracking can be expected, and particularly if any plastic cracking begins to occur, the Contractor 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; and anticipated evaporation rate using Figure 11-8, PCA, Design and Control of Concrete Mixtures.

(3) Anticipated timing of initial sawing of joint.

(4) Anticipated number and type of saws to be used.

501-4.8 Placing concrete. 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). The finished concrete product must be dense and homogeneous, without segregation and conforming to the standards in this specification. Backhoes and grading equipment shall not be used to distribute the concrete in front of the paver. Front end loaders will not be used. All concrete shall be consolidated without voids or segregation, including under and around all load-transfer devices, joint assembly units, and other features embedded in the pavement. Hauling equipment or other mechanical equipment can be permitted on adjoining previously constructed pavement when the concrete strength **reaches a 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 **compressive** strength of **2,500 psi**.

The Contractor shall have available materials for the protection of the concrete during inclement weather. 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.

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) for slipform and at the end of the dowels for the fill-in lanes. The spacing of internal units shall be uniform and shall not exceed 18 inches (0.5 m).

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 and for a distance of at least one foot (30 cm). 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.

Not more than 15% 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 (9 mm). (The total free edge of 500 feet (150 m) of pavement will be considered the cumulative total linear measurement of pavement edge originally constructed as nonadjacent to any existing pavement; that is, 500 feet (150 m) of paving lane originally constructed as a separate lane will have 1,000 feet (300 m) of free edge, 500 feet (150 m) of fill-in lane

will have no free edge, etc.). The area affected by the downward movement of the concrete along the pavement edge shall be limited to not more than 18 inches (0.5 m) from the edge. When excessive edge slump cannot be corrected before the concrete has hardened, the area with excessive edge slump shall be removed and replaced at the expense of the Contractor as directed by the Engineer.

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 or greater than 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 (30 cm) 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. Concrete shall be consolidated with the specified type of lane-spanning, gang-mounted, mechanical, immersion type vibrating equipment mounted in front of the paver, supplemented, in rare instances as specified, by hand-operated vibrators. The vibrators shall be inserted into the concrete to a depth that will provide the best full-depth consolidation but not closer to the underlying material than two inches (50 mm). Excessive vibration shall not be permitted. If the vibrators cause visible tracking in the paving lane, the paving operation shall be stopped and equipment and operations modified to prevent it. Concrete in small, odd-shaped slabs or in isolated locations inaccessible to the gang-mounted vibration equipment shall be vibrated with an approved hand-operated immersion vibrator operated from a bridge spanning the area. Vibrators shall not be used to transport or spread the concrete. Hand-operated vibrators shall not be operated in the concrete at one location for more than 20 seconds. Insertion locations for hand-operated vibrators shall be between 6 to 15 inches (150 to 400 mm) on centers. For each paving train, at least one additional vibrator spud, or sufficient parts for rapid replacement and repair of vibrators shall be maintained at the paving site at all times. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) shall require the immediate stopping of the paving operation and adjustment of the equipment or procedures as approved by the Engineer.

If a lack of consolidation of the concrete is suspected by the Engineer, referee testing may be required. Referee testing of hardened concrete will be performed by the Engineer by cutting cores from the finished pavement after a minimum of 24 hours curing. Density determinations will be made by the Engineer based on the water content of the core as taken. ASTM C642 shall be used for the determination of core density in the saturated-surface dry condition. When required, referee cores will be taken at the minimum rate of one for each 500 cubic yards (382 m^2) of pavement, or fraction. The Contractor shall be responsible for all referee testing cost if they fail to meet the required density.

The average density of the cores shall be at least 97% of the original mix design density, with no cores having a density of less than 96% of the original mix design density. Failure to meet the referee tests will be considered evidence that the minimum requirements for vibration are inadequate for the job conditions. Additional vibrating units or other means of increasing the effect of vibration shall be employed so that the density of the hardened concrete conforms to the above 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 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 (12 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 12 feet (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 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. Isolation (expansion). Isolation 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. 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. Tie 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.

e. Dowel bars. Dowel bars or other load-transfer units of an approved type shall be placed across joints 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. The dowels shall be

coated with a bond-breaker or other lubricant recommended by the manufacturer and approved by the Engineer.

f. Dowels bars at longitudinal construction joints shall be bonded in drilled holes.

g. Placing dowels and tie bars. The method used in installing and holding dowels in position shall ensure that the error in alignment of any dowel from its required horizontal and vertical alignment after the pavement has been completed will not be greater than 1/8 inch per feet (3 mm per 0.3 m). Except as otherwise specified below, horizontal spacing of dowels shall be within a tolerance of ±5/8 inch (16 mm). The vertical location on the face of the slab shall be within a tolerance of ±1/2 inch (12 mm). The vertical alignment of the dowels shall be measured parallel to the designated top surface of the pavement, except for those across the crown or other grade change joints. Dowels across crowns and other joints at grade changes shall be measured to a level surface. Horizontal alignment shall be checked perpendicular to the joint edge. The horizontal alignment shall be checked with a framing square. Dowels **and tie bars** shall not be placed closer than 0.6 times the dowel bar **or tie bar** length to the planned joint line. If the last regularly spaced longitudinal dowel **or tie bar** is closer than that dimension, it shall be moved away from the joint to a location 0.6 times the dowel bar **or tie bar** length, but not closer than 6 inches (150 mm) to its nearest neighbor. The portion of each dowel intended to move within the concrete or expansion cap shall be wiped clean and coated with a thin, even film of lubricating oil or light grease before the concrete is placed. Dowels shall be installed as specified in the following subparagraphs.

(1) Contraction joints. Dowels and tie bars in longitudinal and transverse contraction joints within the paving lane shall be held securely in place, as indicated, by means of rigid metal frames or basket assemblies of an approved type. The basket assemblies shall be held securely in the proper location by means of suitable pins or anchors. Do not cut or crimp the dowel basket tie wires. At the Contractor's option, in lieu of the above, dowels and tie bars in contraction joints shall be installed near the front of the paver by insertion into the plastic concrete using approved equipment and procedures. Approval will be based on the results of a preconstruction demonstration, showing that the dowels and tie bars are installed within specified tolerances.

(2) Construction joints. Install dowels and tie bars by the cast-in- place or the drill-and-dowel method. Installation by removing and replacing in preformed holes will not be permitted. Dowels and tie bars shall be prepared and placed across joints where indicated, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms. The spacing of dowels and tie bars in construction joints shall be as indicated.

(3) Dowels installed in isolation joints and other hardened concrete. Install dowels for isolation joints and in other hardened concrete by bonding the dowels into holes drilled into the hardened concrete. The concrete shall have cured for seven (7) days or reached a minimum **compressive strength of 2,500 psi** before drilling commences. Holes 1/8 inch (3 mm) greater in diameter than the dowels shall be drilled into the hardened concrete using rotary-core drills. Rotary-percussion drills may be used, provided that excessive spalling does not occur to the concrete joint face. Modification of the equipment and operation shall be required if, in the Engineer's opinion, the equipment and/or operation is causing excessive damage. Depth of dowel hole shall be within a tolerance of ±1/2 inch (12 mm) of the dimension shown on the drawings. On completion of the drilling operation, the dowel hole shall be blown out with oil-free, compressed air. Dowels shall be bonded in the drilled holes using epoxy resin. Epoxy resin shall be injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel will not be permitted. The dowels shall be held in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic grout retention ring fitted around the dowel.

Dowels required to be installed in any joints between new and existing concrete shall be grouted in holes drilled in the existing concrete, all as specified above.

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 of the slot shall be widened by sawing to provide adequate space for joint sealers as shown on the plans. Sawing shall commence, without regard to day or night, as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing and before uncontrolled shrinkage cracking of the pavement occurs and shall continue without interruption until all joints have been sawn. The joints shall be sawn at the required spacing. All slurry and debris produced in the sawing of joints shall be removed by vacuuming and washing. Curing compound or system shall be reapplied in the initial saw cut and maintained for the remaining cure period.

501-4.11 Finishing. Finishing operations shall be a continuing part of placing operations starting immediately behind the strike-off of the paver. Initial finishing shall be provided by the transverse screed or extrusion plate. The sequence of operations shall be transverse finishing, longitudinal machine floating if used, straightedge finishing, texturing, and then edging of joints. Finishing shall be by the machine method. The hand method shall be used only on isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. Supplemental hand finishing for machine finished pavement shall be kept to an absolute minimum. Any machine finishing operation which requires appreciable hand finishing, other than a moderate amount of straightedge finishing, shall be immediately stopped and proper adjustments made or the equipment replaced. Any operations which produce more than 1/8 inch (3 mm) of mortar-rich surface (defined as deficient in plus U.S. No. 4 (4.75 mm) sieve size aggregate) shall be halted immediately and the equipment, mixture, or procedures modified as necessary. Compensation shall be made for surging behind the screeds or extrusion plate and settlement during hardening and care shall be taken to ensure that paving and finishing machines are properly adjusted so that the finished surface of the concrete (not just the cutting edges of the screeds) will be at the required line and grade. Finishing equipment and tools shall be maintained clean and in an approved condition. At no time shall water be added to the surface of the slab with the finishing equipment or tools, or in any other way, except for fog (mist) sprays specified to prevent plastic shrinkage cracking.

a. Machine finishing with slipform pavers. The slipform paver shall be operated so that only a very minimum of additional finishing work is required to produce pavement surfaces and edges meeting the specified tolerances. Any equipment or procedure that fails to meet these specified requirements shall immediately be replaced or modified as necessary. A self-propelled non-rotating pipe float may be used while the concrete is still plastic, to remove minor irregularities and score marks. Only one pass of the pipe float shall be allowed. If there is concrete slurry or fluid paste on the surface that runs over the edge of the pavement, the paving operation shall be immediately stopped and the equipment, mixture, or operation modified to prevent formation of such slurry. Any slurry which does run down the vertical edges shall be immediately removed by hand, using stiff brushes or scrapers. No slurry, concrete or concrete mortar shall be used to build up along the edges of the pavement to compensate for excessive edge slump, either while the concrete is plastic or after it hardens.

b. Machine finishing with fixed forms. The machine shall be designed to straddle the forms and shall be operated to screed and consolidate the concrete. Machines that cause displacement of the forms shall be replaced. The machine shall make only one pass over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, the operation shall be immediately stopped and the equipment, mixture, and procedures adjusted as necessary.

c. Other types of finishing equipment. Clary screeds, other rotating tube floats, or bridge deck finishers are not allowed on mainline paving, but may be allowed on irregular or odd-shaped slabs, and near buildings or trench drains, subject to the Engineer's approval.

Bridge deck finishers shall have a minimum operating weight of 7500 pounds (3400 kg) and shall have a transversely operating carriage containing a knock-down auger and a minimum of two immersion vibrators. Vibrating screeds or pans shall be used only for isolated slabs where hand finishing is permitted as specified, and only where specifically approved.

d. Hand finishing. Hand finishing methods will not be permitted, except under the following conditions: (1) in the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade and (2) in areas of narrow widths or of irregular dimensions where operation of the mechanical equipment is impractical. Use hand finishing operations only as specified below.

(1) Equipment and screed. In addition to approved mechanical internal vibrators for consolidating the concrete, provide a strike-off and tamping screed and a longitudinal float for hand finishing. The screed shall be at least one foot (30 cm) longer than the width of pavement being finished, of an approved design, and sufficiently rigid to retain its shape, and shall be constructed of metal or other suitable material shod with metal. The longitudinal float shall be at least 10 feet (3 m) long, of approved design, and rigid and substantially braced, and shall maintain a plane surface on the bottom. Grate tampers (jitterbugs) shall not be used.

(2) Finishing and floating. As soon as placed and vibrated, the concrete shall be struck off and screeded to the crown and cross-section and to such elevation above grade that when consolidated and finished, the surface of the pavement will be at the required elevation. In addition to previously specified complete coverage with handheld immersion vibrators, the entire surface shall be tamped with the strike-off and tamping template, and the tamping operation continued until the required compaction and reduction of internal and surface voids are accomplished. Immediately following the final tamping of the surface, the pavement shall be floated longitudinally from bridges resting on the side forms and spanning but not touching the concrete. If necessary, additional concrete shall be placed, consolidated and screeded, and the float operated until a satisfactory surface has been produced. The floating operation shall be advanced not more than half the length of the float and then continued over the new and previously floated surfaces.

e. Straightedge 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 12-foot (3.7-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. This straight-edging is not a replacement for the straightedge testing of paragraph 501-5.2e(3), Smoothness.

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 one foot (30 cm) 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 (60 cm) 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 inch-long polyethylene turf blades per square foot. The corrugations shall be uniform in appearance and approximately 1/16 inch (2 mm) in depth.

501-4.13 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.

When a two-saw cut method is used to construct the contraction joint, the curing compound shall be applied to the saw cut immediately after the initial cut has been made. The sealant reservoir shall not be sawed until after the curing period has been completed. When the one cut method is used to construct the contraction joint, the joint shall be cured with wet rope, wet rags, or wet blankets. The rags, ropes, or blankets shall be kept moist for the duration of 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 one gallon (4 liters) to not more than 150 sq ft (14 sq m). 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 ensure 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. Curing shall be applied immediately after the bleed water is gone from the surface.

b. White burlap-polyethylene sheets. The surface of the pavement shall be entirely covered with the sheeting. The sheeting used shall be such length (or width) that it will extend at least twice the thickness of the pavement beyond the edges of the slab. The sheeting shall be placed so that the entire surface and both edges of the slab are completely covered. The sheeting shall be placed and weighted to remain in contact with the surface covered, and the covering shall be maintained fully saturated and in position for seven (7) days after the concrete has been placed.

c. Water method. The entire area shall be covered with burlap or other water absorbing material. The material shall be of sufficient thickness to retain water for adequate curing without excessive runoff. The material shall be kept wet at all times and maintained for seven (7) days. When the forms are stripped, the vertical walls shall also be kept moist. It shall be the responsibility of the Contractor to prevent ponding of the curing water on the subbase.

d. Concrete protection for cold weather. The concrete shall be maintained at an ambient temperature of at least 50°F (10°C) for a period of 72 hours after placing and at a temperature above freezing for the remainder of the curing time. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather; and any concrete damaged shall be removed and replaced at the Contractor's expense.

e. Concrete protection for hot weather. Concrete should be continuous moisture cured for the entire curing period and shall commence as soon as the surfaces are finished and continue for at least 24 hours. However, if moisture curing is not practical beyond 24 hours, the concrete surface shall be protected from drying with application of a liquid membrane-forming curing compound while the surfaces are still damp. Other curing methods may be approved by the Engineer.

501-4.14 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 per the methods indicated in paragraph 501-4.13. Major honeycombed areas shall be considered as defective work and shall be removed and replaced in accordance with paragraph 501-5.2(f).

501-4.15 Saw-cut grooving. If shown on the plans, grooved surfaces shall be provided in accordance with the requirements of Item P-621.

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 until accepted by the Engineer. 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.

Aggregates, rubble, or other similar construction materials shall not be placed on airfield pavements. Traffic shall be excluded from the new pavement by erecting and maintaining barricades and signs until the concrete is at least seven (7) days old, or for a longer period if directed by the Engineer.

In paving intermediate lanes between newly paved pilot lanes, operation of the hauling and paving equipment will be permitted on the new pavement after the pavement has been cured for seven (7) days and the joints have been sealed or otherwise protected, and the concrete has attained a minimum field cured **compressive** strength of **3,500 psi** and approved means are furnished to prevent damage to the slab edge.

All new and existing pavement carrying construction traffic or equipment shall be continuously kept completely clean, and spillage of concrete or other materials shall be cleaned up immediately upon occurrence.

Damaged pavements shall be removed and replaced at the Contractor's expense. Slabs shall be removed to the full depth, width, and length of the slab.

501-4.18 Opening to construction traffic. The pavement shall not be opened to traffic until test specimens molded and cured in accordance with ASTM C31 have attained a **compressive** strength of **3,500 psi** when tested in accordance with ASTM **C39**. 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.

501-4.19 Repair, removal, or replacement of slabs.

a. General. New pavement slabs that are broken or contain cracks or are otherwise defective or unacceptable shall be removed and replaced or repaired, as directed by the Engineer and 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 C881, Type V. Repair of cracks as described in this section shall not be allowed if in the opinion of the Engineer the overall condition of the pavement indicates that such repair is unlikely to achieve an acceptable and durable finished pavement. No repair of cracks shall be allowed in any panel that demonstrates segregated aggregate with an absence of coarse aggregate in the upper 1/8 inch (3 mm) of the pavement surface.

b. Shrinkage cracks. Shrinkage cracks, which do not exceed 4 inches (100 mm) in depth, shall be cleaned and then pressure injected with epoxy resin, Type IV, Grade 1, using procedures as approved by the Engineer. 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 (100 mm) 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 (150 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 (100 mm) in depth, that extend into the interior area.

d. Cracks close to and parallel to joints. All cracks essentially parallel to original joints, extending full depth of the slab, and lying wholly within 6 inches (150 mm) either side of the joint shall be treated as specified here. Any crack extending more than 6 inches (150 mm) from the joint shall be treated as specified above in subparagraph c.

(1) Full depth cracks present, original joint not opened. When the original un-cracked joint has not opened, the crack 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 inches (19 mm), ±1/16 inch (2 mm), and to a width of 5/8 inch (16 mm), ±1/8 inch (3 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 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 dowels, or tie bars are present along any edges, these edges shall be sawed full depth just beyond the end of the dowels or tie bars. These joints shall then be carefully sawed on the joint line to within one inch (25 mm) of the depth of the dowel or tie bar.

The main slab 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 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 to concrete to remain in place. The joint face below 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 one inch (25 mm) when tested in a horizontal direction with a 12-foot (3.7-m) straightedge.

No mechanical impact breakers, other than the above hand-held equipment shall be used for any removal of slabs. If underbreak between 1-1/2 and 4 inches (38 and 100 mm) deep occurs at any point along any edge, the area 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 or tie bars, or where they have been damaged, dowels

or tie bars of the size and spacing as specified for other joints in similar pavement 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 four (4) edges of the new slab shall contain dowels 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 one inch (25 mm) outside the spalled area and to a depth of at least 2 inch (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 m^3) in size, and mortar shall be used for the smaller ones. Any spall less than 0.1 cu. ft. (0.003 m^3) 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°F (60°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. If any spall would require over 25% of the length of any single joint to be repaired, the entire slab shall be removed and replaced. Repair of spalls as described in this section shall not be allowed if in the opinion of the Engineer the overall condition of the pavement indicates that such repair is unlikely to achieve an acceptable and durable finished pavement. No repair of spalls shall be allowed in any panel that demonstrates segregated aggregate with a significant absence of coarse aggregate in the upper one-eight (1/8th) inch of the pavement surface.

g. Diamond grinding of PCC surfaces. Diamond grinding of the hardened concrete with an approved diamond grinding machine should not be performed until the concrete is 14 days or more old and concrete has reached full minimum strength. When required, diamond grinding shall be accomplished by sawing with saw blades impregnated with industrial diamond abrasive. The saw blades shall be assembled in a cutting head mounted on a machine designed specifically for diamond grinding that will produce the required texture and smoothness level without damage to the pavement. The saw blades shall

be 1/8-inch (3-mm) wide and there shall be a minimum of 55 to 60 blades per 12 inches (300 mm) of cutting head width; the actual number of blades will be determined by the Contractor and depend on the hardness of the aggregate. Each machine shall be capable of cutting a path at least 3 feet (0.9 m) wide. Equipment that causes ravels, aggregate fractures, spalls or disturbance to the joints will not be permitted. The area corrected by diamond grinding the surface of the hardened concrete should not exceed 10% of the total area of any sublot. The depth of diamond grinding shall not exceed 1/2 inch (13 mm) and all areas in which diamond grinding has been performed will be subject to the final pavement thickness tolerances specified. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. All pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified above may require removing and replacing in conformance with paragraph 501-4.19.

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, the joint between the removal area and adjoining pavement to stay in place**, including dowels or tie bars,** shall first be cut full depth with a standard diamond-type concrete saw. 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**. 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 501-4.10g.** The joint face shall be sawed or otherwise trimmed so that there is no abrupt offset in any direction greater than 1/2 inches (12 mm) and no gradual offset greater than one inch (25 mm) when tested in a horizontal direction with a 12-foot (3.7-m) straightedge.

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.

(1) Spall repair. Spalls shall be repaired where indicated and where directed by the Engineer. Repair materials and procedures shall be as previously specified in subparagraph 501-4.19f.

(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 and 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 501-4.20b(2). 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 necessary to determine conformance with the requirements specified in this section, with the exception of coring for thickness determination, will be performed by the Engineer at no cost to the Contractor. 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). Testing organizations performing these tests shall be accredited in accordance with ASTM C1077. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for acceptance sampling and testing must be listed on the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the Engineer prior to start of construction.

Concrete shall be accepted for strength and thickness on a lot basis.

