



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES

Division of Facilities Construction and Management

DFCM

STANDARD LOW BID PROJECT

July 13, 2010

IED DEFEAT LANE CAMP WILLIAMS

UTAH NATIONAL GUARD

DRAPER, UTAH

DFCM Project Number: 10181480

Stanley Consultants

TABLE OF CONTENTS

	<u>Page Numbers</u>
Title Sheet	1
Table of Contents	2
Notice to Contractors	3
Project Description	4
Project Schedule	5
Bid Form	6
Instructions to Bidders	9
Bid Bond	13
Instructions and Subcontractors List Form	14
Contractor's Agreement	17
Performance Bond	22
Payment Bond	23
Certificate of Substantial Completion	24
General Contractor Past Performance Rating Form	
Technical Specifications:	
Drawings:	

Current copies of the following documents are hereby made part of these contract documents by reference. These documents are available on the DFCM web site at <http://dfcm.utah.gov/StdDocs/index.html> "Standard Documents" – "Reference Documents I" – "Item 6. Supplemental General Conditions" or are available upon request from DFCM:

DFCM Supplemental General Conditions dated July 1, 2010 *

DFCM Supplemental General Conditions revised May 11, 2010
DFCM Supplemental General Conditions dated July 1, 2009
DFCM Supplemental General Conditions dated July 15, 2008
DFCM General Conditions dated May 25, 2005
DFCM Application and Certification for Payment dated May 25, 2005.

*** NOTE: THE NEW SUPPLEMENTAL GENERAL CONDITIONS EFFECTIVE JULY 1, 2010 ADDRESSING DRUG AND ALCOHOL TESTING ARE REFERENCED AT THE LINK ABOVE.**

The Agreement and General Conditions dated May 25, 2005 have been updated from versions that were formally adopted and in use prior to this date. The changes made to the General Conditions are identified in a document entitled Revisions to General Conditions that is available on DFCM's web site at <http://dfcm.utah.gov>

NOTICE TO CONTRACTORS

Sealed bids will be received by the Division of Facilities Construction and Management (DFCM) for:

IED DEFEAT LANE CAMP WILLIAMS
UTAH NATIONAL GUARD – DRAPER, UTAH
DFCM PROJECT NO: 10181480

Bids will be in accordance with the Contract Documents that will be available on **Tuesday, July 13, 2010**, and distributed in electronic format only on CDs from DFCM, 4110 State Office Building, Salt Lake City, Utah and on the DFCM web page at <http://dfcm.utah.gov>. For questions regarding this project, please contact **Wayne Smith**, DFCM, at **801-550-6536**. No others are to be contacted regarding this bidding process. The construction estimate for this project is \$728,000.00.

A **mandatory** pre-bid meeting will be held at Bldg. 1190 Camp Williams, 17800 South Redwood Road, Riverton, Utah on at **Thursday, July 15, 2010 at 8:00 A.M.** All bidders wishing to bid on this project are required to attend this meeting.

Bids will be received until the hour of **3:00 PM** on **Wednesday, July 28, 2010** at DFCM, 4110 State Office Building, Salt Lake City, Utah 84114. Bids will be opened and read aloud in the DFCM Conference Room, 4110 State Office Building, Salt Lake City, Utah. NOTE: Bids must be received at 4110 State Office Building by the specified time.

A bid bond in the amount of five percent (5%) of the bid amount, made payable to the Division of Facilities Construction and Management on DFCM's bid bond form, shall accompany the bid.

The Division of Facilities Construction and Management reserves the right to reject any or all bids or to waive any formality or technicality in any bid in the interest of DFCM.

DIVISION OF FACILITIES CONSTRUCTION AND MANAGEMENT

Joanna Reese, Contract Coordinator
4110 State Office Building, Salt Lake City, Utah 84114

PROJECT DESCRIPTION

This project is primarily civil work to develop training sites. Phase 1 will consist of the first two miles of lane 1 with an alternate to include Lane 2 or the second two miles of the project. The primary objective of the scope of work is to regrade, widening the existing roadway and providing adequate drainage for the area.

The area consists of 8 training sites which will be graded and have conex containers placed on the sites for training use. No structures or sleepers will be required to support the conex containers.

**PROJECT SCHEDULE****PROJECT NAME: IED DEFEAT LANE CAMP WILLIAMS – UTAH NATIONAL GUARD
DRAPER, UTAH****DFCM PROJECT NO. 10181480**

Event	Day	Date	Time	Place
Bidding Documents Available	Tuesday	July 13, 2010	4:00 PM	DFCM 4110 State Office Bldg SLC, UT and the DFCM web site *
Mandatory Pre-bid Site Meeting	Thursday	July 15, 2010	8:00 AM	Bldg 1190 Camp Williams 17800 S. Redwood Rd. Riverton, Utah
Last Day to Submit Questions	Tuesday	July 20, 2010	5:00 PM	Wayne Smith – DFCM E-mail:wfsmith@utah.gov Fax 801-538-3267
Addendum Deadline (exception for bid delays)	Thursday	July 22, 2010	2:00 PM	DFCM web site *
Prime Contractors Turn In Bid and Bid Bond	Wednesday	July 28, 2010	3:00 PM	DFCM 4110 State Office Bldg SLC, UT
Sub-contractor List Due	Thursday	July 29, 2010	3:00 PM	DFCM 4110 State Office Bldg SLC, UT Fax 801-538-3677
Substantial Completion Date		December 15, 2010		

* **NOTE: DFCM's web site address is <http://dfcm.utah.gov>**



BID FORM

NAME OF BIDDER _____ DATE _____

To the Division of Facilities Construction and Management
4110 State Office Building
Salt Lake City, Utah 84114