A lot shall consist of a day's production not to exceed 2,000 cubic yards **(12,000 square yards).**

a. Compressive 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 D3665. The concrete shall be sampled in accordance with ASTM C172.

(2) Testing. Two (2) specimens shall be made from each sample. Specimens shall be made in accordance with ASTM C31 and the compressive strength of each specimen shall be determined in accordance with ASTM C39. The compressive strength for each sublot shall be computed by averaging the results of the two test specimens representing that sublot.

(3) Curing. The Contractor shall provide adequate facilities for the initial curing of cylinders. During the 24 hours after molding, the temperature immediately adjacent to the specimens must be maintained in the range of 60° to 80°F (16°to 27°C), and loss of moisture from the specimens must be prevented. The specimens may be stored in tightly constructed wooden boxes, damp sand pits, temporary buildings at construction sites, under wet burlap in favorable weather or in heavyweight closed plastic bags, or use other suitable methods, provided the temperature and moisture loss requirements are met.

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 D3665. 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 C174.

(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, that is, n=5 or n=6.

d. Outliers. All individual **compressive** strength tests within a lot shall be checked for an outlier (test criterion) in accordance with ASTM E178, at a significance level of 5%. Outliers shall be discarded, and the percentage of material within specification limits (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 discussed in paragraph 501-5.2e:

(1) Compressive strength

(2) Thickness

(3) Smoothness

(4) Grade

(5) Edge slump

Compressive strength and thickness shall be evaluated for acceptance on a lot basis using the method of estimating PWL. Acceptance using PWL considers the variability (standard deviation) of the material and the testing procedures, as well as the average (mean) value of the test results to calculate the percentage of material that is above the lower specification tolerance limit (L).

Acceptance for **compressive** 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, notwithstanding previous plant acceptance, reject and require the Contractor to dispose of any batch of concrete mixture which is rendered unfit for use due to contamination, segregation, or improper slump. Such rejection may be based on only visual inspection. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the 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. Compressive strength. Acceptance of each lot of in-place pavement for **compressive** 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 PWL shall be determined in accordance with procedures specified in Section 110 of the General Provisions.

The lower specification tolerance limit (L) for **compressive** strength and thickness shall be:

Lower Specification Tolerance Limit (L)

Compressive Strength	**4,140 psi**
Thickness	Lot plan thickness in inches, - 0.50 in

e. Acceptance criteria.

(1) Compressive strength. If the PWL of the lot equals or exceeds 90%, 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%, 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, but not later than 48 hours after placement, the surface of each lot shall be tested in both longitudinal and transverse directions for smoothness to reveal all surface irregularities exceeding the tolerances specified. The Contractor shall furnish paving equipment and employ methods that produce a surface for each section of pavement having an average profile index meeting the requirements of paragraph 501-8.1c when evaluated with a profilograph; and the finished surface of the pavement shall not vary more than 1/4 inch (6mm) when evaluated with a 12-foot (3.7m) straightedge. When the surface smoothness exceeds specification tolerances which cannot be corrected by diamond grinding of the pavement, full depth removal and replacement of pavement shall be to the limit of the longitudinal placement. Corrections involving diamond grinding will be subject to the final pavement thickness tolerances specified.

(a) Transverse measurements. Transverse measurements will be taken for each lot placed. Transverse measurements will be taken perpendicular to the pavement centerline each 50 feet (15m) or more often as determined by the Engineer.

(i) Testing shall be continuous across all joints, starting with one-half the length of the straight edge at the edge of pavement section being tested and then moved ahead one-half the length of the straight edge for each successive measurement. Smoothness readings will not be made across grade changes or cross slope transitions; at these transition areas, the straightedge position shall be adjusted to measure surface smoothness and not design grade or cross slope transitions. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. Deviations on final pavement > 1/4 inch (6mm) in transverse direction shall be corrected with

diamond grinding per paragraph 501-4.19g or by removing and replacing full depth of pavement. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area and these areas shall be retested after grinding.

(ii) The joint between lots shall be tested separately to facilitate smoothness between lots. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface, with half the straightedge on one side of the joint and the other half of the straightedge on the other side of the joint. Measure the maximum gap between the straightedge and the pavement surface in the area between these two high points. One measurement shall be taken at the joint every 50 feet (15m) or more often if directed by the Engineer. Maximum gap on final pavement surface > 1/4 inch (6mm) in transverse direction shall be corrected with diamond grinding per paragraph 501-4.19g or by removing and replacing full depth of surface. Each measurement shall be recorded and a copy of the data shall be furnished to the Engineer at the end of each days testing.

(b) Longitudinal measurements. Longitudinal measurements will be taken for each lot placed. Longitudinal tests will be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6m); and at the one third points of paving lanes when widths of paving lanes are 20 ft (6m) or greater.

(i) Longitudinal Short Sections. Longitudinal Short Sections are when the longitudinal lot length is less than 200 feet (60m) and areas not requiring a profilograph. When approved by the Engineer, the first and last 15 feet (4.5m) of the lot can also be considered as short sections for smoothness. The finished surface shall not vary more than 1/4 inch (6mm) when evaluated with a 12-foot (3.7m) straightedge. Smoothness readings will not be made across grade changes or cross slope transitions, at these transition areas, the straightedge position shall be adjusted to measure surface smoothness and not design grade or cross slope transitions. Testing shall be continuous across all joints, starting with one-half the length of the straight edge at the edge of pavement section being tested and then moved ahead one-half the length of the straight edge for each successive measurement. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. Deviations on final pavement surface > 1/4 inch (6mm) in longitudinal direction will be corrected with diamond grinding per paragraph 501-4.19g or by removing and replacing full depth of surface. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area and these areas shall be retested after grinding.

(ii) Profilograph Testing. Profilograph testing shall be performed by the contractor using approved equipment and procedures as described as ASTM E1274. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate “must grind” bumps and the Profile Index for the pavement using a 0.2 inch (5 mm) blanking band. The bump template must span one inch (25 mm) with an offset of 0.4 inches (10 mm). The profilograph must be calibrated prior to use and operated by a factory or State DOT approved operator. Profilograms shall be recorded on a longitudinal scale of one inch (25 mm) equals 25 feet (7.5 m) and a vertical scale of one inch (25 mm) equals one inch (25 mm). A copy of the reduced tapes shall be furnished to the Engineer at the end of each days testing.

The pavement must have an average profile index meeting the requirements of paragraph 501-8.1c. Deviations on final surface in longitudinal direction shall be corrected with diamond grinding per paragraph 501-4.19g or by removing and replacing full depth of pavement. Grinding will be tapered in all

directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area and these areas shall be retested after grinding.

Where corrections are necessary, second profilograph runs shall be performed to verify that the corrections produced an average profile index of 15 inches (38 cm) per mile or less. If the initial average profile index was less than 15 inches (38 cm), only those areas representing greater than 0.4 inch (10 mm) deviation will be re-profiled for correction verification.

(iii) Final profilograph of **runway**. Final profilograph, full length of runway, shall be performed to facilitate testing of smoothness between lots. Profilograph testing shall be performed by the contractor using approved equipment and procedures as described as ASTM E1274. The pavement must have an average profile index meeting the requirements of paragraph 501-8.1c. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate "must grind" bumps and the Profile Index for the pavement using a 0.2 inch (5 mm) blanking band. The bump template must span one inch (25 mm) with an offset of 0.4 inches (10 mm). The profilograph must be calibrated prior to use and operated by a factory or State DOT approved, trained operator. Profilograms shall be recorded on a longitudinal scale of one inch (25 mm) equals 25 feet (7.5 m) and a vertical scale of one inch (25 mm) equals one inch (25 mm). A copy of the reduced tapes shall be furnished to the Engineer at the end of each days testing. Profilograph of final runway shall be performed one foot right and left of runway centerline and 15 feet right and left of centerline. Any areas that indicate "must grind" will be corrected as directed by the Engineer.

Smoothness testing indicated in the above paragraphs except paragraph (iii) shall be performed within 48 hours of placement of material. Smoothness texting indicated in paragraph (iii) shall be performed within 48 hours final paving completion. The primary purpose of smoothness testing is to identify areas that may be prone to ponding of water which could lead to hydroplaning of aircraft. If the contractor's machines and/or methods are producing significant areas that need corrective actions then production should be stopped until corrective measures can be implemented. If corrective measures are not implemented and when directed by the Engineer, production shall be stopped until corrective measures can be implemented.

(4) Grade. An evaluation of the surface grade shall be made by the Engineer for compliance to the tolerances contained below. The finish grade will be determined by running levels at intervals of 50 feet (15 m) or less longitudinally and all breaks in grade transversely (not to exceed 50 feet (15 m)) to determine the elevation of the completed pavement. The Contractor shall pay the costs of surveying the level runs, and this work shall be performed by a licensed surveyor. The documentation, stamped and signed by a licensed surveyor, shall be provided by the Contractor to the Engineer.

(a) Lateral deviation. Lateral deviation from established alignment of the pavement edge shall not exceed ±0.10 feet (3 mm) in any lane.

(b) Vertical deviation. Vertical deviation from established grade shall not exceed ±0.04 feet (12 mm) at any point.

(5) Edge slump. 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 as directed by the Engineer in accordance with paragraph 501-4.8a.

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 501-4.20.

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. 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 C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

(2) Moisture content. If an electric moisture meter is used, at least two direct measurements of moisture content 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 C70 or ASTM C566.

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 C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

(2) Moisture content. If an electric moisture meter is used, at least two direct measurements of moisture content 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 C566.

c. Slump. Four slump tests shall be performed for each lot of material produced in accordance with the lot size defined in paragraph 501-5.1. One test shall be made for each sublot. Slump tests shall be performed in accordance with ASTM C143 from material randomly sampled from material discharged from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

d. Air content. Four air content tests shall be performed for each lot of material produced in accordance with the lot size defined in paragraph 501-5.1. One test shall be made for each sublot. Air content tests shall be performed in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag or other porous coarse aggregate, from material randomly sampled from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

e. Four unit weight and yield tests shall be made in accordance with ASTM C138. The samples shall be taken in accordance with ASTM C172 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, moisture content 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 the Lower Specification Tolerance Limit (L) table above and the Control Chart Limits table below 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 (that is, difference between highest and lowest measurements) for slump and air content in accordance with the following Action and Suspension Limits.

Control Chart Limits

Control Parameter	Individual Measurements		Range Suspension Limit
	Action Limit	Suspension Limit	
Slip Form:			
Slump	+0 to -1 inch (0-25 mm)	+0.5 to -1.5 inch (13-38 mm)	±1.5 inch (38 mm)
Air Content	±1.2%	±1.8%	±2.5%
Side Form:			
Slump	+0.5 to -1 inch (13-25 mm)	+1 to -1.5 inch (25-38 mm)	±1.5 inch (38 mm)
Air Content	±1.2%	±1.8%	±2.5%

The individual measurement control charts 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 specification limits in paragraph 501-2.1, 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%, the scale settings for the aggregate batcher 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 **square yards** of either plain or reinforced pavement as specified in-place, completed and accepted.

BASIS OF PAYMENT

501-8.1 Payment. Payment for concrete pavement meeting all acceptance criteria as specified in paragraph 501-5.2 Acceptance Criteria shall be based on results of **smoothness,** strength and thickness tests. Payment for acceptable lots of concrete pavement shall be adjusted in accordance with paragraph 501-8.1a for strength and thickness and 501-8.1c for smoothness, 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 **square yards** of concrete pavement used in the accepted work (See Note 1 under the Price Adjustment Schedule table below).

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.

a. Basis of adjusted payment. The pay factor for each individual lot shall be calculated in accordance with the Price Adjustment Schedule table below. A pay factor shall be calculated for both **compressive** strength and thickness. The lot pay factor shall be the higher of the two values when calculations for both **compressive** strength and thickness are 100% or higher. The lot pay factor shall be the product of the two values when only one of the calculations for either **compressive** strength or thickness is 100% or higher. The lot pay factor shall be the lower of the two values when calculations for both **compressive** strength and thickness are less than 100%.

Price Adjustment Schedule[1]

Percentage of Materials Within Specification Limits (PWL)	Lot Pay Factor (Percent of Contract Unit Price)
96 – 100	106
90 – 95	PWL + 10
75 – 90	0.5 PWL + 55
55 – 74	1.4 PWL – 12
Below 55	Reject[2]

[1] Although it is theoretically possible to achieve a pay factor of 106% for each lot, actual payment in excess of 100% 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 have reasons to decide to allow the rejected lot to remain. In that case, the Engineer will consult and get concurrence from the FAA ADO, as stated in Section 50-02, to enter into a written agreement with the Contractor. This written agreement shall include the reasoning why the lot shall not be removed and that it shall be paid for at*

50% 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% 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%.

b. Payment. Payment shall be made under:

P.C.C. Pavement (6") **-- per square yard**

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:

(Square yard in section) × (original unit price per square yard) × PFm = reduction in payment for area within section

Average Profile Index (Inches Per Mile) Pavement Strength Rating			**Contract Unit Price Adjustment (PFm)**
Over 30,000 lb	**30,000 lb or Less**	**Short Sections**	
0 - 7	0 - 10	0 - 15	0.00
7.1 - 9	10.1 - 11	15.1 - 16	0.02
9.1 - 11	11.1 - 12	16.1 - 17	0.04
11.1 - 13	12.1 - 13	17.1 - 18	0.06
13.1 - 14	13.1 - 14	18.1 - 20	0.08
14.1 - 15	14.1 - 15	20.1 - 22	0.10
15.1 and up	15.1 and up	22.1 and up	Corrective work required

TESTING REQUIREMENTS

ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C70	Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Standard Test Method for Materials Finer Than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates

ASTM C138 Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142 Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143 Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C172 Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C174 Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C227 Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
ASTM C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C289 Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
ASTM C295 Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C114 Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C311 Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland Cement Concrete
ASTM C566 Standard Test Method for Total Evaporable Moisture Content of Aggregates by Drying
ASTM C642 Standard Test Method for Density, Absorption, and Voids in Hardened Concrete
ASTM C666 Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C1077 Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1260 Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567 Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602 Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D3665 Standard Practice for Random Sampling of Construction Materials
ASTM D4791 Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM E178 Standard Practice for Dealing With Outlying Observations
ASTM E1274 Standard Test Method for Measuring Pavement Roughness Using a Profilograph
U.S. Army Corps of Engineers (USACE) Concrete Research Division (CRD) C662 Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method)

MATERIAL REQUIREMENTS

ASTM A184 Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A704 Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement

ASTM A706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A714	Standard Specification for High-Strength Low-Alloy Welded and Seamless Steel Pipe
ASTM A775	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A934	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A996	Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1078	Standard Specification for Epoxy-Coated Steel Dowels for Concrete Pavement
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving And Structural Construction
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting
ACI 309R	Guide for Consolidation of Concrete
AC 150/5320-6	Airport Pavement Design and Evaluation
PCA	Design and Control of Concrete Mixtures

END ITEM P-501

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SECTION 26

ITEM L-108

UNDERGROUND POWER CABLE FOR AIRPORTS

DESCRIPTION

108-1.1 This item shall consist of furnishing and installing power cables that are direct buried and furnishing and/or installing power cables within conduit or duct banks per 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 cable for FAA owned/operated facilities. Requirements and payment for trenching and backfilling for the installation of underground conduit and duct banks is in Item L-110, Airport Underground Electrical Duct Banks and Conduits.

EQUIPMENT AND MATERIALS

108-2.1 General.

a. Airport lighting equipment and materials covered by advisory circulars (AC) shall be approved under the Airport Lighting Equipment Certification Program per 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 requested by the Engineer.

c. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the Engineer) and replaced with materials that comply with these specifications at the Contractor's cost.

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 products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

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 submitted to the Engineer in PDF format.** The Engineer reserves the right to reject any and all equipment, materials, or procedures that do not meet the system design and the standards and codes, specified in this document.

f. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for at least **twelve (12) months** from the date of 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 a minimum insulation resistance per AC 150/5340-26B, Maintenance Airport Visual aid Facilities, Table 5-1 and paragraph 5.1.3.1, 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 latest edition. Conductors for use on 6.6 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #8 American wire gauge AWG), L-824 **Type C**, 5,000 volts, nonshielded, with **cross-linked polyethylene insulation**. Conductors for use on 20 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #6 AWG, L-824 **Type C**, 5,000 volts, nonshielded, with **cross-linked polyethylene insulation**. L-824 conductors for use on the L-830 secondary of airfield lighting series circuits shall be sized in accordance with the manufacturer's recommendations. All other conductors shall comply with FAA and National Electric Code (NEC) requirements. 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 ***A-A-59544*** and shall be type THWN-2, 75°C. Conductors for parallel (voltage) circuits shall be sized and installed in accordance with NFPA-70, National Electrical Code.

Unless noted otherwise, all 600-volt and less non-airfield lighting conductor sizes are based on a 75°C, THWN-2, 600 volt insulation, copper conductors, not more than three single insulated conductors, in raceway, in free air. The conduit/duct sizes are based on the use of THWN-2, 600 volt insulated conductors. The Contractor shall make the necessary increase in conduit/duct sizes for other types of wire insulation. In no case shall the conduit/duct size be reduced. The minimum power circuit wire size shall be #12 AWG.

Conductor sizes may have been adjusted due to voltage drop or other engineering considerations. Equipment provided by the Contractor shall be capable of accepting the quantity and sizes of conductors shown in the Contract Documents. All conductors, pigtails, cable step-down adapters, cable step-up adapters, terminal blocks and splicing materials necessary to complete the cable termination/splice shall be considered incidental to the respective pay items provided.

Cable type, size, number of conductors, strand and service voltage shall be as specified in the Contract Document.

108-2.3 Bare copper wire (counterpoise, bare copper wire ground and ground rods). Wire for counterpoise or ground installations for airfield lighting systems shall be No. 6 AWG bare solid copper wire for counterpoise and/or No. 6 AWG insulated stranded for ground wire per ASTM B3 and ASTM B8, and shall be **bare copper wire** per ASTM B33. See AC 150/5340-30 for additional details about counterpoise and ground wire types and installation. For voltage powered circuits, the equipment ground conductor shall be minimum No. 6 AWG, 600V rated, Type XHHW insulated, green color, stranded copper equipment ground conductor.

Ground rods shall be **copper-clad steel** The ground rods shall be of the length and diameter specified on the plans, but in no case be less than **8 feet (2.4 m)** long and **5/8 inch (16 mm)** in diameter.

108-2.4 Cable connections. In-line connections or splices 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 3M™ Company, "Scotchcast" Kit No. 82-B, or as manufactured by Hysol® Corporation, "Hyseal Epoxy Splice" Kit No. E1135, or an approved equivalent, 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.

c. The factory-molded plug-in splice. Specification for L-823 Connectors, Factory-Molded to Individual Conductors, is acceptable.

d. The taped or heat-shrink 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 D4388 and the plastic tape should comply with Military Specification MIL-I-24391 or Commercial Item Description 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 that are 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 per 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 that a light base ground clamp connector shall be used for attachment to the light base. See AC 150/5340-30 for additional information about methods of attaching a ground to a galvanized light base. All exothermic connections shall be made per the manufacturer's recommendations and listings.

108-2.5 Splicer qualifications. Every airfield lighting cable splicer shall be qualified in making airport cable splices and terminations on cables rated at or above 5,000 volts AC. The Contractor shall submit to the Engineer proof of the qualifications of each proposed cable splicer for the airport 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 be per 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 –Scotch™ 88 (1-1/2 inch (38 mm) wide) and Scotch™ 130C® linerless rubber splicing tape (2-inch (50 mm) wide), as manufactured by the Minnesota Mining and Manufacturing Company (3M™), or an approved equivalent.

108-2.10 Electrical coating. Electrical coating shall be Scotchkote™ as manufactured by 3M™, or an 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 per this item and prior to any activity that will affect 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 Detectable warning tape. Plastic, detectable, American Wood Preservers Association (AWPA) Red (electrical power lines, cables, conduit and lighting cable) with continuous legend magnetic tape shall be polyethylene film with a metalized foil core and shall be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item.

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 (1 m) of cable slack on each side of all connections, isolation transformers, light units, and at points where cable is connected to field equipment. Where provisions must be made for testing or for future above grade connections, provide enough slack to allow the cable to be extended at least one foot (30 cm) vertically above the top of the access structure. This requirement also applies where primary cable passes through empty light bases, junction boxes, and access structures to allow for future connections, or as designated by the Engineer.

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, hand holes, 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 1/4 inch (6 mm) in size. The cable circuit identification shall match the circuits noted on the construction plans.

108-3.2 Installation in duct banks or conduits. This item includes the installation of the cable in duct banks or conduit per the following paragraphs. 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 per the latest version of the 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 that any potential interference is avoided.