The undersigned, responsive to the "Notice to Contractors" and in accordance with the "Instructions to Bidders", in compliance with your invitation for bids for the IED Defeat Lane Camp Williams – Utah National Guard – Draper, Utah – DFCM Project No. 10181480 and having examined the Contract Documents and the site of the proposed Work and being familiar with all of the conditions surrounding the construction of the proposed Project, including the availability of labor, hereby proposes to furnish all labor, materials and supplies as required for the Work in accordance with the Contract Documents as specified and within the time set forth and at the price stated below. This price is to cover all expenses incurred in performing the Work required under the Contract Documents of which this bid is a part:

I/We acknowledge receipt of the following Addenda: _____

For all work shown on the Drawings and described in the Specifications and Contract Documents, I/we agree to perform for the sum of:

BASE BID:

_____ DOLLARS (\$ _____)
(In case of discrepancy, written amount shall govern)

ADDITIVE ALTERNATE NO.1: All roadway and drainage improvements for Lane 2 – Roadway Station 140+00 to 240+15.

_____ DOLLARS (\$ _____)
(In case of discrepancy, written amount shall govern)

ADDITIVE ALTERNATE NO.2: All site preparation grading, and completion of Training Areas 7 and 8

_____ DOLLARS (\$ _____)
(In case of discrepancy, written amount shall govern)

BID FORM
PAGE NO. 2

ADDITIVE ALTERNATE NO.3: Full width asphaltic concrete pavement (3" thickness) and Portland cement concrete pavement curb and gutter sections on both sides (APWA Drawing 205, Type A) over base course provided as part of Base Bid. Asphaltic paving shall be from Roadway Station 1+00 to 2+00 and Roadway Station 24+50 to 27+50

_____ DOLLARS (\$_____)
(In case of discrepancy, written amount shall govern)

ADDITIVE ALTERNATE NO.4: Additional improvements at Training Site 8 to include a 1600 SF Portland cement concrete pad (6" thickness) and two (2) four-row aluminum bleacher units.

_____ DOLLARS (\$_____)
(In case of discrepancy, written amount shall govern)

Unit Prices: For all additional work not shown (but which may be provided at the direction of the Owner) on the Drawings and described in the Specifications and Contract Documents, I/we agree to perform for the additional sum of:

- 6" Thickness Untreated Base Course over prepared subgrade: \$_____per square foot
(Additional Roadway Widening)
- 3" Thickness Asphaltic Concrete Paving Over prepared road base: \$_____per square foot
- Portland Cement Curb and Gutter in place \$_____ per linear foot

I/We guarantee that the Work will be Substantially Complete by December 15, 2010, should I/we be the successful bidder, and agree to pay liquidated damages in the amount of **\$500.00** per day for each day after expiration of the Contract Time as stated in Article 3 of the Contractor's Agreement.

This bid shall be good for 45 days after bid opening.

Enclosed is a 5% bid bond, as required, in the sum of _____

The undersigned Contractor's License Number for Utah is _____.

Upon receipt of notice of award of this bid, the undersigned agrees to execute the contract within ten (10) days, unless a shorter time is specified in the Contract Documents, and deliver acceptable Performance and Payment bonds in the prescribed form in the amount of 100% of the Contract Sum for faithful performance of the contract.

The Bid Bond attached, in the amount not less than five percent (5%) of the above bid sum, shall become the property of the Division of Facilities Construction and Management as liquidated damages for delay and additional expense caused thereby in the event that the contract is not executed and/or acceptable 100% Performance and Payment bonds are not delivered within the time set forth.

Type of Organization:

(Corporation, Partnership, Individual, etc.)

Any request and information related to Utah Preference Laws:

Respectfully submitted,

Name of Bidder

ADDRESS:

Authorized Signature

INSTRUCTIONS TO BIDDERS

1. Drawings and Specifications, Other Contract Documents

Drawings and Specifications, as well as other available Contract Documents, may be obtained as stated in the Invitation to Bid.

2. Bids

Before submitting a bid, each contractor shall carefully examine the Contract Documents, shall visit the site of the Work; shall fully inform themselves as to all existing conditions and limitations; and shall include in the bid the cost of all items required by the Contract Documents. If the bidder observes that portions of the Contract Documents are at variance with applicable laws, building codes, rules, regulations or contain obvious erroneous or uncoordinated information, the bidder shall promptly notify the DFCM Representative and the necessary changes shall be accomplished by Addendum.

The bid, bearing original signatures, must be typed or handwritten in ink on the Bid Form provided in the procurement documents and submitted in a sealed envelope at the location specified by the Invitation to Bid prior to the deadline for submission of bids.

A bid bond properly signed by a qualified surety, as indicated on the DFCM Bid Bond form provided along with this Instruction to Bidders, in the amount of 5% of the bid, shall accompany the bid submission to DFCM. **THIS BID BOND MUST BE ON THE DFCM BID BOND FORM PROVIDED WITH THIS INSTRUCTION TO BIDDERS IN ORDER TO BE CONSIDERED AN ACCEPTABLE BID** unless only one bid is received by DFCM, or the failure to comply with the bid bond requirements is determined by the Director of DFCM to be nonsubstantial based on the following:

- (a) the bid bond is submitted on a form other than DFCM's required Bid Bond form and the bid bond meets all other requirements including being issued by a surety firm authorized to do business in the State of Utah and be listed in the U.S. Department of the Treasury Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies for an amount not less than the amount of the bond to be issued. A co-surety may be utilized to satisfy this requirement; and
- (b) the contractor provides a bid bond properly signed by a qualified surety and on the required DFCM Bid Bond form by the close of business of the next succeeding business day after the DFCM notifies the bidder of the defective bid bond.

3. Contract and Bond

The Contractor's Agreement will be in the form found in the specifications. The Contract Time will be as indicated in the bid. The successful bidder, simultaneously with the execution of the Contract Agreement, will be required to furnish a performance bond and a payment bond, both bearing original signatures, upon the forms provided in the procurement documents. The performance and payment bonds shall be for an amount equal to one hundred percent (100%) of the contract sum and secured from a company that meets the requirements specified in the requisite forms. Any bonding requirements for subcontractors will be specified in the Supplementary General Conditions.

4. Listing of Subcontractors

Listing of Subcontractors shall be as summarized in the “Instructions and Subcontractor’s List Form”, which are included as part of these Contract Documents. The Subcontractors List shall be delivered to DFCM or faxed to DFCM at 801-538-3677 within 24 hours of the bid opening. Requirements for listing additional subcontractors will be listed in the Contract Documents.

DFCM retains the right to audit or take other steps necessary to confirm compliance with requirements for the listing and changing of subcontractors. Any contractor who is found to not be in compliance with these requirements is subject to a debarment hearing and may be debarred from consideration for award of contracts for a period of up to three years.

5. Interpretation of Drawings and Specifications

If any person or entity contemplating submitting a bid is in doubt as to the meaning of any part of the drawings, specifications or other Contract Documents, such person shall submit to the DFCM Project Manager a request for an interpretation thereof. The person or entity submitting the request will be responsible for its prompt delivery. Any interpretation of the proposed documents will be made only by addenda posted on DFCM’s web site at <http://dfcm.utah.gov>. Neither the DFCM nor A/E will be responsible for any other explanations or interpretations of the proposed documents. A/E shall be deemed to refer to the architect or engineer hired by DFCM as the A/E or Consultant for the Project.

6. Addenda

Addenda will be posted on DFCM’s web site at <http://dfcm.utah.gov>. Contractors are responsible for obtaining information contained in each addendum from the web site. Addenda issued prior to the submittal deadline shall become part of the bidding process and must be acknowledged on the bid form. Failure to acknowledge addenda may result in disqualification from bidding.

7. Award of Contract

The Contract will be awarded as soon as possible to the lowest, responsive and responsible bidder, based on the lowest combination of base bid and acceptable prioritized alternates, provided the bid is reasonable, is in the interests of the State of Utah to accept and after applying the Utah Preference Laws in U.C.A. Title 63, Chapter 56. DFCM reserves the right to waive any technicalities or formalities in any bid or in the bidding. Alternates will be accepted on a prioritized basis with Alternate 1 being highest priority, Alternate 2 having second priority, etc.

8. DFCM Contractor Performance Rating

As a contractor completes each DFCM project, DFCM, the architect/engineer and the using agency will evaluate project performance based on the enclosed “DFCM Contractor Performance Rating” form. The ratings issued on this project will not affect this project but may affect the award on future projects.

9. Licensure

The Contractor shall comply with and require all of its subcontractors to comply with the license laws as required by the State of Utah.

10. Permits

In concurrence with the requirements for permitting in the General Conditions, it is the responsibility of the Contractor to obtain the fugitive dust plan requirements from the Utah Division of Air Quality and the SWPPP requirements from the Utah Department of Environmental Quality and submit the completed forms and pay any permit fee that may be required for this specific project. Failure to obtain the required permit may result in work stoppage and/or fines from the regulating authority that will be the sole responsibility of the Contractor. Any delay to the project as a result of any such failure to obtain the permit or noncompliance with the permit shall not be eligible for any extension in the Contract Time.

11. Right to Reject Bids

DFCM reserves the right to reject any or all Bids.

12. Time is of the Essence

Time is of the essence in regard to all the requirements of the Contract Documents.

13. Withdrawal of Bids

Bids may be withdrawn on written request received from bidder prior to the time fixed for opening. Negligence on the part of the bidder in preparing the bid confers no right for the withdrawal of the bid after it has been opened.

14. Product Approvals

Where reference is made to one or more proprietary products in the Contract Documents, but restrictive descriptive materials of one or more manufacturer(s) is referred to in the Contract Documents, the products of other manufacturers will be accepted, provided they equal or exceed the standards set forth in the drawings and specifications and are compatible with the intent and purpose of the design, subject to the written approval of the A/E. Such written approval must occur prior to the deadline established for the last scheduled addenda to be issued. The A/E's written approval will be in an issued addendum. If the descriptive material is not restrictive, the products of other manufacturers specified will be accepted without prior approval provided they are compatible with the intent and purpose of the design as determined by the A/E.

15. Financial Responsibility of Contractors, Subcontractors and Sub-subcontractors

Contractors shall respond promptly to any inquiry in writing by DFCM to any concern of financial responsibility of the contractor, subcontractor or sub-subcontractor.

16. Debarment

By submitting a bid, the Contractor certifies that neither it nor its principals, including project and site managers, have been, or are under consideration for, debarment or suspension, or any action that would exclude such from participation in a construction contract by any governmental department or agency. If the Contractor cannot certify this statement, attach to the bid a detailed written explanation which must be reviewed and approved by DFCM as part of the requirements for award of the Project.