Duct banks or conduits shall be installed as a separate item per Item L-110, Airport Underground Electrical Duct Banks and Conduit. The Contractor shall run a mandrel through duct banks or conduit prior to installation of cable to ensure that the duct bank or conduit is open, continuous and clear of debris. The mandrel size shall be compatible with the conduit size. The Contractor shall swab out all conduits/ducts and clean light bases, manholes, etc., interiors immediately prior to pulling cable. Once cleaned and swabbed, the light bases and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, light bases, 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 re-cleaned at the Contractor's expense. 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 that prevents harmful stretching of the conductor, damage 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 not exceed the cable manufacturer's recommendations. A non-hardening cable-pulling lubricant recommended for the type of cable being installed shall be used where required.

The Contractor shall submit the recommended 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 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 inches (75 mm) vertical displacement shall be provided with the topmost cable depth at or below the minimum required depth below finished grade.

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 inches (0.5 m) below finished grade per NEC Table 300.5, except as follows:

(1) When off the airport or crossing under a roadway or driveway, the minimum depth shall be 36 inches (91 cm) unless otherwise specified.

(2) Minimum cable depth when crossing under a railroad track, shall be 42 inches (1 m) unless otherwise specified.

Dewatering necessary for cable installation, erosion and turbidity control, per 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 inches (150 mm). 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 inches (75 mm) 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 inch (6 mm) 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 ensure 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 inches (75 mm) deep, loose measurement, and shall be either earth or sand containing no mineral aggregate particles that would be retained on a 1/4 inch (6 mm) sieve. This layer shall not be compacted. The second layer shall be 5 inches (125 mm) deep, loose measurement, and shall contain no particles that would be retained on a one inch (25 mm) sieve. The remaining third and subsequent layers of backfill shall not exceed 8 inches (20 cm) of loose measurement and be excavated or imported material and shall not contain stone or aggregate larger than 4 inches (100 mm) 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.

If the cable is to be installed in locations or areas where other compaction requirements are specified (under pavements, embankments, etc.) the compaction requirements per Item P-152 for that area shall be followed.

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 per 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 inches (150 mm) above the direct-buried cable or the counterpoise wire if present. A 4-6 inch (100 - 150 mm) 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 inch (200 mm) minimum below finished grade.

c. Restoration. Following restoration of all trenching near airport movement surfaces, the Contractor shall visually inspect the area for foreign object debris (FOD) and remove any that is found. 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 **seeding and mulching** as shown on the plans. 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. 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 inch (10 - 15 cm) thick, extending approximately

one inch (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 (61 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 inches (100 mm) high and 3 inches (75 mm) wide, with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep.

At the location of each underground cable connection, except at lighting units, or isolation transformers, or power a concrete marker slab must mark adapters 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. After placement, all cable or splice markers shall be given one coat of high-visibility aviation orange paint as approved by the Engineer. 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 per the manufacturer's instructions and to the satisfaction of the Engineer.

b. Field-attached plug-in splices. These shall be assembled per the 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 inches (38 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 inches (38 mm) on each side of the joint.

d. Taped or heat-shrink 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 inch (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 inches (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 one inch (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.

Surfaces of equipment or conductors being terminated or connected shall be prepared in accordance with industry standard practice and manufacturer's recommendations. All surfaces to be connected shall be thoroughly cleaned to remove all dirt, grease, oxides, nonconductive films, or other foreign material. Paints and other nonconductive coatings shall be removed to expose base metal. Clean all surfaces at least 1/4 inch (6.4 mm) beyond all sides of the larger bonded area on all mating surfaces. Use a joint compound suitable for the materials used in the connection. Repair painted/coated surface to original condition after completing the connection.

108-3.6 Bare counterpoise wire installation for lightning protection and grounding. If shown on the plans or included in the job specifications, bare solid **#6 AWG** copper counterpoise wire shall be installed for lightning protection of the underground cables. The Engineer shall select one of two methods of lightning protection for the airfield lighting circuit based on the frequency of local lightning:

a. Equipotential. – may be used by the Engineer for areas that have high rates of lightning strikes. This is where the counterpoise is bonded to the light base (edge lights included) and counterpoise size is determined by the Engineer.

b. Isolation. – used in areas where lightning strikes are not common. The counterpoise is not bonded to edge light fixtures, in-pavement fixtures are boned to the counterpoise. Counterpoise size is selected by the Engineer.

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.

For raceways installed under pavement; for raceways and cables not installed adjacent to the full strength pavement edge; for fixtures installed in full strength pavement and shoulder pavement and for optional method of edge lights installed in turf (stabilized soils); and for raceways or cables adjacent to the full strength pavement edge, the counterpoise conductor shall be centered over the raceway or cable to be protected as described below.

The counterpoise conductor shall be installed no less than 8 inches (203 mm) above the raceway or cable to be protected, except as permitted below.

The minimum counterpoise conductor height above the raceway or cable to be protected shall be permitted to be adjusted subject to coordination with the airfield lighting and pavement designs.

Where raceway is installed by the directional bore, jack and bore, or other drilling method, the counterpoise conductor shall be permitted to be installed concurrently with the directional bore, jack and bore, or other drilling method raceway, external to the raceway or sleeve.

The counterpoise conductor shall be installed no more than 12 inches (305 mm) above the raceway or cable to be protected.

The counterpoise conductor height above the protected raceway(s) or cable(s) shall be calculated to ensure that the raceway or cable is within a 45-degree area of protection.

The counterpoise conductor shall be bonded to each metallic light base, mounting stake, and metallic airfield lighting component.

All metallic airfield lighting components in the field circuit on the output side of the constant current regulator (CCR) or other power source shall be bonded to the airfield lighting counterpoise system.

The counterpoise wire shall also be exothermically welded to ground rods installed as shown on the plans but not more than 500 feet (150 m) apart around the entire circuit. The counterpoise system shall be continuous and terminate at the transformer vault or at 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:

c. A ground rod installed at and securely attached to each light fixture base, mounting stake, and to all metal surfaces at junction/access structures via #6 AWG wire.

d. For parallel voltage systems only, install a #6 AWG green insulated equipment ground conductor internal to the conduit system and securely attached it to each light fixture base internal grounding lug and to all metal surfaces at junction/access structures. Dedicated ground rods shall be installed and exothermically welded to the counterpoise wires at each end of a duct bank crossing under pavement.

Where an existing airfield lighting system is being extended or modified, the new counterpoise conductors shall be interconnected to existing counterpoise conductors at each intersection of the new and existing airfield lighting counterpoise systems.

108-3.7 Counterpoise 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 area 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 22-1/2 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.

108-3.8 Counterpoise 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.

108-3.9 Exothermic bonding. Bonding of 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. Using an exothermic weld to bond the counterpoise to a lug on a galvanized light base is not recommended unless the base has been specially modified. Consult the manufacturer's installation directions for proper methods of bonding copper wire to the light base. See also AC 150/5340-30 for galvanized light base exception.

c. If called for in the plans, all buried copper and weld material at weld connections shall be thoroughly coated with 6 mm of 3M™ Scotchkote™, or approved equivalent, or coated with coal tar Bitumastic® material to prevent surface exposure to corrosive soil or moisture.

108-3.10 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. The Contractor must maintain the test results throughout the entire project as well as during the warranty period that meet the following:

a. 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.

b. 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:

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

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

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

f. That the insulation resistance to ground of all new non-grounded conductors of new multiple circuits or circuit segments is not less than 100 megohms.

g. That all affected circuits (existing and new) are properly connected per applicable wiring diagrams.

h. 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.

i. 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 American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81, to verify this requirement. As an alternate, clamp-on style ground impedance

test meters may be used to satisfy the impedance testing requirement. Test equipment and its calibration sheets shall be submitted for review and approval by the Engineer prior to performing the testing.

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.

METHOD OF MEASUREMENT

108-4.1 Cable or counterpoise wire installed in trench, duct bank or conduit shall be measured by the number of linear feet installed and grounding connectors, and trench marking tape ready for operation, and accepted as satisfactory. Separate measurement shall be made for each cable or counterpoise wire installed in trench, duct bank or conduit. The measurement for this item **shall** include additional quantities required for slack.

108-4.2 Ground rods shall not be measured.

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:

Install Cable in Duct (1/c, #8 AWG, 5kV, L-824C)	**-- Per Linear Foot**
Install Cable in Duct (1/c, #8 AWG, 600V, L-824C)	**-- Per Linear Foot**
Bare Counterpoise Wire (#6 AWG)	**-- Per Linear Foot**

(Rev. Per Add. No. 1)

MATERIAL REQUIREMENTS

AC 150/5340-26	Maintenance of Airport Visual Aid Facilities
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
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
AC 150/5345-53	Airport Lighting Equipment Certification Program
Commercial Item Description A-A-59544	Cable and Wire, Electrical (Power, Fixed Installation)

Commercial Item Description A-A-55809	
	Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic
ASTM B3	Standard Specification for Soft or Annealed Copper Wire
ASTM B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes
ASTM D4388	Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes
FED SPEC J-C-30	Cable and Wire, Electrical (Power, Fixed Installation)
MIL-I-24391	Insulation Tape, Electrical, Plastic, Pressure Sensitive

REFERENCE DOCUMENTS

NFPA-70	National Electrical Code (NEC)
NFPA-780	Standard for the Installation of Lightning Protection Systems
MIL-S-23586F	Performance Specification: Sealing Compound (with Accelerator), Silicone Rubber, Electrical
ANSI/IEEE STD 81	IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

END OF ITEM L-108

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SECTION 28

ITEM L-110

AIRPORT UNDERGROUND ELECTRICAL DUCT BANKS AND CONDUITS

DESCRIPTION

110-1.1 This item shall consist of underground electrical conduits and duct banks (single or multiple conduits encased in concrete or buried in sand) installed per this specification at the locations and per the dimensions, designs, and details shown on the plans. This item shall include furnishing and installing of all underground electrical duct banks and individual and multiple underground conduits. It shall also include all turfing trenching, backfilling, removal, and restoration of any paved or turfed areas; concrete encasement, mandrelling, pulling lines, duct markers, plugging of conduits, and the testing of the installation as a completed system ready for installation of cables per the plans and specifications. This item shall also include furnishing and installing conduits and all incidentals for providing positive drainage of the system. Verification of existing ducts is incidental to the pay items provided in this specification.

EQUIPMENT AND MATERIALS

110-2.1 General.

a. All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the Engineer.

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

c. 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 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 made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in project that accrue directly or indirectly from late submissions or resubmissions of submittals.

d. 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 submitted to the Engineer in PDF format.** The Engineer reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes specified in this document.

e. 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.

110-2.2 Steel conduit. Rigid galvanized steel (RGS) conduit and fittings shall be hot dipped galvanized inside and out and conform to the requirements of Underwriters Laboratories Standards 6, 514B, and 1242. All RGS conduits or RGS elbows installed below grade, in concrete, permanently wet locations or other similar environments shall be painted with a 10 mil thick coat of asphaltum sealer or shall have a factory bonded polyvinyl chloride (PVC) cover. Any exposed galvanizing or steel shall be coated with 10 mil of asphaltum sealer. When using PVC coated RGS conduit, care shall be exercised not to damage the factory PVC coating. Damaged PVC coating shall be repaired per the manufacturer's written instructions.

110-2.3 Plastic conduit. Plastic conduit and fittings-shall conform to the following requirements:

- UL 514B covers W-C-1094-Conduit fittings all types, classes 1 thru 3 and 6 thru 10.
- UL 514C covers W-C-1094- all types, Class 5 junction box and cover in plastic (PVC).
- UL 651 covers W-C-1094-Rigid PVC Conduit, types I and II, Class 4.
- UL 651A covers W-C-1094-Rigid PVC Conduit and high density polyethylene (HDPE) Conduit type III and Class 4.

Underwriters Laboratories Standards UL-651 and Article 352 of the current National Electrical Code shall be one of the following, as shown on the plans:

a. Type I–Schedule 40 PVC suitable for underground use either direct-buried or encased in concrete.

b. Type II–Schedule 40 PVC suitable for either above ground or underground use.

c. Type III – Schedule 80 PVC suitable for either above ground or underground use either direct-buried or encased in concrete.

d. Type III –HDPE pipe, meeting the requirements of ASTM D3035 minimum standard dimensional ratio (SDR) 11, suitable for placement with directional boring under pavement.

The type of solvent cement shall be as recommended by the conduit/fitting manufacturer.

110-2.4 Split conduit. Split conduit shall be pre-manufactured for the intended purpose and shall be made of steel or plastic.

110-2.5 Conduit spacers. Conduit spacers shall be prefabricated interlocking units manufactured for the intended purpose. They shall be of double wall construction made of high grade, high density polyethylene complete with interlocking cap and base pads, They shall be designed to accept No. 4 reinforcing bars installed vertically.

110-2.6 Concrete. Concrete shall conform to Item P-610, Structural Portland Cement Concrete, using **3/4** inch maximum size coarse aggregate with a minimum 28-day compressive strength of **4,000** psi. Where reinforced duct banks are specified, reinforcing steel shall conform to ASTM A615 Grade 60. Concrete and reinforcing steel are incidental to the respective pay item of which they are a component part.

110-2.7 Flowable backfill. Flowable material used to back fill conduit and duct bank trenches shall conform to the requirements of Item P-153, Controlled Low Strength Material. Fill shall be designed to achieve a 28-day compressive strength of 200 psi (1.4 MPa) under pavement.

110-2.8 Detectable warning tape. Plastic, detectable, American Wood Preservers Association (AWPA) Red (electrical power lines, cables, conduit and lighting cable) with continuous legend magnetic tape shall be polyethylene film with a metallized foil core and shall be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item.

CONSTRUCTION METHODS

110-3.1 General. The Contractor shall install underground duct banks and conduits at the approximate locations indicated on the plans. The Engineer shall indicate specific locations as the work progresses, if required to differ from the plans. Duct banks and conduits shall be of the size, material, and type indicated on the plans or specifications. Where no size is indicated on the plans or in the specifications, conduits shall be not less than 2 inches (50 mm) inside diameter or comply with the National Electrical Code based on cable to be installed, whichever is larger. All duct bank and conduit lines shall be laid so as to grade toward access points and duct or conduit ends for drainage. Unless shown otherwise on the plans, grades shall be at least 3 inches (75 mm) per 100 feet (30 m). On runs where it is not practicable to maintain the grade all one way, the duct bank and conduit lines shall be graded from the center in both directions toward access points or conduit ends, with a drain into the storm drainage system. Pockets or traps where moisture may accumulate shall be avoided. No duct bank or underground conduit shall be less than 18 inches (0.5 m) below finished grade. Where under pavement, the top of the duct bank shall not be less than 18 inches (0.5 m) below the subgrade.

The Contractor shall mandrel each individual conduit whether the conduit is direct-buried or part of a duct bank. An iron-shod mandrel, not more than 1/4 inch (6 mm) smaller than the bore of the conduit shall be pulled or pushed through each conduit. The mandrel shall have a leather or rubber gasket slightly larger than the conduit hole.

The Contractor shall swab out all conduits/ducts and clean base can, manhole, pull boxes, etc., interiors IMMEDIATELY prior to pulling cable. Once cleaned and swabbed the light bases, manholes, pull boxes, etc., 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.

For pulling the permanent wiring, each individual conduit, whether the conduit is direct-buried or part of a duct bank, shall be provided with a 200 pound (90 kg) test polypropylene pull rope. The ends shall be secured and sufficient length shall be left in access points to prevent it from slipping back into the conduit. Where spare conduits are installed, as indicated on the plans, the open ends shall be plugged with removable tapered plugs, designed for this purpose.

All conduits shall be securely fastened in place during construction and shall be plugged to prevent contaminants from entering the conduits. Any conduit section having a defective joint shall not be installed. Ducts shall be supported and spaced apart using approved spacers at intervals not to exceed 5 feet (1.5 m).

Unless otherwise shown on the plans, concrete encased duct banks shall be used when crossing under pavements expected to carry aircraft loads, such as runways, taxiways, taxilanes, ramps and aprons. When under paved shoulders and other paved areas, conduit and duct banks shall be encased using flowable fill for protection.

All conduits within concrete encasement of the duct banks shall terminate with female ends for ease in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored.

Trenches for conduits and duct banks may be excavated manually or with mechanical trenching equipment unless in pavement, in which case they shall be excavated with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. Blades of graders shall not be used to excavate the trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 inches (75 mm) below the required conduit or duct bank 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 inch (6 mm) sieve. Flowable backfill 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.

Underground electrical warning (Caution) tape shall be installed in the trench above all underground duct banks and conduits in unpaved areas. Contractor shall submit a sample of the proposed warning tape for approval by the Engineer. If not shown on the plans, the warning tape shall be located 6 inches above the duct/conduit or the counterpoise wire if present.

Joints in plastic conduit shall be prepared per the manufacturer's recommendations for the particular type of conduit. Plastic conduit shall be prepared by application of a plastic cleaner and brushing a plastic solvent on the outside of the conduit ends and on the inside of the couplings. The conduit fitting shall then be slipped together with a quick one-quarter turn twist to set the joint tightly. Where more than one conduit is placed in a single trench, or in duct banks, joints in the conduit shall be staggered a minimum of 2 feet (60 cm).

Changes in direction of runs exceeding 10 degrees, either vertical or horizontal, shall be accomplished using manufactured sweep bends.

Whether or not specifically indicated on the drawings, where the soil encountered at established duct bank grade is an unsuitable material, as determined by the Engineer, the unsuitable material shall be removed per Item P-152 and replaced with suitable material. Alternatively, additional duct bank supports that are adequate and stable shall be installed, as approved by the Engineer.

All excavation shall be unclassified and shall be considered incidental to the respective L-110 pay item of which it is a component part. Dewatering necessary for duct installation, erosion and turbidity control, per Federal, state, and local requirements is incidental to its respective pay item as a part of Item L-110. The cost of all excavation regardless of type of material encountered, shall be included in the unit price bid for the L-110 Item.

Unless otherwise specified, excavated materials that are deemed by the Engineer to be unsuitable for use in backfill or embankments shall be removed and disposed of offsite.

Any excess excavation shall be filled with suitable material approved by the Engineer and compacted per Item P-152.

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 ensure 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:

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

b. 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.

110-3.2 Duct banks. Unless otherwise shown in the plans, duct banks shall be installed so that the top of the concrete envelope is not less than 18 inches (0.5 m) below the bottom of the base or stabilized base course layers where installed under runways, taxiways, aprons, or other paved areas, and not less than 18 inches (0.5 m) below finished grade where installed in unpaved areas.

Unless otherwise shown on the plans, duct banks under paved areas shall extend at least 3 feet (1 m) beyond the edges of the pavement or 3 feet (1 m) beyond any under drains that may be installed alongside the paved area. Trenches for duct banks shall be opened the complete length before concrete is placed so that if any obstructions are encountered, provisions can be made to avoid them. Unless otherwise shown on the plans, all duct banks shall be placed on a layer of concrete not less than 3 inches (75 mm) thick prior to its initial set. The Contractor shall space the conduits not less than 3 inch (75 mm) apart (measured from outside wall to outside wall). All such multiple conduits shall be placed using conduit spacers applicable to the type of conduit. As the conduit laying progresses, concrete shall be placed around and on top of the conduits not less than 3 inches (75 mm) thick unless otherwise shown on the plans. All conduits shall terminate with female ends for ease of access in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

Conduits forming the duct bank shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth prior to placing the concrete encasement. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot (1.5-m) intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the Engineer for review prior to use.

When specified, the Contractor shall reinforce the bottom side and top of encasements with steel reinforcing mesh or fabric or other approved metal reinforcement. When directed, the Contractor shall supply additional supports where the ground is soft and boggy, where ducts cross under roadways, or where shown on the plans. Under such conditions, the complete duct structure shall be supported on reinforced concrete footings, piers, or piles located at approximately 5-foot (1.5-m) intervals.

All pavement surfaces that are to have ducts installed therein shall be neatly saw cut to form a vertical face. All excavation shall be included in the contract with price for the duct.

Install a plastic, detectable, color as noted, 3 to 6 inches (75 to 150 mm) wide tape, 8 inches (200 mm) minimum below grade above all underground conduit or duct lines not installed under pavement. Utilize the 3-inch (75-mm) wide tape only for single conduit runs. Utilize the 6-inch (150-mm) wide tape for multiple conduits and duct banks. For duct banks equal to or greater than 24 inches (600 mm) in width, utilize more than one tape for sufficient coverage and identification of the duct bank as required.

When existing cables are to be placed in split duct, encased in concrete, the cable shall be carefully located and exposed by hand tools. Prior to being placed in duct, the Engineer shall be notified so that he may inspect the cable and determine that it is in good condition. Where required, split duct shall be installed as shown on the drawings or as required by the Engineer.

110-3.3 Conduits without concrete encasement. Trenches for single-conduit lines shall be not less than 6 inches (150 mm) nor more than 12 inches (300 mm) wide. The trench for 2 or more conduits installed at the same level shall be proportionately wider. Trench bottoms for conduits without concrete encasement shall be made to conform accurately to grade so as to provide uniform support for the conduit along its entire length. Installation of conduit by plowing method is acceptable.

Unless otherwise shown on the plans, a layer of fine earth material, at least 4 inches (100 mm) thick (loose measurement) shall be placed in the bottom of the trench as bedding for the conduit. The bedding material shall consist of soft dirt, sand or other fine fill, and it shall contain no particles that would be retained on a 1/4 inch (6 mm) sieve. The bedding material shall be tamped until firm. Flowable backfill may alternatively be used.

Unless otherwise shown on plans, conduits shall be installed so that the tops of all conduits within the Airport's secured area where trespassing is prohibited are at least 18 inches (0.5 m) below the finished grade. Conduits outside the Airport's secured area shall be installed so that the tops of the conduits are at least 24 inches (60 cm) below the finished grade per National Electric Code (NEC), Table 300.5.

When two or more individual conduits intended to carry conductors of equivalent voltage insulation rating are installed in the same trench without concrete encasement, they shall be spaced not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches (150 mm) apart in a vertical direction. Where two or more individual conduits intended to carry conductors of differing voltage insulation rating are installed in the same trench without concrete encasement, they shall be placed not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and lot less than 6 inches (150 mm) apart in a vertical direction.

Unless the plowing method is used, trenches shall be opened the complete length between normal termination points before conduit is installed so that if any unforeseen obstructions are encountered, proper provisions can be made to avoid them.

Conduits shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth while backfilling. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot (1.5-m) intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the Engineer for review prior to use.

110-3.4 Markers. The location of each end and of each change of direction of conduits and duct banks shall be marked by a concrete slab marker 2 feet (60 cm) square and 4 - 6 inches (100 - 150 mm) thick extending approximately one inch (25 mm) above the surface. The markers shall also be located directly above the ends of all conduits or duct banks, except where they terminate in a junction/access structure or building. Each cable or duct run from a line of lights and signs to the equipment vault must be marked at approximately every 200 feet (61 m) along the cable or duct run, with an additional marker at each change of direction of cable or duct run.

The Contractor shall impress the word "DUCT" or "CONDUIT" on each marker slab. Impression of letters shall be done in a manner, approved by the Engineer, for a neat, professional appearance. All letters and words must be neatly stenciled. After placement, all markers shall be given one coat of high-visibility orange paint, as approved by the Engineer. The Contractor shall also impress on the slab the

number and size of conduits beneath the marker along with all other necessary information as determined by the Engineer. The letters shall be 4 inches (100 mm) high and 3 inches (75 mm) wide with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep or as large as the available space permits. Furnishing and installation of duct markers is incidental to the respective duct pay item.

110-3.5 Backfilling for conduits. For conduits, 8 inches (200 mm) of sand, soft earth, or other fine fill (loose measurement) shall be placed around the conduits ducts and carefully tamped around and over them with hand tampers. The remaining trench shall then be backfilled and compacted per Item P-152 "Excavation and Embankment" except that material used for back fill shall be select material not larger than 4 inches (100 mm) in diameter.

Flowable backfill may alternatively be used.

Trenches shall not contain pools of water during back filling operations.

The trench shall be completely backfilled and tamped level with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of per instructions issued by the Engineer.

110-3.6 Backfilling for duct banks. After the concrete has cured, the remaining trench shall be backfilled and compacted per Item P-152 "Excavation and Embankment" except that the material used for backfill shall be select material not larger than 4 inches (100 mm) in diameter. In addition to the requirements of P-152, where duct banks are installed under pavement, one moisture/density test per lift shall be made for each 250 linear feet (76 m) of duct bank or one work period's construction, whichever is less.

Flowable backfill may alternatively be used.

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, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of per instructions issued by the Engineer.

110-3.7 Restoration. Where sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by the work shall be restored to its original condition. The restoration shall include **seeding and mulching** shown on the plans. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. All restoration shall be considered incidental to the respective L-110 pay item. Following restoration of all trenching near airport movement surfaces, the Contractor shall thoroughly visually inspect the area for foreign object debris (FOD), and remove any such FOD that is found. This FOD inspection and removal shall be considered incidental to the pay item of which it is a component part.

METHOD OF MEASUREMENT

110-4.1 Underground conduits and duct banks shall be measured by the linear feet of conduits and duct banks installed, including encasement, locator tape, trenching and backfill with designated material, and

for drain lines, the termination at the drainage structure, all measured in place, completed, and accepted. Separate measurement shall be made for the various types and sizes.

BASIS OF PAYMENT

110-5.1 Payment will be made at the contract unit price per linear foot for each type and size of conduit and duct bank completed and accepted, including trench and backfill with the designated material, and, for drain lines, the termination at the drainage structure. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item per the provisions and intent of the plans and specifications.

Payment will be made under:

1" Electrical Duct and Trench *(Rev. Per Add No. 1)*	**-- Per Linear Foot**
1-2" PVC, Schedule 40, Concrete Encased Electrical Duct	**-- Per Linear Foot**
2-2" PVC, Schedule 40, Concrete Encased Electrical Duct	**-- Per Linear Foot**
1-2" PVC, Schedule 80, Bore Duct Under Pavement	**-- Per Linear Foot**

MATERIAL REQUIREMENTS

Advisory Circular (AC) 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-53	Airport Lighting Equipment Certification Program
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m^3))
ASTM D2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
NFPA-70	National Electrical Code (NEC)
Underwriters Laboratories Standard 6	Electrical Rigid Metal Conduit - Steel
Underwriters Laboratories Standard 514B	Conduit, Tubing, and Cable Fittings
Underwriters Laboratories Standard 514C	Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
Underwriters Laboratories Standard 1242	Electrical Intermediate Metal Conduit Steel
Underwriters Laboratories Standard 651	Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
Underwriters Laboratories Standard 651A	Type EB and A Rigid PVC Conduit and HDPE Conduit

END OF ITEM L-110

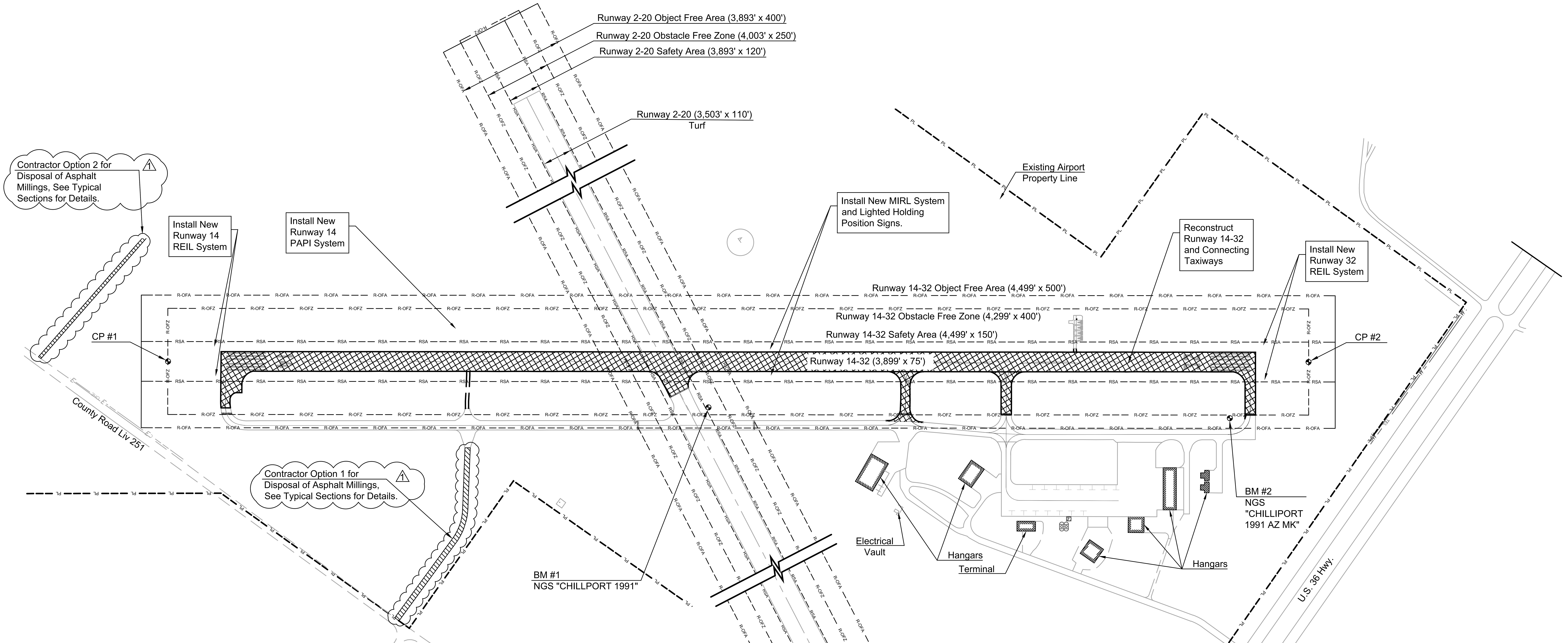
46	L-108	**Bare Counterpoise Wire (#6 AWG) (Revised Per Add. No. 1)**	12,500 L.F.				
47	L-109	Airfield Electrical Vault Modifications, Complete	1 L.S.				
48	L-109	Furnish and Install 4 kW CCR	1 Ea.				
49	L-109	Furnish and Install 7.5 kW CCR	1 Ea.				
50	L-110	**1" Electrical Duct and Trench (Revised Per Add. No. 1)**	12,620 L.F.				
51	L-110	1-2" PVC, Schedule 40, Concrete Encased Electrical Duct	295 L.F.				
52	L-110	2-2" PVC, Schedule 40, Concrete Encased Electrical Duct	192 L.F.				
53	L-110	1-2" PVC, Schedule 80, Bore Duct Under Pavement	135 L.F.				
54	L-115	L-867 Junction Box	10 Ea.				
55	L-125	Retroreflective Markers	24 Ea.				
56	L-125	M.I.R.L. (LED), Base Mounted (Red/Green Lens)	16 Ea.				
57	L-125	M.I.R.L. (LED), Base Mounted (Clear/Yellow Lens)	33 Ea.				
58	L-125	M.I.R.L. (LED), Base Mounted (Yellow/Yellow Lens)	2 Ea.				
59	L-125	M.I.T.L. (LED), Base Mounted (Blue Lens)	42 Ea.				
60	L-125	New 1 Module (LED) Lighted L-858R Sign (Size 1, Style 2)	2 Ea.				
61	L-125	New 2 Module (LED) Lighted L-858R Sign (Size 1, Style 2)	2 Ea.				
62	L-125	Furnish and Install REIL System	2 Ea.				
63	L-125	Furnish and Install 4-Box PAPI System	1 Ea.				
Total Bid							

ACKNOWLEDGEMENTS BY BIDDER

a. By submittal of a proposal, the BIDDER acknowledges and accepts that the quantities established by the OWNER are an approximate estimate of the quantities required to fully complete the Project and that the estimated quantities are principally intended to serve as a basis for evaluation of bids. The BIDDER further acknowledges and accepts that payment under this contract will be made only for actual quantities and that quantities will vary in accordance with the General Provisions subsection entitled "Alteration of Work and Quantities".

b. The BIDDER acknowledges and accepts that the Bid Documents are comprised of the documents identified within the General Provisions. The BIDDER further acknowledges that each the individual documents that comprise the Bid Documents are complementary to one another and together establishes the complete terms, conditions and obligations of the successful BIDDER.

c. As evidence of good faith in submitting this proposal, the undersigned encloses a bid guaranty in the form of a certified check, cashier's check or bid bond in the amount of 5% of the bid price. The BIDDER acknowledges and accepts that refusal or failure to accept award and execute a contract within the terms and conditions established herein will result in forfeiture of the bid guaranty to the owner as a liquidated damage.



GENERAL AIRPORT LAYOUT PLAN

GENERAL NOTES

1. The existing features shown on these Plans are those noted in the field and those taken from record drawings. This does not guarantee that all features are shown on the Plans. There will be no additional payment to the Contractor due to variations in size, quantity or location of existing features.

2. Extreme caution shall be used when working near existing light fixtures, underground electrical ducts, underground electrical cable and other existing airport fixtures. Should damage occur to any of these items, they will be replaced at the Contractor's expense to the satisfaction of the Engineer.

3. The Contractor shall be responsible for locating any underground utilities prior to beginning construction. See Safety Notes for additional information. The Contractor shall notify Missouri One Call at 1-800-DIG-RITE a minimum of 48 hours prior to any construction activities to allow One Call sufficient time to locate and mark any existing utilities the might be affected by this project. The Contractor shall contact Ms. Laurie Ratliff, FAA MKC SSC Manager at 816-329-2828, thirty (30) days prior to start of construction to allow the FAA to locate the Runway 32 PAPI power circuit. (Δ1)

4. Only rubber-tired vehicles under 60,000 lbs. GVWR will be allowed on airport pavement surfaces without prior Engineer Approval.

5. The Contractor shall be responsible for the restoration of the Contractor's storage area, access, and haul roads if damage has occurred due to construction activities. No direct payment will be made for these items. Seeding and Mulching shall be done in accordance with Items T-901: Seeding and T-908: Mulching, of the Project Specifications. All of the Contractors equipment shall be removed for the Air Operations Area prior to reopening the airport.

6. Asphalt millings resulting from existing pavement removal operations may be placed at locations on site and as directed by the Airport Manager in lieu of disposing off Airport property. Existing concrete pavement may be used for Recycled Concrete Aggregate Base Course, however, it must meet the material requirements of Specification Item P-219. All other waste materials resulting from this Project shall be disposed of off Airport Property unless shown otherwise on these plans. (Δ1)

7. The Contractor will be required to repair any damage to public and airport haul roads caused by the Contractor's trucks and equipment during the construction of the project. Repairs shall be adequate to return the roads to a condition equal to or better than the condition prior to damage. All repair work shall be at the Contractor's expense. The public roads (Airport Entrance Road, Airport Apron and Taxiway) shall be video recorded in the presence of the Engineer prior to construction in order to document their existing condition.

8. The Construction Safety & Phasing Plan (CSPP) drawings depict haul routes for access from surrounding public roadways and haul route through the airport perimeter fence. Contractor access and hauling operations are strictly limited to the haul routes shown.

9. The Contractor shall notify the Airport of any changes on the approved Safety and Phasing Plan at least 72 hours in advance of planned activity for approval and concurrence from the FAA.

10. The Contractor shall provide the Airport with the contact information of the Supervisor on site.

11. The Contractor has the option of installing temporary drainage structures for construction of temporary access drives during construction. Once construction is complete, the drives and drainage structures shall be removed and the area restored to it's original condition. This work shall be considered subsidiary to other bid items in the contract.

PROJECT DATUM

BM #1 National Geodetic Survey marker designation "CHILLPORT 1991" stainless steel rod in sleeve. Located 49 feet northeast of the taxiway and 36 feet east of the taxiway crossover.
N: 1439409.52, E: 1360390.41 Elev: 774.60

BM #2 National Geodetic Survey marker designation "CHILLPORT AZ MK 1991" stainless steel rod in sleeve.
N: 1437797.84, E: 1361515.36 Elev: 760.97

RUNWAY 14-32 ALIGNMENT

CP #1: Sta. 8+00.00
Set Iron Bar
N:1441157.48
E: 1359300.41

CP #2: Sta. 50+98.70
Set Iron Bar
N: 1437682.88
E: 1361861.43

200 0 200 400
Scale in Feet

Addendum 1

1. Added Optional Locations for Disposal of Asphalt Millings.
2. Revised General Note #3 to include Point of Contact for locating FAA Runway 32 PAPI Circuit.
3. Revised General Note #6 to include Option for Disposal of Asphalt Millings on Airport Property and for Utilizing the Existing Concrete Pavement as Recycled Concrete Aggregate Base.

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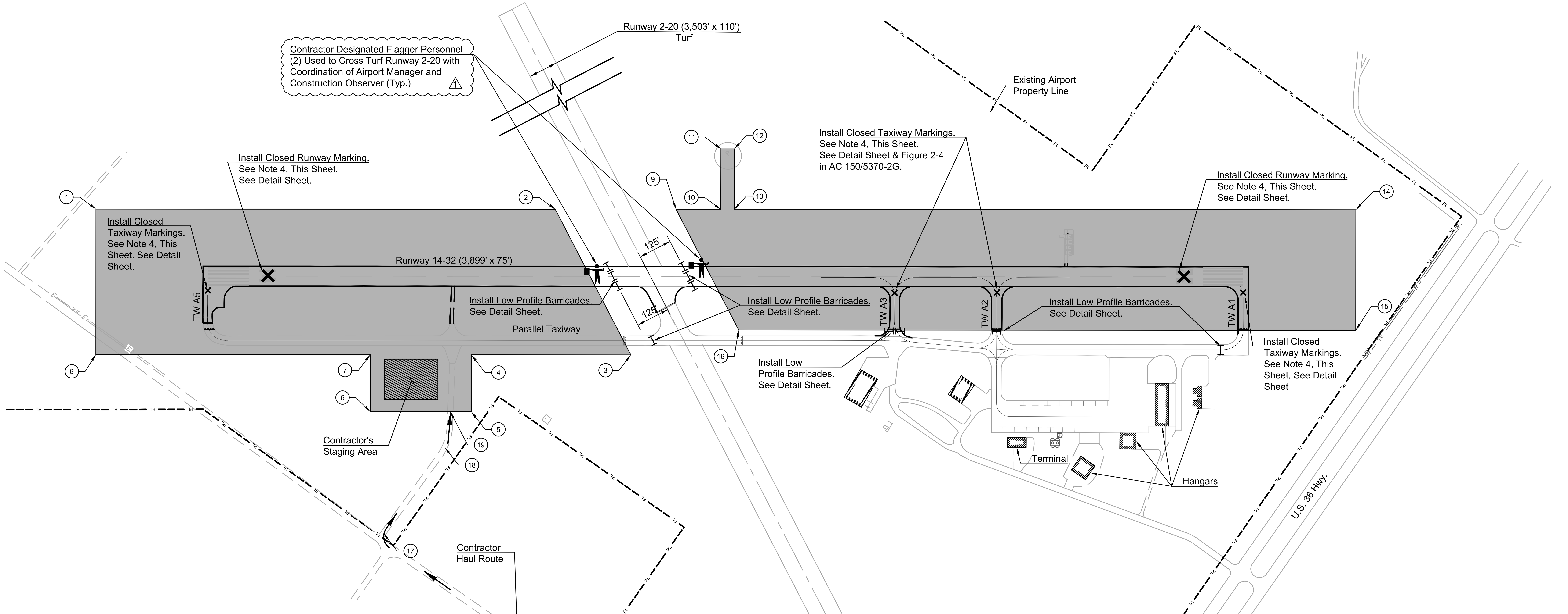
CITY OF CHILLICOTHE, MISSOURI
CHILLICOTHE MUNICIPAL AIRPORT
CHILLICOTHE, MISSOURI

PROJECT NO.	000012850
DRAWN BY BRE	DATE 2/26/2019
CHECKED BY RMD	DATE 3/7/2019
DESIGNED BY BRE	DATE 2/26/2019
REVISIONS Δ1 Addendum 1	6/11/2019

GENERAL AIRPORT LAYOUT PLAN

2

Drawing Name: I:\KAC\PRJ\000012850\PROJECT FILES\AE\CIVIL 3D PROJECT FOLDER\Production Drawings\12850 Title.dwg Jun 11,2019 - 12:01pm



CONSTRUCTION PHASE 1 (Total Project Time: 150 Calendar Days or Less)

1. Chillicothe Municipal Airport will be OPEN for 105 calendar days during Phase 1 Construction.
2. Runway 14-32 will be CLOSED during Phase 1 construction and Runway 2-20 shall remain OPEN except during Phase 2 construction. Contractor shall provide two (2) Flaggers when crossing Runway 2-20. Flaggers shall monitor Airport CTAF 122.8 at all times when vehicles are crossing Runway 2-20. A Power Broom will be on-site and available at all times to clear FOD from the runway intersection.
3. The Contractor shall implement the Safety Plan Compliance Document (SPCD) and prepare the Runway 14-32 for CLOSURE. See next sheet for Phase 2.
4. Closed Runway Markings shall be placed over each Runway Designation Number and Closed Taxiway Markings shall be placed on the taxiways prior to the start of construction. When construction activities interfere with the Closed Runway and Taxiway Markings, the Runway Markings shall be placed just off of each end of Runway 14-32 and the Taxiway Markings may be removed. Once Paving and/or Pavement Marking operations are completed, place Closed Runway Markings over Runway Designation Numbers and Taxiway Markings as indicated on this sheet until the opening of the Runway. Low Profile Barricades will be placed as shown on this plan.
5. The following construction work shall be completed.
   - Complete all pavement removal and demolition work.
   - Complete all grading and compaction.
   - Install underdrain system, drainage pipes, and end sections.
   - Complete all runway and taxiway paving operations including subgrade modification, base rock construction, and concrete paving.
   - Install MIRL, MITL, related cables, and conduit.
   - Install REILs, Runway 14 PAPI, related cables, and conduit.
   - Install Electrical Vault equipment.
   - Complete seeding, mulching, and erosion control to all disturbed areas during this phase.