**Division of Facilities Construction and****INSTRUCTIONS AND SUBCONTRACTORS LIST FORM**

The three low bidders, as well as all other bidders that desire to be considered, are required by law to submit to DFCM within 24 hours of bid opening a list of **ALL** first-tier subcontractors, including the subcontractor's name, bid amount and other information required by Building Board Rule and as stated in these Contract Documents, based on the following:

DOLLAR AMOUNTS FOR LISTING

PROJECTS UNDER \$500,000: ALL FIRST-TIER SUBS \$20,000 OR OVER MUST BE LISTED
PROJECTS \$500,000 OR MORE: ALL FIRST-TIER SUBS \$35,000 OR OVER MUST BE LISTED

- Any additional subcontractors identified in the bid documents shall also be listed.
- The DFCM Director may not consider any bid submitted by a bidder if the bidder fails to submit a subcontractor list meeting the requirements of State law.
- List subcontractors for base bid as well as the impact on the list that the selection of any alternate may have.
- Bidder may not list more than one subcontractor to perform the same work.
- If there are no subcontractors for the job that are required to be reported by State law (either because there are no subcontractors that will be used on the project or because there are no first-tier subcontractors over the dollar amounts referred to above), then you do not need to submit a sublist. If you do not submit a sublist, it will be deemed to be a representation by you that there are no subcontractors on the job that are required to be reported under State law. At any time, DFCM reserves the right to inquire, for security purposes, as to the identification of the subcontractors at any tier that will be on the worksite.

LICENSURE:

The subcontractor's name, the type of work, the subcontractor's bid amount, and the subcontractor's license number as issued by DOPL, if such license is required under Utah Law, shall be listed. Bidder shall certify that all subcontractors, required to be licensed, are licensed as required by State law. A subcontractor includes a trade contractor or specialty contractor and does not include suppliers who provide only materials, equipment, or supplies to a contractor or subcontractor.

'SPECIAL EXCEPTION':

A bidder may list 'Special Exception' in place of a subcontractor when the bidder intends to obtain a subcontractor to perform the work at a later date because the bidder was unable to obtain a qualified or reasonable bid under the provisions of U.C.A. Section 63A-5-208(4). The bidder shall insert the term 'Special Exception' for that category of work, and shall provide documentation with the subcontractor list describing the bidder's efforts to obtain a bid of a qualified subcontractor at a reasonable cost and why the bidder was unable to obtain a qualified subcontractor bid. The Director must find that the bidder complied in good faith with State law requirements for any 'Special Exception' designation, in order for the bid to be considered. If awarded the contract, the Director shall supervise the bidder's efforts to obtain a qualified subcontractor bid. The amount of the awarded contract may not be adjusted to reflect the actual amount of the subcontractor's bid. Any listing of 'Special Exception' on the sublist form shall also include amount allocated for that work.

GROUND FOR DISQUALIFICATION:

The Director may not consider any bid submitted by a bidder if the bidder fails to submit a subcontractor list meeting the requirements of State law. Director may withhold awarding the contract to a particular bidder if one or more of the proposed subcontractors are considered by the Director to be unqualified to do the Work or for

INSTRUCTIONS AND SUBCONTRACTORS LIST FORM
Page No. 2

such other reason in the best interest of the State of Utah. Notwithstanding any other provision in these instructions, if there is a good faith error on the sublist form, at the sole discretion of the Director, the Director may provide notice to the contractor and the contractor shall have 24 hours to submit the correction to the Director. If such correction is submitted timely, then the sublist requirements shall be considered met.

CHANGES OF SUBCONTRACTORS SPECIFICALLY IDENTIFIED ON SUBLIST FORM:

Subsequent to twenty-four hours after the bid opening, the contractor may change its listed subcontractors only after receiving written permission from the Director based on complying with all of the following criteria.

- (1) The contractor has established in writing that the change is in the best interest of the State and that the contractor establishes an appropriate reason for the change, which may include, but not is not limited to, the following reasons: the original subcontractor has failed to perform, or is not qualified or capable of performing, and/or the subcontractor has requested in writing to be released.
- (2) The circumstances related to the request for the change do not indicate any bad faith in the original listing of the subcontractors.
- (3) Any requirement set forth by the Director to ensure that the process used to select a new subcontractor does not give rise to bid shopping.
- (4) Any increase in the cost of the subject subcontractor work is borne by the contractor.
- (5) Any decrease in the cost of the subject subcontractor work shall result in a deductive change order being issued for the contract for such decreased amount.
- (6) The Director will give substantial weight to whether the subcontractor has consented in writing to being removed unless the Contractor establishes that the subcontractor is not qualified for the work.

EXAMPLE:

Example of a list where there are only four subcontractors:

TYPE OF WORK	SUBCONTRACTOR, "SELF" OR "SPECIAL EXCEPTION"	SUBCONTRACTOR BID AMOUNT	CONTRACTOR LICENSE #
ELECTRICAL	ABCD Electric Inc.	\$350,000.00	123456789000
LANDSCAPING	"Self" *	\$300,000.00	123456789000
CONCRETE (ALTERNATE #1)	XYZ Concrete Inc	\$298,000.00	987654321000
MECHANICAL	"Special Exception" (attach documentation)	Fixed at: \$350,000.00	(TO BE PROVIDED AFTER OBTAINING SUBCONTRACTOR)

* Bidders may list "self", but it is not required.

PURSUANT TO STATE LAW - SUBCONTRACTOR BID AMOUNTS CONTAINED IN THIS SUBCONTRACTOR LIST SHALL NOT BE DISCLOSED UNTIL THE CONTRACT HAS BEEN AWARDED.



SUBCONTRACTORS LIST
FAX TO 801-538-3677

PROJECT TITLE: _____

Caution: You must read and comply fully with instructions.

Table with 4 columns: TYPE OF WORK, SUBCONTRACTOR, 'SELF' OR 'SPECIAL EXCEPTION', SUBCONTRACTOR BID AMOUNT, CONT. LICENSE #

We certify that:

- 1. This list includes all subcontractors as required by the instructions, including those related to the base bid as well as any alternates.
2. We have listed 'Self' or 'Special Exception' in accordance with the instructions.
3. All subcontractors are appropriately licensed as required by State law.

FIRM: _____

DATE: _____

SIGNED BY: _____

NOTICE: FAILURE TO SUBMIT THIS FORM, PROPERLY COMPLETED AND SIGNED, AS REQUIRED IN THESE CONTRACT DOCUMENTS, SHALL BE GROUNDS FOR OWNER'S REFUSAL TO ENTER INTO A WRITTEN CONTRACT WITH BIDDER. ACTION MAY BE TAKEN AGAINST BIDDERS BID BOND AS DEEMED APPROPRIATE BY OWNER. ATTACH A SECOND PAGE IF NECESSARY.

CONTRACTOR'S AGREEMENT

FOR:

THIS CONTRACTOR'S AGREEMENT, made and entered into this ____ day of _____, 20__, by and between the DIVISION OF FACILITIES CONSTRUCTION AND MANAGEMENT, hereinafter referred to as "DFCM", and _____, incorporated in the State of _____ and authorized to do business in the State of Utah, hereinafter referred to as "Contractor", whose address is _____.

WITNESSETH: WHEREAS, DFCM intends to have Work performed at _____.

WHEREAS, Contractor agrees to perform the Work for the sum stated herein.

NOW, THEREFORE, DFCM and Contractor for the consideration provided in this Contractor's Agreement, agree as follows:

ARTICLE 1. SCOPE OF WORK. The Work to be performed shall be in accordance with the Contract Documents prepared by _____ and entitled "_____."

The DFCM General Conditions ("General Conditions") dated May 25, 2005 and all Supplemental General Conditions ("also referred to as General Conditions") on file at the office of DFCM and available on the DFCM website (<http://dfcm.utah.gov/StdDocs/index.html>), are hereby incorporated by reference as part of this Agreement and are included in the specifications for this Project. All terms used in this Contractor's Agreement shall be as defined in the Contract Documents, and in particular, the General Conditions.

The Contractor Agrees to furnish labor, materials and equipment to complete the Work as required in the Contract Documents which are hereby incorporated by reference. It is understood and agreed by the parties hereto that all Work shall be performed as required in the Contract Documents and shall be subject to inspection and approval of DFCM or its authorized representative. The relationship of the Contractor to the DFCM hereunder is that of an independent Contractor.

ARTICLE 2. CONTRACT SUM. The DFCM agrees to pay and the Contractor agrees to accept in full performance of this Contractor's Agreement, the sum of _____ DOLLARS AND NO CENTS (\$_____.00), which is the base bid, and which sum also includes the cost of a 100% Performance Bond and a 100%

CONTRACTOR'S AGREEMENT
PAGE NO. 2

Payment Bond as well as all insurance requirements of the Contractor. Said bonds have already been posted by the Contractor pursuant to State law. The required proof of insurance certificates have been delivered to DFCM in accordance with the General Conditions before the execution of this Contractor's Agreement.

ARTICLE 3. TIME OF COMPLETION AND DELAY REMEDY. The Work shall be Substantially Complete by _____. Contractor agrees to pay liquidated damages in the amount of \$_____ per day for each day after expiration of the Contract Time until the Contractor achieves Substantial Completion in accordance with the Contract Documents, if Contractor's delay makes the damages applicable. The provision for liquidated damages is: (a) to compensate the DFCM for delay only; (b) is provided for herein because actual damages can not be readily ascertained at the time of execution of this Contractor's Agreement; (c) is not a penalty; and (d) shall not prevent the DFCM from maintaining Claims for other non-delay damages, such as costs to complete or remedy defective Work.

No action shall be maintained by the Contractor, including its or Subcontractor or suppliers at any tier, against the DFCM or State of Utah for damages or other claims due to losses attributable to hindrances or delays from any cause whatsoever, including acts and omissions of the DFCM or its officers, employees or agents, except as expressly provided in the General Conditions. The Contractor may receive a written extension of time, signed by the DFCM, in which to complete the Work under this Contractor's Agreement in accordance with the General Conditions.

ARTICLE 4. CONTRACT DOCUMENTS. The Contract Documents consist of this Contractor's Agreement, the Conditions of the Contract (DFCM General Conditions, Supplementary and other Conditions), the Drawings, Specifications, Addenda and Modifications. The Contract Documents shall also include the bidding documents, including the Invitation to Bid, Instructions to Bidders/ Proposers and the Bid/Proposal, to the extent not in conflict therewith and other documents and oral presentations that are documented as an attachment to the contract.

All such documents are hereby incorporated by reference herein. Any reference in this Contractor's Agreement to certain provisions of the Contract Documents shall in no way be construed as to lessen the importance or applicability of any other provisions of the Contract Documents.

ARTICLE 5. PAYMENT. The DFCM agrees to pay the Contractor from time to time as the Work progresses, but not more than once each month after the date of Notice to Proceed, and only upon Certificate of the A/E for Work performed during the preceding calendar month, ninety-five percent (95%) of the value of the labor performed and ninety-five percent (95%) of the value of materials furnished in place or on the site. The Contractor agrees to furnish to the DFCM invoices for materials purchased and on the site but not installed, for which the Contractor requests payment and agrees to

safeguard and protect such equipment or materials and is responsible for safekeeping thereof and if such be stolen, lost or destroyed, to replace same.