Addendum 1

1. Revised Plan Note for the use of two (2) Flaggers.
2. Revised Construction Phasing Note No. 2 to include two (2) Flaggers and a Power Broom.

200 0 200 400
Scale in Feet

LEGEND

- Contractor Haul Route
- Contractor Staging Area
- Construction Limits
- Runway and Taxiway Closed Markings
- Low Profile Barricades
- Flagger Personnel

Construction Limits - Phase 1					
Point	Latitude	Longitude	Site Elev.	Object Ht.	Overall Elev.
1	N39° 47' 15.84"	W93° 29' 59.86"	759	15	774
2	N39° 47' 02.27"	W93° 29' 46.75"	778	15	793
3	N39° 46' 56.82"	W93° 29' 50.17"	776	15	791
4	N39° 47' 01.53"	W93° 29' 54.72"	780	15	795
5	N39° 47' 00.90"	W93° 29' 56.90"	778	15	793
6	N39° 47' 03.27"	W93° 29' 59.78"	770	15	785
7	N39° 47' 04.52"	W93° 29' 57.61"	779	15	794
8	N39° 47' 12.63"	W93° 30' 05.44"	750	15	765
9	N39° 46' 58.70"	W93° 29' 43.30"	774	15	789
10	N39° 46' 57.37"	W93° 29' 42.02"	772	15	787
11	N39° 46' 58.71"	W93° 29' 39.70"	768	15	783
12	N39° 46' 58.31"	W93° 29' 39.32"	768	15	783
13	N39° 46' 56.98"	W93° 29' 41.64"	772	15	787
14	N39° 46' 38.61"	W93° 29' 23.89"	751	15	766
15	N39° 46' 35.95"	W93° 29' 28.51"	758	15	773
16	N39° 46' 54.19"	W93° 29' 46.13"	773	15	788
17	N39° 47' 00.20"	W93° 30' 04.07"	761	15	776
18	N39° 47' 00.27"	W93° 29' 59.02"	774	15	789
19	N39° 47' 00.90"	W93° 29' 57.50"	776	15	791

Drawing Name: I:\KAC\PRJ\000012850\PROJECT FILES\AE\CIVIL 3D PROJECT FOLDER\Production Drawings\12850 Title.dwg Jun 07,2019 - 11:20am

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CITY OF CHILLICOTHE, MISSOURI
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PROJECT NO. 000012850
DRAWN BY BRE DATE 2/26/2019
CHECKED BY RMD DATE 3/7/2019
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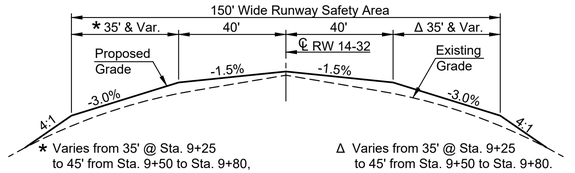
REVISIONS DATE
Addendum 1 6/11/2019

SAFETY PLAN - PHASE 1

SUMMARY OF QUANTITIES

ITEM NO.	SPEC	ITEM DESCRIPTION	UNIT	QUANTITY	
				ESTIMATED	AS-CONST.
1	MOB	Mobilization	L.S.	1	
2	TEMP	Temporary Marking, Lighting, & Barricades	L.S.	1	
3	P-101	Saw Cut	L.F.	362	
4	P-101	Pavement and Base Course Removal	S.Y.	36,578	
5	P-101	Pavement Marking Removal	S.F.	537	
6	P-101	Existing CMP Removal	L.F.	616	
7	P-101	Existing Lighting System and Signs Removal	L.S.	1	
8	P-101	Existing Underdrain System Removal	L.S.	1	
9	P-152	Unclassified Excavation	C.Y.	6,202	
10	P-152	Unsuitable Subgrade Removal and Replacement	C.Y.	500	
11	P-155	Lime-Treated Subgrade (12")	S.Y.	37,534	
12	P-156	Erosion Control Barrier (Silt Fence)	L.F.	1,970	
13	P-156	Erosion Control Barrier (Straw Wattle)	L.F.	140	
14	TREC	Erosion Control Blanket (Type 2C)	S.Y.	11,000	
15	PTM	Permanent Transition Mat	S.F.	288	
16	P-154	Unsuitable Subgrade Removal and Replacement with Rock Base	C.Y.	1,000	
17	P-208 P-209 P-219	Aggregate Base Course (6")	S.Y.	37,534	
18	P-154 P-208 P-209 P-219	Aggregate Subbase Course (6")	S.Y.	37,534	
19	P-501	P.C.C. Pavement (6")	S.Y.	36,520	
20	P-620	Permanent Reflectorized Pavement Marking (White)(Solid)	S.F.	13,550	
21	P-620	Permanent Reflectorized Pavement Marking (White)(Striated)	S.F.	1,274	
22	P-620	Permanent Reflectorized Pavement Marking (Yellow)	S.F.	1,425	
23	P-620	Permanent Non-Reflectorized Pavement Marking (Black)	S.F.	7,128	
24	P-620	Temporary Non-Reflectorized Pavement Marking (White)(Solid)	S.F.	3,200	
25	P-620	Temporary Non-Reflectorized Pavement Marking (White)(Striated)	S.F.	1,274	
26	P-620	Temporary Non-Reflectorized Pavement Marking (Yellow)	S.F.	1,425	
27	D-701	18" Pipe	L.F.	96	
28	D-701	24" Pipe	L.F.	88	
29	D-701	30" Pipe	L.F.	112	
30	D-701	18" RCP End Section	Ea.	2	
31	D-701	24" RCP End Section	Ea.	2	
32	D-701	30" RCP End Section	Ea.	2	
33	D-705	Conventional Underdrain (4") (Schedule 40)	L.F.	7,718	
34	D-705	Conventional Underdrain (4") (Schedule 80)	L.F.	117	
35	D-705	Non-Perforated Outlet Pipe (4") (Schedule 40)	L.F.	768	
36	D-705	Non-Perforated Outlet Pipe (4") (Schedule 80)	L.F.	456	
37	D-705	Underdrain Cleanout Riser	Ea.	25	
38	D-705	Splash Pad	Ea.	8	
39	D-705	Connect to Proposed Storm Pipe	Ea.	10	
40	T-901	Permanent Seeding	Ac.	12.6	
41	T-901	Temporary Seeding	Ac.	12.6	
42	T-905	Placement of Topsoil (Obtained on Site)	L.S.	1	
43	T-908	HydroMulch	Ac.	10.3	
44	L-108	Install Cable in Duct (1/c, #8 AWG, 5kV L-824C)	L.F.	16,520	
45	L-108	Install Cable in Duct (1/c, #6 AWG, 600V L-824C)	L.F.	2,775	
46	L-108	**Bare Counterpoise Wire (#6 AWG) (Revised Per Add. No. 1)**	L.F.	12,500	
47	L-109	Airfield Electrical Vault Modifications, Complete	L.S.	1	
48	L-109	Furnish and Install 4 kW CCR	Ea.	1	
49	L-109	Furnish and Install 7.5 kW CCR	Ea.	1	
50	L-110	**1" Electrical Duct and Trench (Revised Per Add. No. 1)**	L.F.	12,620	
51	L-110	1-2" PVC, Schedule 40, Concrete Encased Electrical Duct	L.F.	295	
52	L-110	2-2" PVC, Schedule 40, Concrete Encased Electrical Duct	L.F.	192	
53	L-110	1-2" PVC, Schedule 80, Bore Duct Under Pavement	L.F.	135	
54	L-115	L-867 Junction Box	Ea.	10	
55	L-125	Retroreflective Markers	Ea.	24	
56	L-125	M.I.R.L. (LED), Base Mounted (Red/Green Lens)	Ea.	16	
57	L-125	M.I.R.L. (LED), Base Mounted (Clear/Yellow Lens)	Ea.	33	
58	L-125	M.I.R.L. (LED), Base Mounted (Yellow/Yellow Lens)	Ea.	2	
59	L-125	M.I.T.L. (LED), Base Mounted (Blue Lens)	Ea.	42	
60	L-125	New 1 Module (LED) Lighted L-858R Sign (Size 1, Style 2)	Ea.	2	
61	L-125	New 2 Module (LED) Lighted L-858R Sign (Size 1, Style 2)	Ea.	2	
62	L-125	Furnish and Install REIL System	Ea.	2	
63	L-125	Furnish and Install 4-Box PAPI System	Ea.	1	



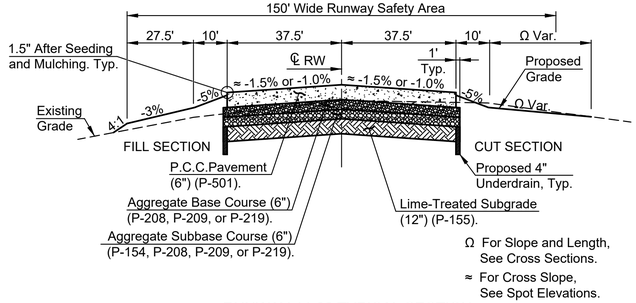
* Varies from 35' @ Sta. 9+25 to 45' from Sta. 9+50 to Sta. 9+80, then 35' @ Sta. 9+75.

* Varies from 35' @ Sta. 49+10 to 45' from Sta. 49+30 to Sta. 49+50, then 35' @ Sta. 49+75.

Δ Varies from 35' @ Sta. 9+25 to 45' from Sta. 9+50 to Sta. 9+80.

Δ Varies, 45' from Sta. 49+30 to 49+50, to 35' @ Sta. 49+75.

RUNWAY 14-32 SAFETY AREA TYPICAL SECTION
STA. 5+95.00 TO STA. 10+00
STA. 48+98.70 TO STA. 52+06.00
NO SCALE

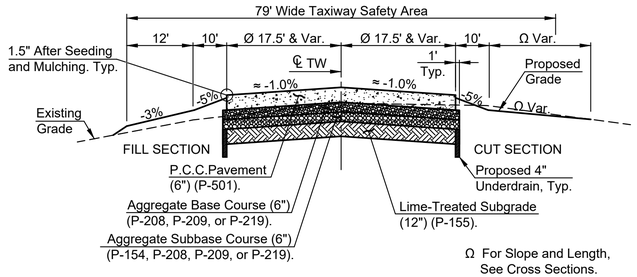


Ω For Slope and Length, See Cross Sections.

≈ For Cross Slope, See Spot Elevations.

RUNWAY 14-32 TYPICAL SECTION
STA. 10+00 TO STA. 48+98.70

RUNWAY 2-20 TYPICAL SECTION
STA. 51+20 TO STA. 52+07.75
NO SCALE

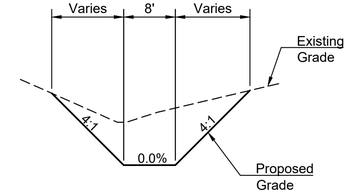


Ω For Slope and Length, See Cross Sections.

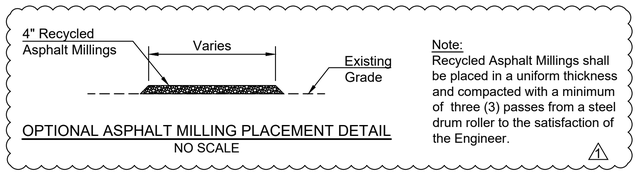
≈ For Cross Slope, See Spot Elevations.

Ø For Fillet Locations and Dimensions, See Joint Plan.

TAXIWAY TYPICAL SECTION
TW A5, STA. 10+25 TO STA. 11+62.50
TW A3, STA. 20+05 TO STA. 21+92.50
TW A2, STA. 30+00 TO STA. 31+62.50
TW A1, STA. 40+00 TO STA. 41+62.50
NO SCALE



INFIELD DITCH TYPICAL SECTION
NO SCALE



OPTIONAL ASPHALT MILLING PLACEMENT DETAIL
NO SCALE

Note:
Recycled Asphalt Millings shall be placed in a uniform thickness and compacted with a minimum of three (3) passes from a steel drum roller to the satisfaction of the Engineer. 1

EARTHWORK

AREA	ON-SITE EXCAVATION * CU. YDS. (1)		COMPACTED EMBANKMENT CU. YDS. (2)	
	UNCLASSIFIED EXCAVATION	REVISED	COMMON	REVISED
Runway 14-32 Grading Limits	6,202		4,729	
Excess Material	0		1,473 (3)	
Total	6,202		6,202	

1. The quantities for Unclassified Excavation were calculated based on the volume of material required between the existing surface with pavement and base removed and proposed datum surfaces.
2. No shrinkage allowance is included in this quantity.
3. Any excess excavation material shall be wasted on site as directed by the Engineer.

Addendum 1
1. Revised Bid Item #46 to "Bare Counterpoise Wire (#6 AWG)".
2. Revised Bid Item #50 to "1" Electrical Duct and Trench".
3. Added Optional Asphalt Milling Placement Detail.

STATE OF MISSOURI
MATTHEW R. MYERS
NUMBER PE-2002025585
6/11/19
PROFESSIONAL ENGINEER

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CITY OF CHILLICOTHE, MISSOURI
CHILLICOTHE MUNICIPAL AIRPORT
CHILLICOTHE, MISSOURI

PROJECT NO. 000012850
DRAWN BY BRE DATE 2/26/2019
CHECKED BY RMD DATE 3/7/2019
DESIGNED BY BRE DATE 2/26/2019
REVISIONS
1 Addendum 1 6/11/2019

SUMMARY OF QUANTITIES & TYPICAL SECTIONS

7

Sta. 10+00
1. Point Not Set. N = 1440995.82,
E = 13594489.17

Sta 9+98, Runway 14-32 ℄, 38' Lt.
INSTALL Underdrain Cleanout Riser.
See Drainage Detail Sheet.

Sta. 10+00, Runway 14-32 ℄
End Runway Safety Area Grading.
Begin Runway Construction.
See Typical Sections, Pavement Joint Plan,
Spot Elevations, and Cross Sections.

Runway 14-32 ℄

INSTALL T-Fitting to
Proposed Underdrain.
Connection is Subsidiary to
Installation of Underdrains.

Sta. 13+50, Runway 14-32 ℄,
INSTALL 76 L.F. of 4" Non-Perforated
Outlet Pipe (Sch. 80)
See Drainage Detail Sheet.

Sta. 9+98 to Sta. 16+75, Runway 14-32 ℄,
INSTALL 677 L.F. of 4" Perforated Underdrain Lt.
See Drainage Detail Sheet.

Sta. 16+80 to Sta. 19+50, Runway 14-32 ℄,
INSTALL 270 L.F. of 4" Perforated Underdrain Lt.
See Drainage Detail Sheet.

Sta 16+75, Runway 14-32 ℄, 38' Lt.
INSTALL Underdrain Cleanout Riser.
See Drainage Detail Sheet.

Sta 16+80, Runway 14-32 ℄, 38' Lt.
INSTALL Underdrain Cleanout Riser.
See Drainage Detail Sheet.

5+75 6+00 7+00 8+00 9+00 10+00 11+00 12+00 13+00 14+00 15+00 16+00 17+00 18+00 19+00

37.5'
37.5'

MATCHLINE STA. 19+50, SEE NEXT SHEET

INSTALL Cross-Fitting to
Proposed Underdrain.
Connection is Subsidiary to
Installation of Underdrains.

Sta. 10+93 to Sta. 16+75, Runway 14-32 ℄,
INSTALL 582 L.F. of 4" Perforated Underdrain Rt.
See Drainage Detail Sheet.

See Taxiway A5
Plan and Profile
for Details.

Sta 10+93, Runway 14-32 ℄, 38' Rt.
INSTALL Underdrain Cleanout Riser.
See Drainage Detail Sheet.

Sta. 13+50, Runway 14-32 ℄,
INSTALL 84 L.F. of 4" Non-Perforated
Outlet Pipe (Sch. 40) with Splash Pad.
See Drainage Detail Sheet.

+50
125' Rt.

Sta 16+80, Runway 14-32 ℄, 38' Rt.
INSTALL Underdrain Cleanout Riser.
See Drainage Detail Sheet.

Sta 16+75, Runway 14-32 ℄, 38' Rt.
INSTALL Underdrain Cleanout Riser.
See Drainage Detail Sheet.

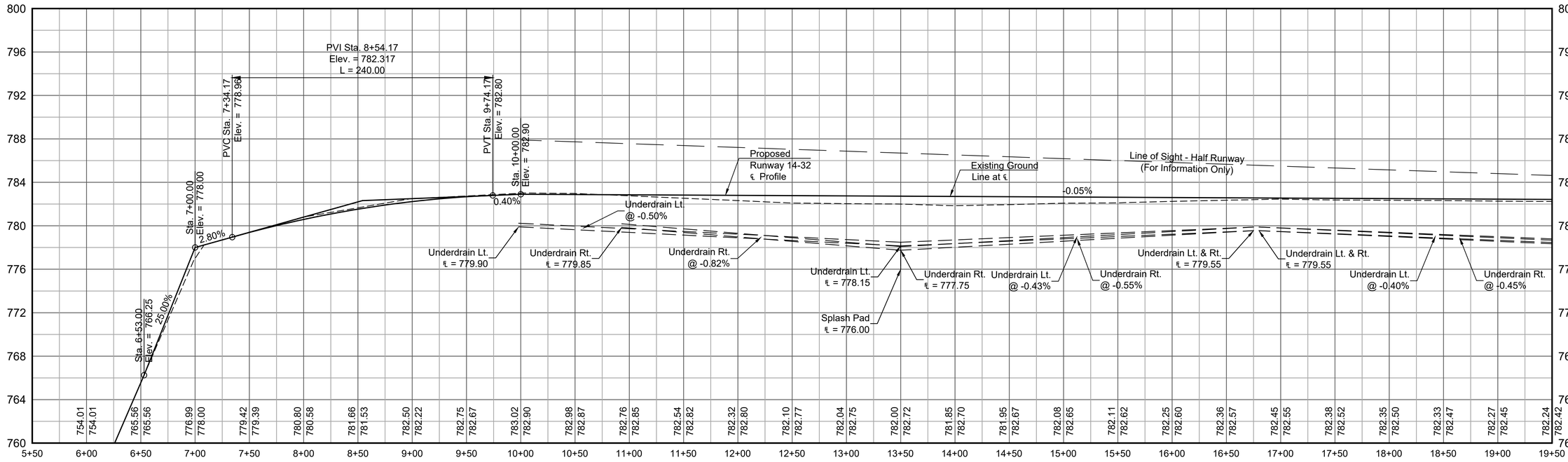
Sta. 16+80 to Sta. 19+50, Runway 14-32 ℄,
INSTALL 270 L.F. of 4" Perforated Underdrain Rt.
See Drainage Detail Sheet.

Existing Parallel Taxiway

HORIZ. 50 0 50 100
Scale in Feet

VERT. 5 0 5 10
Scale in Feet

Addendum 1
Added missing leader arrows
in Profile view.