Such evidence of labor performed and materials furnished as the DFCM may reasonably require shall be supplied by the Contractor at the time of request for Certificate of Payment on account. Materials for which payment has been made cannot be removed from the job site without DFCM's written approval. Five percent (5%) of the earned amount shall be retained from each monthly payment. The retainage, including any additional retainage imposed and the release of any retainage, shall be in accordance with UCA 13-8-5 as amended. Contractor shall also comply with the requirements of UCA 13-8-5, including restrictions of retainage regarding subcontractors and the distribution of interest earned on the retention proceeds. The DFCM shall not be responsible for enforcing the Contractor's obligations under State law in fulfilling the retention law requirements with subcontractors at any tier.

ARTICLE 6. INDEBTEDNESS. Before final payment is made, the Contractor must submit evidence satisfactory to the DFCM that all payrolls, materials bills, subcontracts at any tier and outstanding indebtedness in connection with the Work have been properly paid. Final Payment will be made after receipt of said evidence, final acceptance of the Work by the DFCM as well as compliance with the applicable provisions of the General Conditions.

Contractor shall respond immediately to any inquiry in writing by DFCM as to any concern of financial responsibility and DFCM reserves the right to request any waivers, releases or bonds from Contractor in regard to any rights of Subcontractors (including suppliers) at any tier or any third parties prior to any payment by DFCM to Contractor.

ARTICLE 7. ADDITIONAL WORK. It is understood and agreed by the parties hereto that no money will be paid to the Contractor for additional labor or materials furnished unless a new contract in writing or a Modification hereof in accordance with the General Conditions and the Contract Documents for such additional labor or materials has been executed. The DFCM specifically reserves the right to modify or amend this Contractor's Agreement and the total sum due hereunder either by enlarging or restricting the scope of the Work.

ARTICLE 8. INSPECTIONS. The Work shall be inspected for acceptance in accordance with the General Conditions.

ARTICLE 9. DISPUTES. Any dispute, PRE or Claim between the parties shall be subject to the provisions of Article 7 of the General Conditions. DFCM reserves all rights to pursue its rights and remedies as provided in the General Conditions.

ARTICLE 10. TERMINATION, SUSPENSION OR ABANDONMENT. This Contractor's Agreement may be terminated, suspended or abandoned in accordance with the General Conditions.

ARTICLE 11. DFCM'S RIGHT TO WITHHOLD CERTAIN AMOUNT AND MAKE USE THEREOF. The DFCM may withhold from payment to the Contractor such amount as, in DFCM's judgment, may be necessary to pay just claims against the Contractor or Subcontractor at any tier for labor and services rendered and materials furnished in and about the Work. The DFCM may apply such withheld amounts for the payment of such claims in DFCM's discretion. In so doing, the DFCM shall be deemed the agent of Contractor and payment so made by the DFCM shall be considered as payment made under this Contractor's Agreement by the DFCM to the Contractor. DFCM shall not be liable to the Contractor for any such payment made in good faith. Such withholdings and payments may be made without prior approval of the Contractor and may be also be prior to any determination as a result of any dispute, PRE, Claim or litigation.

ARTICLE 12. INDEMNIFICATION. The Contractor shall comply with the indemnification provisions of the General Conditions.

ARTICLE 13. SUCCESSORS AND ASSIGNMENT OF CONTRACT. The DFCM and Contractor, respectively bind themselves, their partners, successors, assigns and legal representatives to the other party to this Agreement, and to partners, successors, assigns and legal representatives of such other party with respect to all covenants, provisions, rights and responsibilities of this Contractor's Agreement. The Contractor shall not assign this Contractor's Agreement without the prior written consent of the DFCM, nor shall the Contractor assign any moneys due or to become due as well as any rights under this Contractor's Agreement, without prior written consent of the DFCM.

ARTICLE 14. RELATIONSHIP OF THE PARTIES. The Contractor accepts the relationship of trust and confidence established by this Contractor's Agreement and covenants with the DFCM to cooperate with the DFCM and A/E and use the Contractor's best skill, efforts and judgment in furthering the interest of the DFCM; to furnish efficient business administration and supervision; to make best efforts to furnish at all times an adequate supply of workers and materials; and to perform the Work in the best and most expeditious and economic manner consistent with the interests of the DFCM.

ARTICLE 15. AUTHORITY TO EXECUTE AND PERFORM AGREEMENT. Contractor and DFCM each represent that the execution of this Contractor's Agreement and the performance thereunder is within their respective duly authorized powers.

ARTICLE 16. ATTORNEY FEES AND COSTS. Except as otherwise provided in the dispute resolution provisions of the General Conditions, the prevailing party shall be entitled to reasonable attorney fees and costs incurred in any action in the District Court and/or appellate body to enforce this Contractor's Agreement or recover damages or any other action as a result of a breach thereof.

PERFORMANCE BOND

(Title 63, Chapter 56, U. C. A. 1953, as Amended)

That _____ hereinafter referred to as the "Principal" and _____, a corporation organized and existing under the laws of the State of _____, with its principal office in the City of _____ and authorized to transact business in this State and U. S. Department of the Treasury Listed (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); hereinafter referred to as the "Surety," are held and firmly bound unto the State of Utah, hereinafter referred to as the "Obligee," in the amount of _____ DOLLARS (\$) _____ for the payment whereof, the said Principal and Surety bind themselves and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Contract with the Obligee, dated the _____ day of _____, 20____, to construct _____ in the County of _____, State of Utah, Project No. _____, for the approximate sum of _____ Dollars (\$ _____), which Contract is hereby incorporated by reference herein.