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CITY OF CHILLICOTHE, MISSOURI

CHILLICOTHE MUNICIPAL AIRPORT
CHILLICOTHE, MISSOURI

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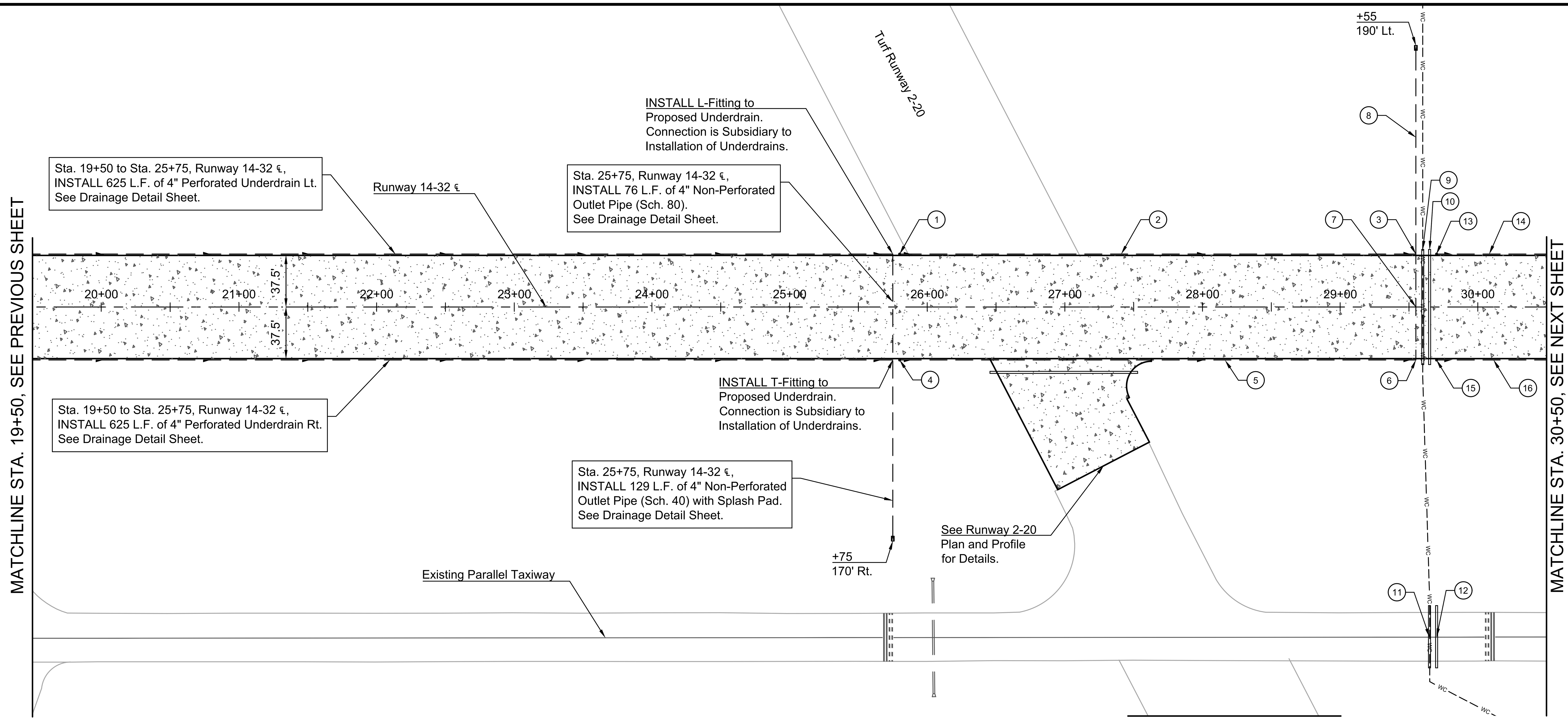
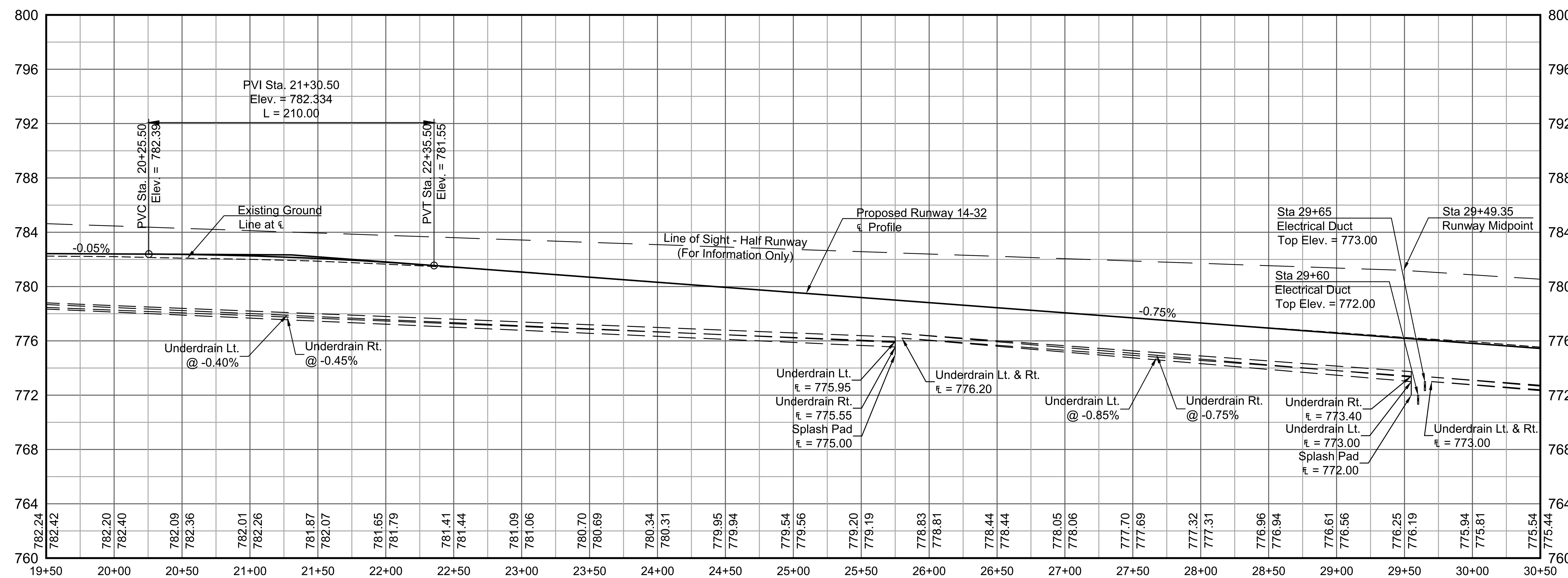
DATE	2/26/2019
REVISIONS	DATE
1 Addendum 1	6/11/2019

RUNWAY 14-32 PLAN & PROFILE

11

Drawing Name: I:\KAC\PRJ\000012850\PROJECT FILES\AE\CIVIL 3D PROJECT FOLDER\Production Drawings\RUNW 14-32 PNP - (1).dwg Jun 07,2019 - 11:20am





1. Sta 25+80, Runway 14-32 ℄, 38' Lt. INSTALL Underdrain Cleanout Riser. See Drainage Detail Sheet.
2. Sta. 25+80 to Sta. 29+55, Runway 14-32 ℄, INSTALL 375 L.F. of 4" Perforated Underdrain Lt. See Drainage Detail Sheet.
3. INSTALL T-Fitting to Proposed Underdrain. Connection is Subsidiary to Installation of Underdrains.
4. Sta 25+80, Runway 14-32 ℄, 38' Rt. INSTALL Underdrain Cleanout Riser. See Drainage Detail Sheet.
5. Sta. 25+80 to Sta. 29+55, Runway 14-32 ℄, INSTALL 375 L.F. of 4" Perforated Underdrain Rt. See Drainage Detail Sheet.
6. INSTALL L-Fitting to Proposed Underdrain. Connection is Subsidiary to Installation of Underdrains.
7. Sta. 29+55, Runway 14-32 ℄, INSTALL 76 L.F. of 4" Non-Perforated Outlet Pipe (Sch. 80). See Drainage Detail Sheet.
8. Sta. 29+55, Runway 14-32 ℄, INSTALL 149 L.F. of 4" Non-Perforated Outlet Pipe (Sch. 40) with Splash Pad. See Drainage Detail Sheet.
9. Sta 29+60, Runway 14-32 ℄, INSTALL 85 L.F of 1-2" PVC, Concrete Encased Electrical Duct. See Electrical Detail Sheet.
10. Sta 29+65, Runway 14-32 ℄, INSTALL 85 L.F of 1-2" PVC, Concrete Encased Electrical Duct. See Electrical Detail Sheet.
11. Sta 29+65, Runway 14-32 ℄, 240' Rt. INSTALL 45 L.F of 1-2" PVC (Sch. 80) Bore Duct Under Pavement, 2' Below Top of Pavement. See Electrical Detail Sheet.
12. Sta 29+70, Runway 14-32 ℄, 240' Rt. INSTALL 45 L.F of 1-2" PVC (Sch. 80) Bore Duct Under Pavement, 2' Below Top of Pavement. See Electrical Detail Sheet.
13. Sta 29+70, Runway 14-32 ℄, 38' Lt. INSTALL Underdrain Cleanout Riser. See Drainage Detail Sheet.
14. Sta. 29+70 to Sta. 30+50, Runway 14-32 ℄, INSTALL 80 L.F. of 4" Perforated Underdrain Lt. See Drainage Detail Sheet.
15. Sta 29+70, Runway 14-32 ℄, 38' Rt. INSTALL Underdrain Cleanout Riser. See Drainage Detail Sheet.
16. Sta. 29+70 to Sta. 30+50, Runway 14-32 ℄, INSTALL 80 L.F. of 4" Perforated Underdrain Rt. See Drainage Detail Sheet.

Addendum 1
Added missing leader arrows in Profile View.

HORIZ. 50 0 50 100 Scale in Feet

VERT. 5 0 5 10 Scale in Feet

STATE OF MISSOURI
NUMBER PE-2002015585
PROFESSIONAL ENGINEER
6/11/19

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CITY OF CHILLICOTHE, MISSOURI
CHILLICOTHE MUNICIPAL AIRPORT
CHILLICOTHE, MISSOURI

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DESIGNED BY	BRE	DATE 2/26/2019
REVISIONS	Addendum 1	DATE 6/11/2019

RUNWAY 14-32 PLAN & PROFILE

12


INSTALL Runway 14 REIL System.
See REIL Detail Sheet.
Runway 14-32 Lighting Circuit
1-1/c #8 AWG, 5kV L-862C
in 1" PVC Conduit and
Bare Counterpoise.
See Electrical Detail Sheet.
Sta. 17+55.00, Lt.
Install 4-Box PAPI System
See PAPI Detail Sheet.
PAPI Circuit
2-1/c #8 AWG, 5kV L-862C
in 1" PVC Conduit and Counterpoise
See Electrical Detail Sheet.
196.25'
Runway 14-32 Edge Lights, 18 Spaces @ 195.90' = 3,526.20'
3 Spa. @ 10' = 30
35'
10'
20'
Runway 14-32
MATCHLINE A, THIS SHEET
See Detail A,
This Sheet.
3 Equal Spaces.
Runway 14-32 Lighting Circuit
1-1/c #8 AWG, 5kV L-862C
in 1" PVC Conduit and
Bare Counterpoise.
See Electrical Detail Sheet.
2 Spa. @ 17.5 = 35'
2 Spa. @ 41.25' = 82.5'
Both Sides
Taxiway A5
INSTALL Lighted Guidance Sign, P1
Connect Sign to Runway 14-32 Lighting
Circuit. See Guidance Sign Detail Sheet.
Runway 14-32 Lighting Circuit
2-1/c #8 AWG, 5kV L-862C
in 1" PVC Conduit and
Bare Counterpoise.
See Electrical Detail Sheet.
Parallel Taxiway
PAPI Circuit
2-1/c #8 AWG, 5kV L-862C
in 1" PVC Conduit and
Bare Counterpoise.
See Electrical Detail Sheet.
Runway 14-32 Lighting Circuit
1-1/c #8 AWG, 5kV L-862C
in 1" PVC Conduit and
Bare Counterpoise.
See Electrical Detail Sheet.
Runway 14-32 Edge Lights, 18 Spaces @ 195.90' = 3,526.20'
MATCHLINE A, THIS SHEET
Runway 14-32
MATCHLINE B, NEXT SHEET
Runway 2-20
Runway 14-32 Lighting Circuit
1-1/c #8 AWG, 5kV L-862C
in 1" PVC Conduit and
Bare Counterpoise.
See Electrical Detail Sheet.
LEGEND
Proposed M.I.R.L. (LED), Base Mounted, Yellow/Clear Lens
Proposed M.I.R.L. (LED), Base Mounted, Red/Green Lens
Proposed M.I.T.L. (LED), Base Mounted, Blue Lens
Proposed Retroreflective Marker
Proposed Junction Box
Proposed Guidance Sign (LED)
Proposed Runway Lighting Circuit
Proposed PAPI Circuit
Proposed Wind Cone Circuit
Existing Retroreflective Marker
13'
5'
DETAIL A
No Scale
Addendum 1
2" PVC Conduit reference was revised to 1" PVC Conduit.
N
40 0 40 80
Scale in Feet
Drawing Name: I:\KAC\PRJ\000012850\PROJECT FILES\AE\CIVIL 3D PROJECT FOLDER\Production Drawings\Electrical P&D.dwg Jun 07,2019 - 11:21am

STATE OF MISSOURI
MATTHEW J. MOHR
NUMBER PE-2002025585
PROFESSIONAL ENGINEER
6/11/19

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CITY OF CHILLICOTHE, MISSOURI

CHILLICOTHE MUNICIPAL AIRPORT

CHILLICOTHE, MISSOURI

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REVISIONS	1 Addendum 1	DATE 6/11/2019

ELECTRICAL PLAN

30

CAUTION
Maintain 1' Vertical Separation between 600V and 5kV Cables.

Existing Wind Cone, ± 450' from RW 14-32 ℄.

Runway 14-32 Lighting Circuit 1-1/c #8 AWG, 5kV L-862C in 1" PVC Conduit and Bare Counterpoise. See Electrical Detail Sheet.

Runway 14-32 Edge Lights, 18 Spaces @ 195.90' = 3,526.20'

MATCHLINE B, PREVIOUS SHEET

MATCHLINE C, NEXT SHEET

Runway 14-32

Wind Cone Circuit 2-1/c #6 AWG, 600V L-862C in 1" PVC Conduit and Bare Counterpoise. See Electrical Detail Sheet.

PAPI Circuit 2-1/c #8 AWG, 5kV L-862C in 1" PVC Conduit and Bare Counterpoise. See Electrical Detail Sheet.

Runway 14-32 Lighting Circuit 2-1/c #8 AWG, 5kV L-862C in 1" PVC Conduit and Bare Counterpoise. See Electrical Detail Sheet.

Runway Lighting Circuit 2-1/c #8 AWG, 5kV L-862C in 2" PVC Conduit. See Electrical Detail Sheet.

See Detail A, This Sheet.

3 Equal Spaces, Both Sides.

2 Spaces @ 40.65' = 81.3'

Taxiway A3

Parallel Taxiway

INSTALL Lighted Guidance Sign, P2 Connect Sign to Runway 14-32 Lighting Circuit. See Guidance Sign Detail Sheet.

Hangar

Electrical Vault Building.

LEGEND

- Proposed M.I.R.L. (LED), Base Mounted, Yellow/Clear Lens
- Proposed M.I.R.L. (LED), Base Mounted, Red/Green Lens
- Proposed M.I.T.L. (LED), Base Mounted, Blue Lens
- Proposed Retroreflective Marker
- Proposed Junction Box
- Proposed Guidance Sign (LED)
- Proposed Runway Lighting Circuit
- Proposed PAPI Circuit
- Proposed Wind Cone Circuit
- Existing Retroreflective Marker

DETAIL A
No Scale

Addendum 1
1. 2" PVC Conduit reference was revised to 1" PVC Conduit.
2. Added Distance from Runway Centerline to Wind Cone.

Scale in Feet: 40 0 40 80

Drawing Name: I:\KAC\PRJ\000012850\PROJECT FILES\AE\CIVIL 3D PROJECT FOLDER\Production Drawings\Electrical P&D.dwg Jun 07,2019 - 11:21am

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CITY OF CHILLICOTHE, MISSOURI
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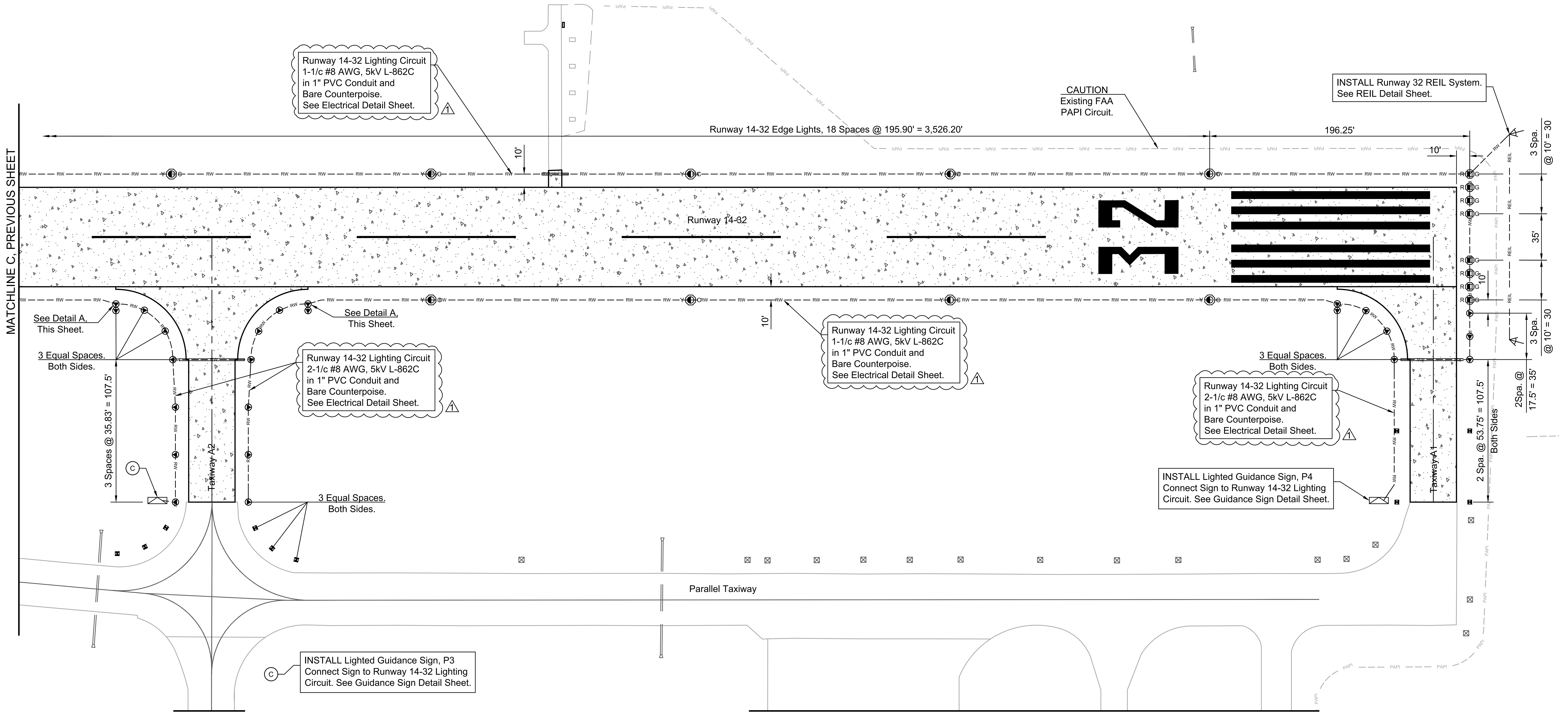
REVISIONS	Addendum 1
DATE	6/11/2019

ELECTRICAL PLAN

31

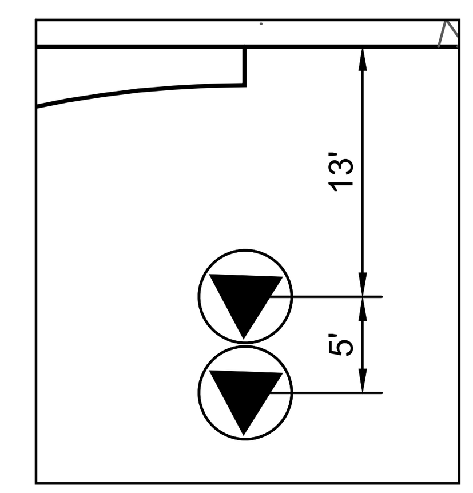


MATCHLINE C, PREVIOUS SHEET
Runway 14-32 Lighting Circuit 1-1/c #8 AWG, 5kV L-862C in 1" PVC Conduit and Bare Counterpoise. See Electrical Detail Sheet.
CAUTION Existing FAA PAPI Circuit.
INSTALL Runway 32 REIL System. See REIL Detail Sheet.
Runway 14-32 Edge Lights, 18 Spaces @ 195.90' = 3,526.20'
196.25'
10'
3 Spa. @ 10' = 30
35'
Runway 14-32
See Detail A, This Sheet.
3 Equal Spaces. Both Sides.
Runway 14-32 Lighting Circuit 2-1/c #8 AWG, 5kV L-862C in 1" PVC Conduit and Bare Counterpoise. See Electrical Detail Sheet.
3 Spaces @ 35.83' = 107.5'
Taxiway A2
Taxiway A1
2 Spa. @ 53.75' = 107.5' Both Sides
2Spa. @ 17.5' = 35'
INSTALL Lighted Guidance Sign, P4 Connect Sign to Runway 14-32 Lighting Circuit. See Guidance Sign Detail Sheet.
Parallel Taxiway
INSTALL Lighted Guidance Sign, P3 Connect Sign to Runway 14-32 Lighting Circuit. See Guidance Sign Detail Sheet.

Addendum 1
2" PVC Conduit reference was revised to 1" PVC Conduit.