NOW, THEREFORE, the condition of this obligation is such that if the said Principal shall faithfully perform the Contract in accordance with the Contract Documents including, but not limited to, the Plans, Specifications and conditions thereof, the one year performance warranty, and the terms of the Contract as said Contract may be subject to Modifications or changes, then this obligation shall be void; otherwise it shall remain in full force and effect.

No right of action shall accrue on this bond to or for the use of any person or corporation other than the state named herein or the heirs, executors, administrators or successors of the Owner.

The parties agree that the dispute provisions provided in the Contract Documents apply and shall constitute the sole dispute procedures of the parties.

PROVIDED, HOWEVER, that this Bond is executed pursuant to the Provisions of Title 63, Chapter 56, Utah Code Annotated, 1953, as amended, and all liabilities on this Bond shall be determined in accordance with said provisions to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, 20____.

WITNESS OR ATTESTATION:

PRINCIPAL:

By: _____ (Seal)

Title: _____

WITNESS OR ATTESTATION:

SURETY:

By: _____ (Seal)

Attorney-in-Fact

STATE OF _____)
) ss.
COUNTY OF _____)

On this _____ day of _____, 20____, personally appeared before me _____, whose identity is personally known to me or proved to me on the basis of satisfactory evidence, and who, being by me duly sworn, did say that he/she is the Attorney in-fact of the above-named Surety Company and that he/she is duly authorized to execute the same and has complied in all respects with the laws of Utah in reference to becoming sole surety upon bonds, undertakings and obligations, and that he/she acknowledged to me that as Attorney-in-fact executed the same.

Subscribed and sworn to before me this _____ day of _____, 20____.

My commission expires: _____

Resides at: _____

NOTARY PUBLIC

Agency: _____
Agent: _____
Address: _____
Phone: _____

Approved As To Form: May 25, 2005
By Alan S. Bachman, Asst Attorney General

PAYMENT BOND

(Title 63, Chapter 56, U. C. A. 1953, as Amended)

KNOW ALL PERSONS BY THESE PRESENTS:

That _____ hereinafter referred to as the "Principal," and _____, a corporation organized and existing under the laws of the State of _____ authorized to do business in this State and U. S. Department of the Treasury Listed (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); with its principal office in the City of _____, hereinafter referred to as the "Surety," are held and firmly bound unto the State of Utah hereinafter referred to as the "Obligee," in the amount of _____ Dollars (\$ _____) for the payment whereof, the said Principal and Surety bind themselves and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Contract with the Obligee, dated the _____ day of _____, 20____, to construct _____ in the County of _____, State of Utah, Project No. _____ for the approximate sum of _____ Dollars (\$ _____), which contract is hereby incorporated by reference herein.

NOW, THEREFORE, the condition of this obligation is such that if the said Principal shall pay all claimants supplying labor or materials to Principal or Principal's Subcontractors in compliance with the provisions of Title 63, Chapter 56, of Utah Code Annotated, 1953, as amended, and in the prosecution of the Work provided for in said Contract, then, this obligation shall be void; otherwise it shall remain in full force and effect.

That said Surety to this Bond, for value received, hereby stipulates and agrees that no changes, extensions of time, alterations or additions to the terms of the Contract or to the Work to be performed thereunder, or the specifications or drawings accompanying same shall in any way affect its obligation on this Bond, and does hereby waive notice of any such changes, extensions of time, alterations or additions to the terms of the Contract or to the Work or to the specifications or drawings and agrees that they shall become part of the Contract Documents.

PROVIDED, HOWEVER, that this Bond is executed pursuant to the provisions of Title 63, Chapter 56, Utah Code Annotated, 1953, as amended, and all liabilities on this Bond shall be determined in accordance with said provisions to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, 20____.

WITNESS OR ATTESTATION:

PRINCIPAL:

By: _____ (Seal)

Title: _____

WITNESS OR ATTESTATION:

SURETY:

By: _____ Attorney-in-Fact (Seal)

STATE OF _____)
) ss.
COUNTY OF _____)

On this _____ day of _____, 20____, personally appeared before me _____, whose identity is personally known to me or proved to me on the basis of satisfactory evidence, and who, being by me duly sworn, did say that he/she is the Attorney-in-fact of the above-named Surety Company, and that he/she is duly authorized to execute the same and has complied in all respects with the laws of Utah in reference to becoming sole surety upon bonds, undertakings and obligations, and that he/she acknowledged to me that as Attorney-in-fact executed the same.

Subscribed and sworn to before me this _____ day of _____, 20____.

My commission expires: _____
Resides at: _____

NOTARY PUBLIC

Agency: _____
Agent: _____
Address: _____
Phone: _____

Approved As To Form: May 25, 2005
By Alan S. Bachman, Asst Attorney General



CERTIFICATE OF SUBSTANTIAL COMPLETION

PROJECT _____ PROJECT NO: _____

AGENCY/INSTITUTION _____

AREA ACCEPTED _____

The Work performed under the subject Contract has been reviewed on this date and found to be Substantially Completed as defined in the General Conditions; including that the construction is sufficiently completed in accordance with the Contract Documents, as modified by any change orders agreed to by the parties, so that the State of Utah can occupy the Project or specified area of the Project for the use for which it is intended.

The DFCM - (Owner) accepts the Project or specified area of the Project as Substantially Complete and will assume full possession of the Project or specified area of the Project at _____ (time) on _____ (date).

The DFCM accepts the Project for occupancy and agrees to assume full responsibility for maintenance and operation, including utilities and insurance, of the Project subject to the itemized responsibilities and/or exceptions noted below:

The Owner acknowledges receipt of the following closeout and transition materials:

- As-built Drawings
- O & M Manuals
- Warranty Documents
- Completion of Training Requirements

A list of items to be completed or corrected (Punch List) is attached hereto. The failure to include an item on it does not alter the responsibility of the Contractor to complete all the Work in accordance with the Contract Documents, including authorized changes thereof. The amount of _____(Twice the value of the punch list work) shall be retained to assure the completion of the punch list work.