LEGEND

- Proposed M.I.R.L. (LED), Base Mounted, Yellow/Clear Lens
- Proposed M.I.R.L. (LED), Base Mounted, Red/Green Lens
- Proposed M.I.T.L. (LED), Base Mounted, Blue Lens
- Proposed Retroreflective Marker
- Proposed Junction Box
- Proposed Guidance Sign (LED)
- Proposed Runway Lighting Circuit
- Proposed PAPI Circuit
- Proposed Wind Cone Circuit
- Existing Retroreflective Marker



DETAIL A
No Scale

40 0 40 80
Scale in Feet

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CITY OF CHILLICOTHE, MISSOURI
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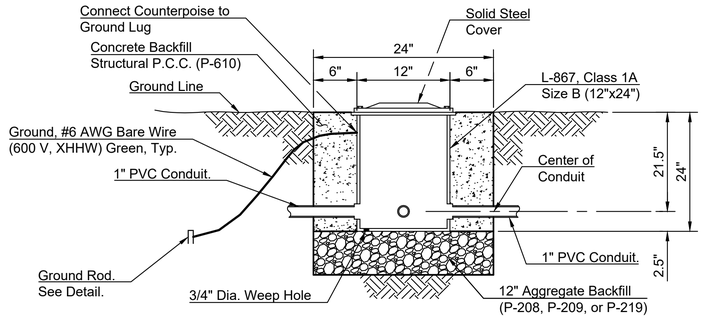
REVISIONS 1 Addendum 1	DATE 6/11/2019

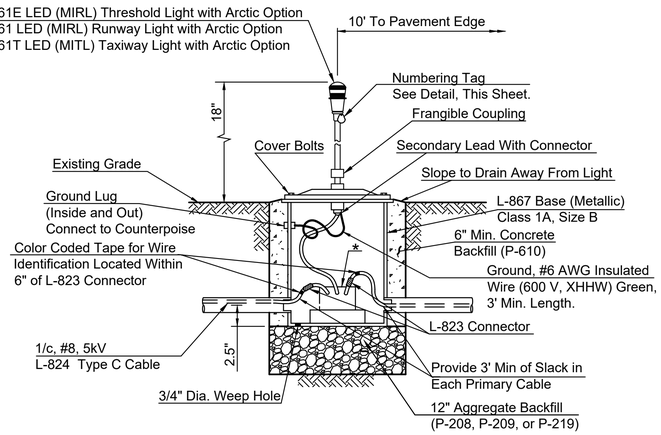
ELECTRICAL PLAN

32

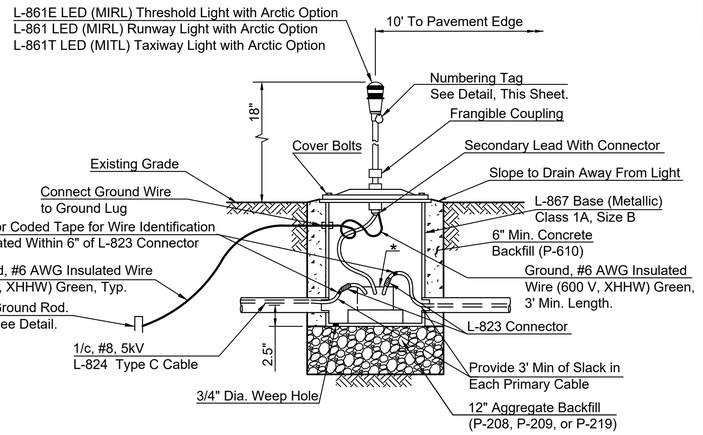


TYPICAL L-867 JUNCTION BOX

No Scale



COUNTERPOISE WITH OPTION 1 INSTALLATION



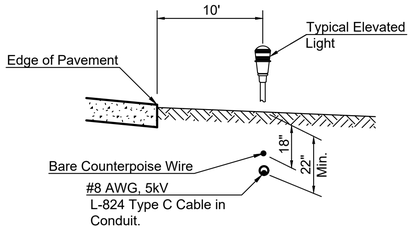
COUNTERPOISE WITH OPTION 2 INSTALLATION

* L-830 Transformer for Runway Lights
L-830-17 Transformer for Taxiway Lights
Size as Required to Serve Fixture

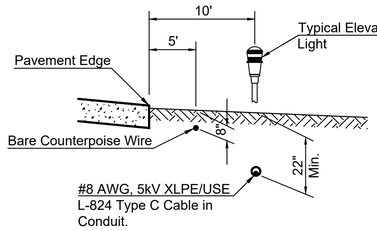
RUNWAY 18-36 L-861 & L-861E LED (MIRL) EDGE LIGHTS
TAXIWAY L-861T LED (MITL) EDGE LIGHTS
BASE MOUNTED

No Scale

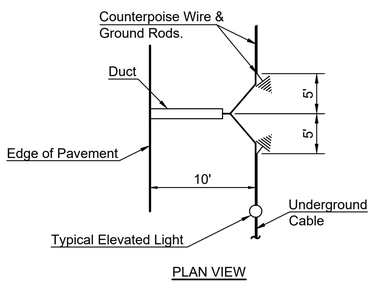
Addendum 1
This Sheet was a Full Revision to Include all Details for the Installation of the Electrical Counterpoise System by the Equipotential Method (Option 1) or the Isolation Method (Option 2).



PROFILE VIEW

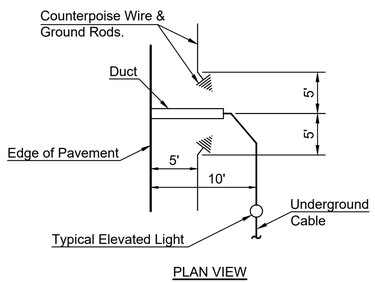


PROFILE VIEW



PLAN VIEW

OPTION 1



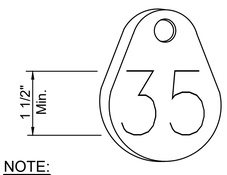
PLAN VIEW

OPTION 2

Note:
1) Contractor shall Choose Between Option 1 or Option 2 for the Entire Length of Light and Cable Installation for Circuits that are Adjacent and Parallel to the Pavement Edge.
2) Only Option 1 is Acceptable for Circuits that are not Adjacent and Parallel to the Pavement Edge, i.e. Homerun Circuits.
3) Option 1 or Option 2 will not be Measured or Paid for Separately, but shall be paid for under the Contract Bid Item "Bare Counterpoise Wire (#6 AWG)" per L.F.
4) Counterpoise Shall Be Connected to a Ground Rod at 500' Maximum Spacing.

LIGHT AND CABLE INSTALLATION DETAIL FOR CABLE IN CONDUIT

No Scale

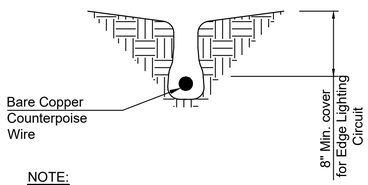


NOTE:

Affix non-corrosive tag to fixture facing runway with set screw, wire tie, or metal band. Numerals shall be engraved for permanent readability. Contractor to coordinate with airport manager on numbering scheme.

TAG DETAIL

No Scale

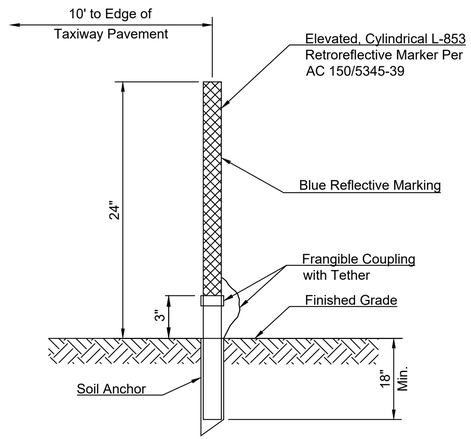


NOTE:

1. Plowed Trench May be Used for Installing Bare Counterpoise Adjacent to Pavement, as Shown in the Light and Cable Installation Detail, This Sheet. Trenching Shall be Incidental to Installation of Counterpoise.

COUNTERPOISE AND TRENCH DETAIL

No Scale



SOIL MOUNTED RETROREFLECTIVE MARKER DETAIL

No Scale

NOTES:

1. The Retroreflective Marker Shall be Flexible or Mounted with a Frangible Fitting with a Breakaway Point of No More than 3 Inches Above Grade.
2. If a Flexible Marker is Used the Blue Reflective Marking Must Extend to at Least 2 Inches Above Grade.
3. New Retroreflective Marker Shall Match Existing Retroreflective Markers.

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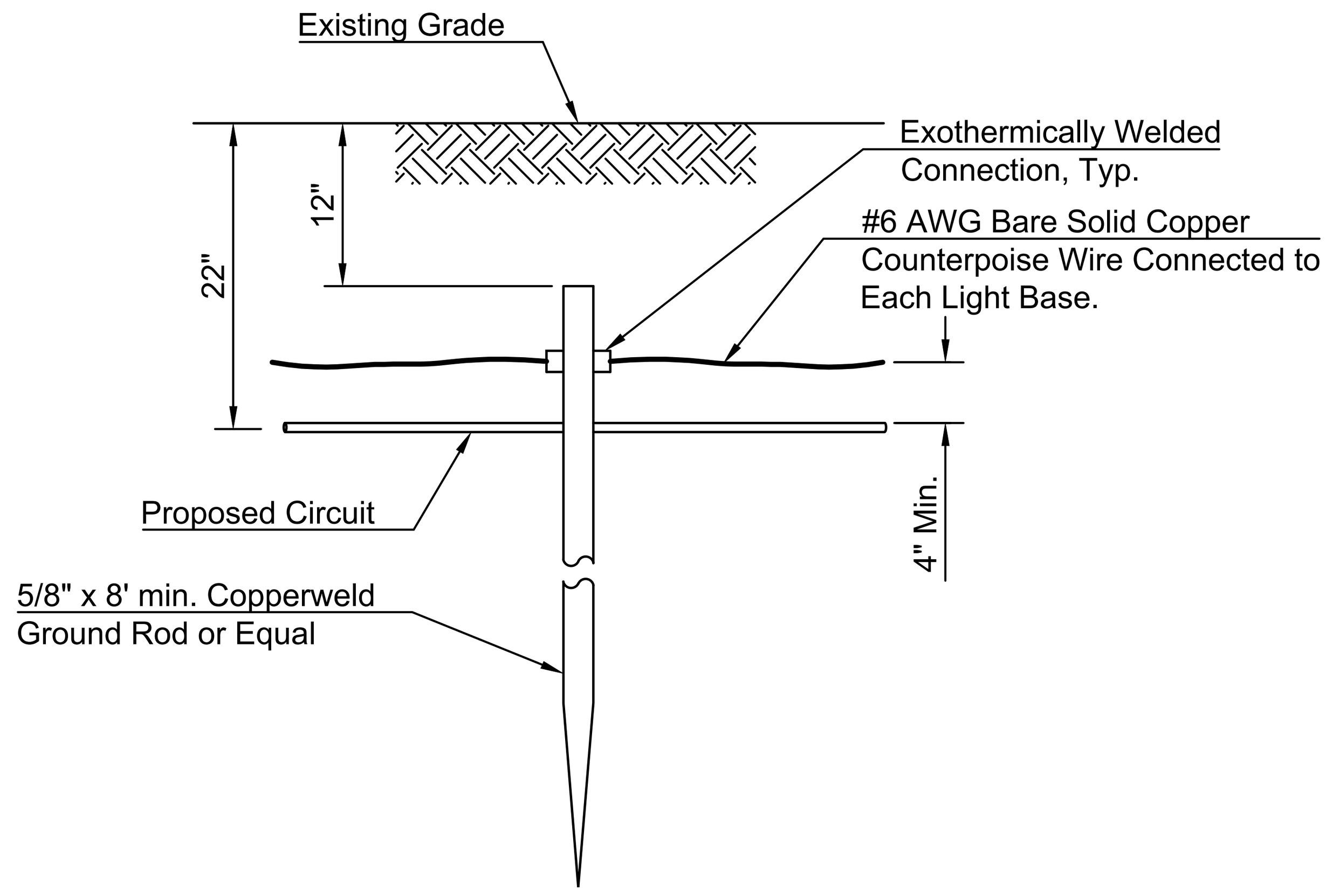
CITY OF CHILLICOTHE, MISSOURI
CHILLICOTHE MUNICIPAL AIRPORT
CHILLICOTHE, MISSOURI

PROJECT NO.	000012850
DRAWN BY	BRE
DATE	2/26/2019
CHECKED BY	RMD
DATE	3/7/2019
DESIGNED BY	BRE
DATE	2/26/2019
REVISIONS	Addendum 1
DATE	6/11/2019

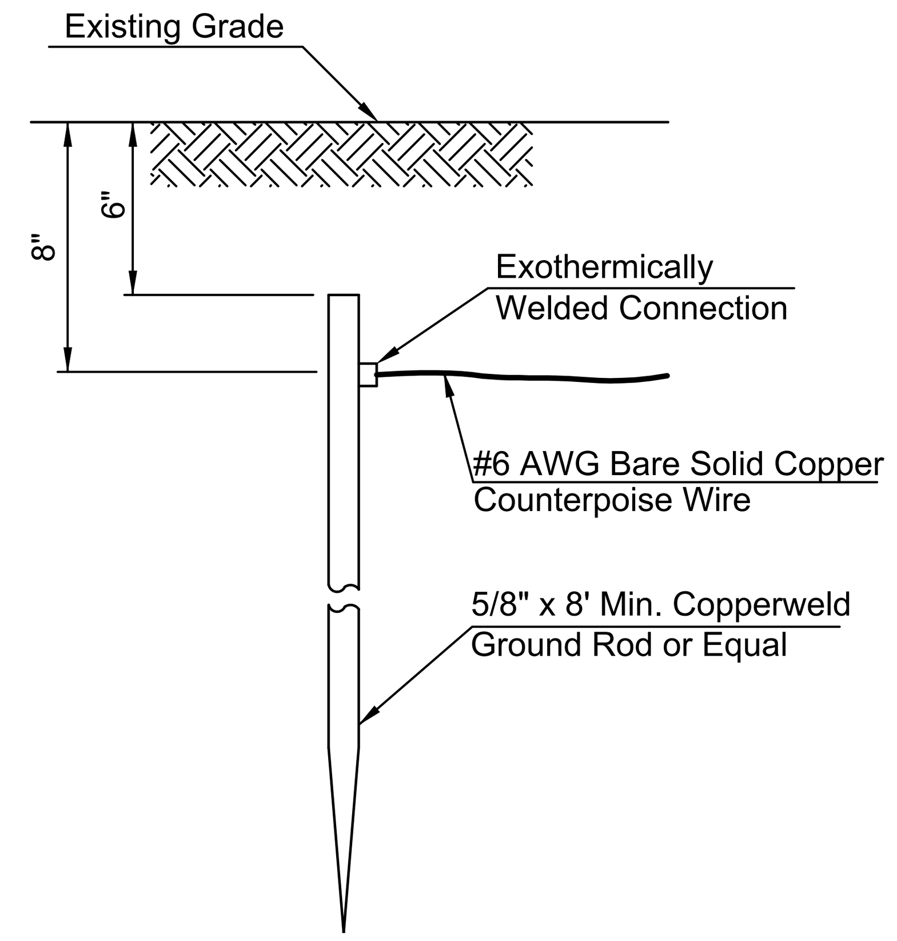
ELECTRICAL DETAILS

33



GROUND ROD DETAIL FOR COUNTERPOISE INSTALLED IN SAME TRENCH AS CIRCUIT

No Scale

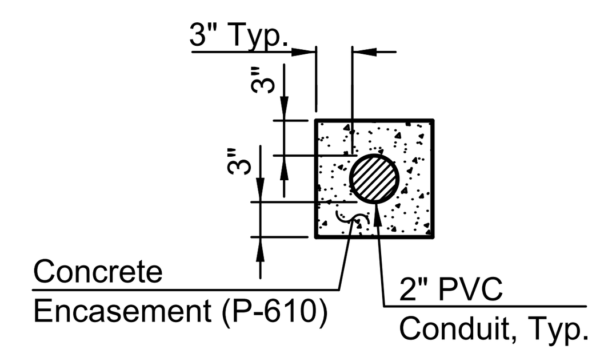


GROUND ROD DETAIL FOR COUNTERPOISE INSTALLED IN SEPARATE TRENCH

No Scale

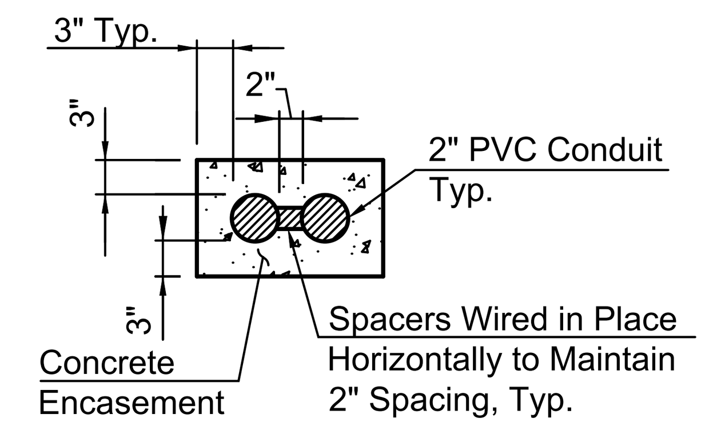
Notes:

1. The Resistance to Ground of the Counterpoise Grounding System Shall Not Exceed 25 OHMS.
2. Cost of Ground Rods is Incidental to the Associated Items Requiring Grounding.
3. Counterpoise Ground Rods Shall be Placed at 500' Apart for the Entire Length of Circuit.
4. The counterpoise conductor shall be bonded to each metallic light base, mounting stake, and metallic airfield lighting component.



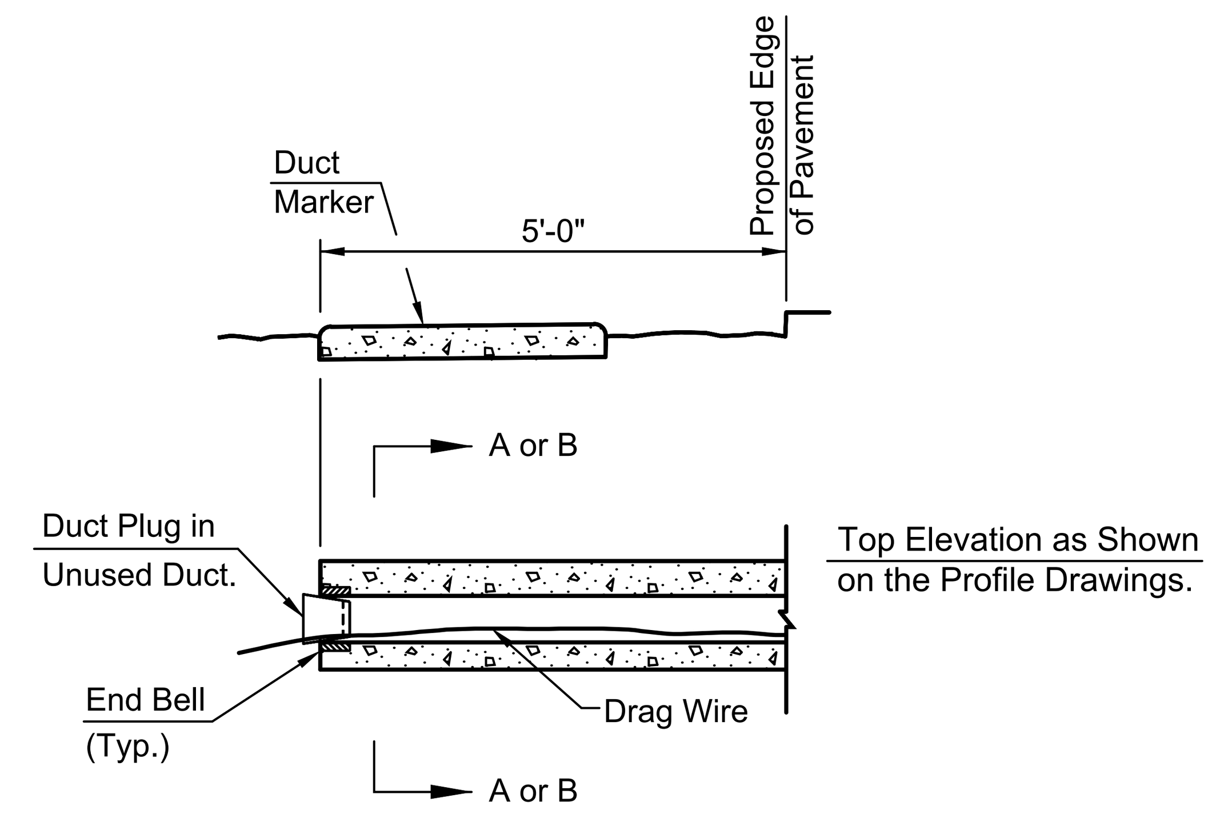
SECTION A-A

No Scale



SECTION B-B

No Scale



2" PVC SCHEDULE 40 CONCRETE ENCASED ELECTRICAL DUCT DETAIL

No Scale

Addendum 1

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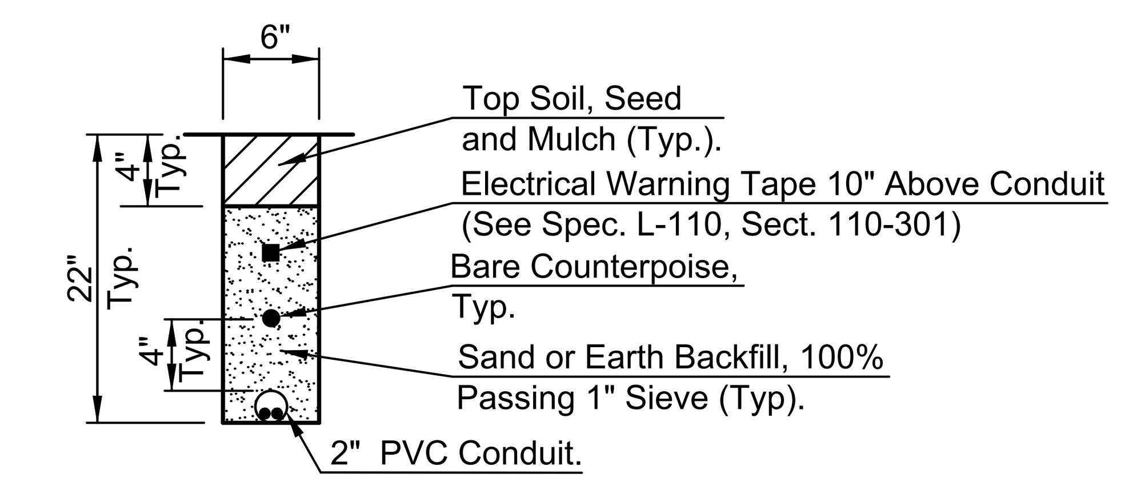


POWER CIRCUIT CABLES AND EDGE LIGHTING HOMERUN CABLES

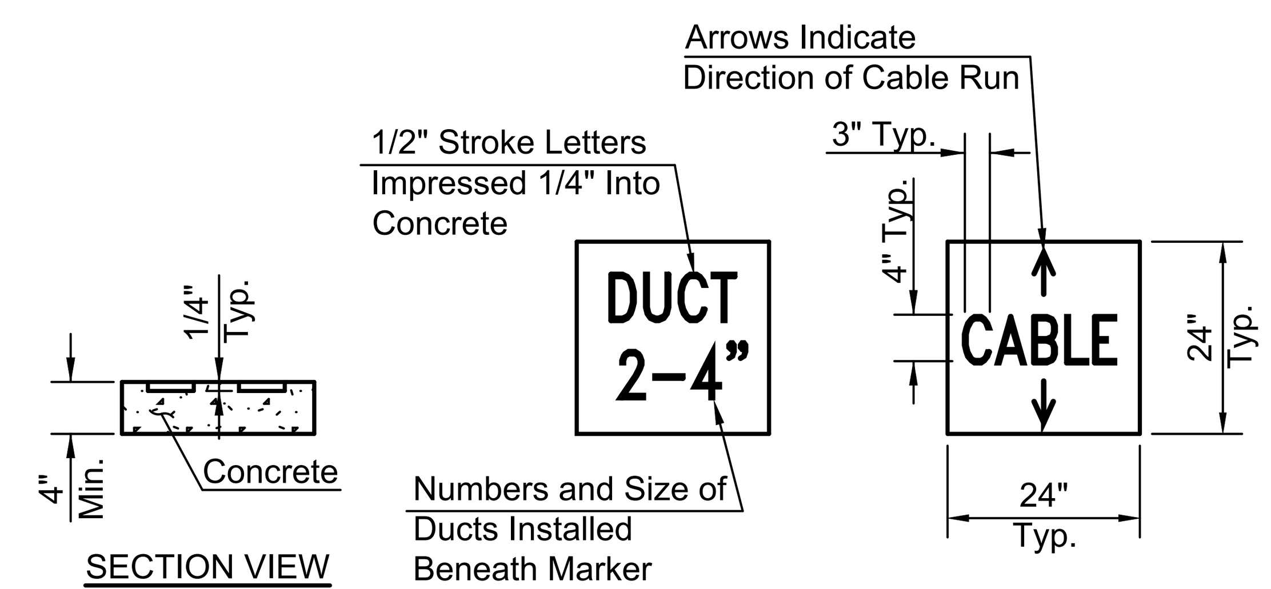
No Scale

Notes:

1. Depth of Trenches Shall be as Shown Above Unless Otherwise Specified on the Plans.
2. Sand Backfill May be Waived by the Engineer if the Existing Soil Meets the Backfill requirements. All Disturbed Surfaces Shall be Restored to Their Original Condition Including Returfing; Cost is Incidental to Trenching.
3. The Counterpoise Shall be Installed Above Cables Only Where the Cables are Not Adjacent to Pavement. For Counterpoise Installation Near Pavement, See Cable Installation Detail This Sheet.

CABLE TRENCH DETAILS

No Scale



NOTES:

1. Markers Shall be Placed in Accordance With the Specifications.
2. Cost of Concrete Markers is Incidental to the Associated Items of Duct or Cable.
3. Edge Exposed Concrete With a 1/4" Radius Tool.
4. Where Additional Space to Fit the Legend is Required, Some of the Following Methods May Be Employed.
   a. Reduce Letter Size to 3" High, 2" Wide
   b. Increase The Marker Size to 30" x 30" Max.
   c. Provide Additional Markers Placed Side by Side

CABLE/DUCT MARKERS

No Scale

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CITY OF CHILLICOTHE, MISSOURI

CHILLICOTHE MUNICIPAL AIRPORT

CHILLICOTHE, MISSOURI

PROJECT NO.	000012850	
DRAWN BY	BRE	DATE 2/26/2019
CHECKED BY	RMD	DATE 3/7/2019
DESIGNED BY	BRE	DATE 2/26/2019
REVISIONS	1 Addendum 1	DATE 6/11/2019

ELECTRICAL DETAILS

33A

Drawing Name: I:\KAC\PRJ\000012850\PROJECT FILES\AE\CIVIL 3D PROJECT FOLDER\Production Drawings\Electrical P&D.dwg Jun 07,2019 - 11:21am

CHILLICOTHE MUNICIPAL AIRPORT
CITY OF CHILLICOTHE, MISSOURI

Reconstruct Runway 14-32 and Connecting Taxiways
Install New Medium Intensity Runway Lighting (MIRL) System
Install New Runway 14 PAPI System
Install New Runway 14-32 REIL Systems
Install Lighted Holding Position Signs

MoDOT PROJECT NO. 17-015A-1
LOCHNER JOB NO. 000012580

PRE-BID MEETING MINUTES

Tuesday, June 4th, 2019 at 10:00 a.m. (CDT)

I. Introduction of Attendees:

(attendees list included with these minutes for reference)

II. Bidding Process:

A. Time and Location:

1. Proposals will be received until **2:00 P.M. (CDT), Thursday, June 20th, 2019** and then publicly opened at:

   City Hall
   Attn: City Clerk
   715 Washington
   Chillicothe, MO 64601

   Bids received after this time will not be considered.

2. Bids may be held by the City of Chillicothe for a period not to exceed One Hundred Twenty (120) calendar days from the date of the bid opening. **Award of contract is contingent upon the City receiving Federal funding assistance from the Federal Aviation Administration (FAA) and Missouri Department of Transportation (MoDOT).**

3. The intentions are to execute contracts after receiving concurrence in award from the FAA. The anticipated early NTP date is **April, 6th, 2020** and the late NTP date is **May 4, 2020**.

4. Envelopes containing bids must be sealed and addressed as shown on Page 2-1 in the Instructions To Bidders of the Contract Documents/Specifications.

B. Contract Provisions:

1. Mandatory contract provisions are identified in Section 3 and Section 4 of the Contract Documents.

2. The EEO goals for this contract are on Page 1-4, 10.0% minority participation and 6.9% female participation in each trade.

3. The DBE goal for this project, as described on Page 1-4 & 1-5, is to subcontract 6.00% of the dollar value of the prime contract to DBEs. It is the responsibility of the Contractor to meet this 6.00% goal. **If the DBE goal is not met, there needs to be substantial documentation of good faith effort (as described on Pages 4-25 through 4-26) in attempts to attain the DBE goal.** The DBE Form is located on Page PF-12 in the Proposal Section.

4. Sixty percent (60%) of the cost of materials or supplies purchased from a DBE regular dealer may be counted. If the materials or supplies are obtained from a DBE manufacturer, 100% of the cost may be counted toward the goal.

5. This contract is subject to the "Buy American Preferences" of the Aviation Safety and Capacity Act of 1990. Prospective Bidders are required to certify that steel and manufactured products have been produced in the United States per the certification included in the Proposal Section on Pages PF-8 through PF-10.

6. The Contractor and all Subcontractors will be required to pay minimum wage rates as established by the United State Department of Labor and Missouri Division of Labor Standards. Minimum wage requirements are identified on the current wage rates included at the end of Section 4. If there is a discrepancy between the two published wage rates, the higher of the two will be used as the requirement.

7. Proposers shall provide a statement of qualifications with their proposal of past similar work, a financial statement, and a statement of plant and equipment proposed for use on the project. In lieu of the financial statement, Contractors may provide evidence that they are pre-qualified with MoDOT for similar work and are on the current MoDOT bidders list.

8. The Contractor and his/her Subcontractors will be required to provide certificates of insurance for at least the minimum amounts specified in Section 4: Supplementary Provisions, Part C: Local Provisions.

9. As part of your proposal, you are required to complete the Worker Eligibility Verification Affidavit on Page PF-11. Note also that you are required to submit with your proposal a completed copy of the first page and a valid copy of the signature page of your E-Verify Memorandum of Understanding.

10. The Contractor is required to provide a 10-hour OSHA construction safety program for all employees who will be on-site at the Project as provided on Page 4-19.

11. Prior to procurement and upon the successful bidder's request, the City of Chillicothe will provide the successful bidder a state tax exempt certification.

C. Contract Proposal Forms:

1. Proposals must be submitted on the "OFFICAL BID FORM" provided by Drexel Technologies for the submittal of bid.

2. When completing the Proposal Form, the unit price needs to be written in numerical form in the column under the header "Unit Price" and the extension (quantity x unit price) needs to be written in numerical form. All bidders submitting proposals must acknowledge receipt of all addendums issued in the space provided in the Proposal on Page PF-5. Page PF-13 needs to be completed and signed. If for some reason any of the pages of the Proposal Form are changed by addendum, replace the page that was revised in your submittal.

3. The bidder shall submit all required DBE information, as contained on the DBE form located on Page PF-12 of the Proposal Form with their bid.

4. A Bid Bond guarantee will be required with each bid as a certified check or a bid bond in the amount of five (5) percent of the total amount of the bid, made payable to the City of Chillicothe. Include the Bid Bond with your Proposal Form in the sealed envelope.

5. The successful bidder will be required to execute the Contract Agreement, the Performance Bond and the Payment Bond. The bonds will be in the amount of 100% of the contract price.

III. Project Description:

The project consists of:

- **Reconstruct Runway 14-32 and Connecting Taxiways**
- **Install New Medium Intensity Runway Lighting (MIRL) System**
- **Install New Runway 14 PAPI System**
- **Install New Runway 14-32 REIL Systems**
- **Install Lighted Holding Position Signs**

A. The total contract period for construction is one hundred fifty (150) calendar days. Phase 2 construction time will be not more than forty-five (45) calendar days and will run concurrent with Phase 1 at the Contractor's discretion. Liquidated damages are set at $1,500.00 per calendar day for the Total Project and $3,000.00 per calendar day for Phase 2. Delays due to weather and other factors out of the control of the Contractor **that are above and beyond a typical season** may be requested in writing as a reason for contract period extension. The request should be made as soon as the Contractor is aware of an issue with the construction period. The Contractor shall also make every attempt to make up any lost days by working extended periods during the day and/or weekends.

B. Lochner will provide Construction Observation and acceptance testing throughout the project. The Contractor shall provide Quality Control Measures as outlined in the Contract Documents/Specifications, specifically Section 100 of the General Provisions and Section 17, Item P-501 Portland Cement Concrete (PCC) Pavement. **Please note the aggregate testing requirements for Alkali-Silica Reactivity (ASR) as outlined in Section 501-2.1.a. of the P-501 Specification.** If intending to use fly ash in mitigating ASR, only Class F or N fly ash is acceptable.

C. Contractor's access roads, haul roads, and staging areas are shown on the Construction Safety and Phasing Plan (CSPP). The Contractor is responsible for restoring any access roads, haul roads, and staging areas to their original, pre-construction condition at no additional cost to the Owner.

D. All bidders should carefully review the Construction Safety and Phasing Plan (CSPP) in the Appendix of the Project Manual. Closed Runway Markings and Low Profile Barricades shall be placed as shown on Safety Plan Sheets 3 & 4, prior to the start of any work. A Contractor furnished flagger is required to be stationed at the intersection of the Turf Runway 2-20 during Phase 1 when construction equipment and vehicles are crossing through this intersection. During the site visit, it was determined that due to the width of the Runway 2-20 safety area, that two flaggers shall be used; one located on each side of the intersection. In addition, the Contractor will be required to keep the intersection swept clean and will need to have a power broom available for use at all times if required. These additional requirements will be added to the Plans by Addendum. The Contractor's Safety Plan Compliance Document (SPCD) will also be required prior to the start of construction.

E. The Contractor is responsible for implementation of the Stormwater Pollution Prevention Plan (SWPPP) contained in the Appendix of the Project Manual. Sheets 20 & 21 of the Plans show the erosion control measures necessary for the Project.

F. Proposed typical pavement section for the Runway and Taxiways consists of:

- PCC Pavement (6") (P-501)
- Aggregate Base Course (6") (P-208, P-209 or P-219)
- Aggregate Subbase Course (6") (P-154, P-208, P-209, or P-219)
- Lime-Treated Subgrade (12") (P-155)
- 6" Compacted Subgrade (P-152)

G. The main runway pavement shall be constructed with the use of acceptable slip form paving equipment. The main taxiway pavement shall be constructed with the use of acceptable slip form or side form paving equipment. Odd shaped irregular sections of pavement shall be considered hand pours and constructed with the use of side forms. These methods were confirmed following the site visit via a phone call with the FAA Central Region Paving Engineer, Dan Wilson. The slump requirement for side form paving and hand pours will be increased to a maximum of four inches. These clarifications/changes will be included in Addendum No. 1.

H. If GPS controlled equipment is used to construct the subgrade, Contractor shall have the area surveyed and approved by the Engineer prior to placement of subbase course.

I. The ¼" chamfer as shown on the Pavement Joint Details (Sheet 24) shall be constructed in order to protect the pavement joint during snow removal operations.

J. Concrete incentive pay is available for this project based on strength and thickness up to 106% of each lot. This may be used to off-set lots requiring less than 100% pay for strength and thickness. However, the total product of the contract unit price and the total number of square yards of concrete shall not exceed **100% pay**. Payment in excess of 100% based on strength and thickness may not be used to offset reduction in payment due to smoothness.

K. Waste material resulting from this Project shall be disposed of off Airport property per General Note No. 6, Sheet 2 of the Plans. Excess earthwork shall be wasted on site as directed by the Engineer as noted on Sheet 7 of the Plans. The existing runway pavement section includes both asphalt and concrete pavement as noted on Sheet 6, Boring Log, of the Plans.

L. It is the Contractor's responsibility to locate existing utilities prior to construction by contacting Missouri One Call at 1-800-DIG-RITE. Any damage to existing utilities shall be repaired by the Contractor at no additional cost to the Owner. For the FAA owned Runway 32 PAPI, the Contractor shall contact FAA Technical Operations point of contact Laurie Ratliff at 816.329.2828 so that she can coordinate marking of their cable.

M. Access to water may be achieved by way of the fire hydrants. The Contractor may obtain a meter from the City. All costs shall be at the Contractor's expense. Contact the City for water rates.

N. Type 2C erosion control blanket to be utilized adjacent to proposed pavement for a width of 8 feet and in the infield ditch as shown on the Grading Plans in lieu of mulch material. HydroMulch as specified in specification Item T-908 shall be utilized elsewhere.

O. The Contractor shall have the option of installing the electrical counterpoise system by the Equipotential Method (in the same trench as the conduit) or the Isolation Method (in a separate trench from the conduit). If installed in the same trench as the conduit, the counterpoise wire shall be connected to the ground lug of each light base and ground rods installed at intervals not to exceed 500 feet. If the counterpoise is installed in a separate trench, with ground rods installed at intervals not to exceed 500 feet, then a ground rod shall also be installed at each light base. No quantity adjustment will be made to the bid item, however the bid item will be changed to read "Bare Counterpoise Wire (#6 AWG)". This option will be added to the plans and specifications by Addendum.

P. Furnishing and Installing a 4-Box PAPI system are all encompassed into one pay item.

Q. Furnishing and Installing a REIL system are all encompassed into one pay item.

R. Per Section 110-3.3 of the Specifications, installation of conduit by the plowing method is acceptable.

S. The Contractor shall have a representative on site during the FAA flight check for the new PAPI and REIL systems.

T. A contractor furnished Engineer's Field Office is not required.

IV. Additional Notes:

A. During construction, the first pay estimate shall be processed when necessary. All subsequent pay estimates will only be processed once the prime contractor has submitted lien releases from their subcontractors.

B. Potential addendum items include:

1. Adding a new contract pay item "1" Electrical Duct and Trench" for circuits that have less than three conductors in the same conduit. The quantity for the existing contract pay item "2" Electrical Duct and Trench" shall be modified for that quantity of circuits that have three or more conductors in the same conduit. If all the circuits only require two conductors, then the existing pay item will be revised to reflect the use of 1" duct.

2. As previously mentioned, two options for the installation of the bare counterpoise wire will be provided for, the Equipotential Method (in the same trench as the conduit) or the Isolation Method (in a separate trench from the conduit).

3. The P-208, Aggregate Base Course, gradation table included in Section 208-2.2 of the Specification is incorrect and will be revised by addendum.

4. The use of the FAA 10H version of the P-501, Portland Cement Concrete (PCC) Pavement, specification will not be allowed. However, the current 10G version of the specification included with the Project Manual will be revised to clarify acceptable paving operations for runway, taxiway, and odd shaped areas. In addition, the maximum slump requirement for side form paving and hand pours will be increased to four inches. A separate mix design for slip form and side form paving operations shall be prepared by the Contractor and submitted to the Engineer for review prior to the start of paving operations.

5. The Construction Plans will be revised to require the use of two flaggers when crossing through the intersection of turf Runway 2-20 along with the requirement to have a power broom available at all times.

6. During the site visit, it was mentioned that the Contractor will have the option of placing asphalt millings resulting from pavement demolition operations on the existing haul road near the staging area in lieu of hauling the material off-site. The Plans will be revised to offer this option.

7. Additional information related to the proposed wind cone circuit will be added to the Plans.

8. FAA Technical Operations contact information will be added to the Plans for use in marking the Runway 32 PAPI cable.

V. Optional Site Visit for Attendees.

CHILLICOTHE MUNICIPAL AIRPORT
CITY OF CHILLICOTHE, MISSOURI

Reconstruct Runway 14-32 and Connecting Taxiways
Install New Medium Intensity Runway Lighting (MIRL) System
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Install Lighted Holding Position Signs

MoDOT PROJECT NO. 17-015A-1
LOCHNER JOB NO. 000012850

ATTENDEES LIST FOR PRE-BID MEETING
Tuesday, June 4th, 2019 at 10:00 a.m. (CDT)

NAME	REPRESENTING	PHONE	EMAIL
Matt Jacobs	Lochner	816-590-7517	mjacobs@hwlochner.com
Brian Beggs	Lochner	"	beggsb@hwlochner.com
Bill Kieffer	City of Chillicothe	660 646 6073	CHT@Greenhills.net
Darren Woods	Phillips Hardy	573-447-8000	dwoods@PhillipsHardy.com
Don Abell	Emery Sapp & Sons, Inc.	573-489-9232	don.abell@emerysapp.com
Paul Ideker	Ideker Inc.	816-364-3970	paul@ideker.net
Chris Carr	Carr Enterprises	719-406-9147	Carrenterprises@live.com

NAME	REPRESENTING	PHONE	EMAIL
Chance Hollingsworth	Clarkson Const.	816-383-1962	CHollingsworth@clarksonconstruction.com
Jason Rapp	Rivercrest Electric	816-863-1046	jason@rivercrestelectric.com
Larry Gastineau	Gastineau Electric	816-807-2528	lgastineau@windjammercable.net
Darin Chappell	City of Chillicothe	660-247-2152	cityadmin@chillicothecity.org
Duane Hagerling	Pinnacle Electric	816-279-1800	dahle@pinnacleelectricinc.com
Rodney Rapp	Rivercrest Elec	573-864-5170	Jason@Rivercrestelectric.com
Kyle LePage	MoDOT Aviation	573-526-5571	kyle.lepage@modot.mo.gov