The Contractor shall complete or correct the Work on the list of (Punch List) items appended hereto within _____ calendar days from the above date of issuance of this Certificate. The amount withheld pending completion of the list of items noted and agreed to shall be: \$_____. If the list of items is not completed within the time allotted the Owner has the right to be compensated for the delays and/or complete the work with the help of independent contractor at the expense of the retained project funds. If the retained project funds are insufficient to cover the delay/completion damages, the Owner shall be promptly reimbursed for the balance of the funds needed to compensate the Owner.

CONTRACTOR (include name of firm) by: _____
(Signature) DATE

A/E (include name of firm) by: _____
(Signature) DATE

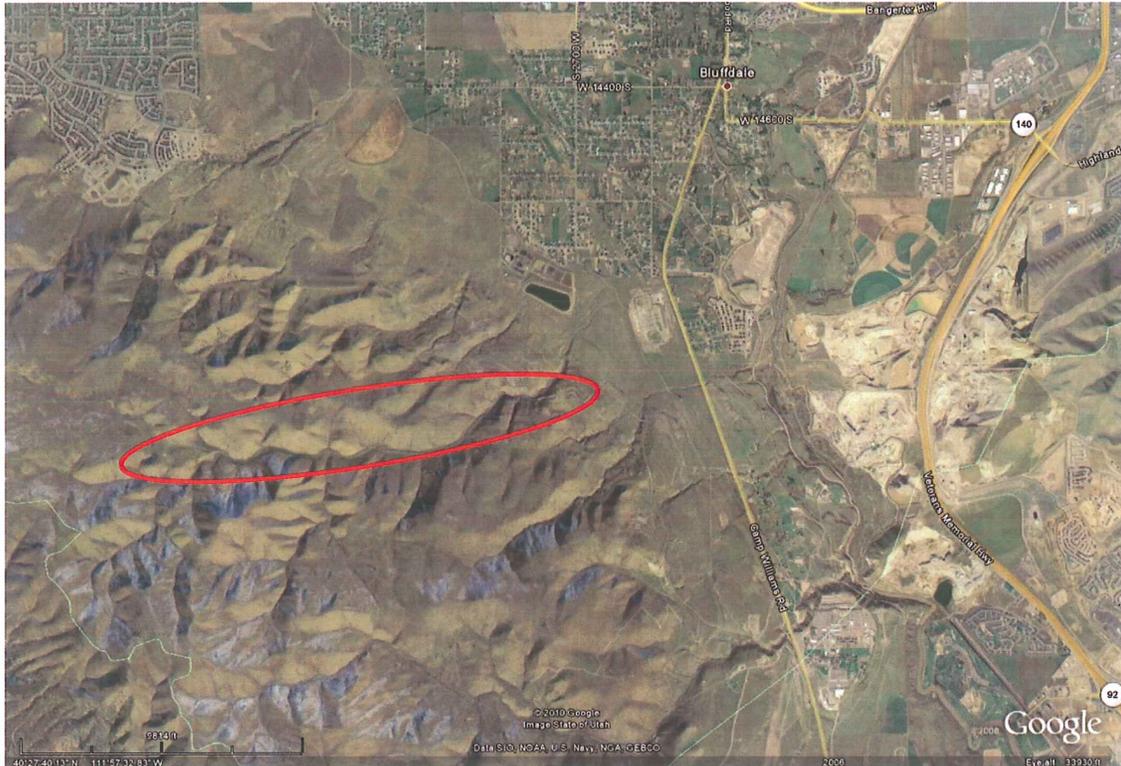
USING INSTITUTION OR AGENCY by: _____
(Signature) DATE

DFCM (Owner) by: _____
(Signature) DATE

Project Manual

for

Utah National Guard Camp Williams IED Defeat Lane DFCM Project No. 10181480



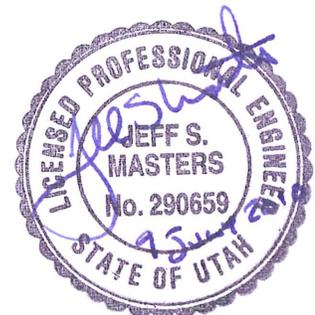
**Utah National Guard - Camp Williams
17800 South Camp Williams Rd
Riverton, Ut 84065**

***Issued for Review*
July 9, 2010**



Stanley Consultants INC.

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Engineering, Environmental and Construction Services - Worldwide



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**UTAH NATIONAL GUARD
CAMP WILLIAMS IED DEFEAT LANE
DFCM PROJECT NO. 10181480**

**UTAH NATIONAL GUARD - CAMP WILLIAMS
17800 SOUTH CAMP WILLIAMS RD
RIVERTON, UT 84065**

SPECIFICATIONS GROUP**GENERAL REQUIREMENTS SUBGROUP**

Section	Title	Page
DIVISION 01 GENERAL REQUIREMENTS		
01 11 00	Summary of Work	1 thru 2
01 41 00	Regulatory Requirements	1 thru 1
01 45 29	Testing Laboratory Services	1 thru 2
01 50 00	Temporary Facilities and Controls	1 thru 6
01 57 13	Temporary Erosion and Sediment Control	1 thru 2

FACILITY CONSTRUCTION SUBGROUP

DIVISION 03 CONCRETE		
03 00 10	Concrete Work	1 thru 7
DIVISION 05 METALS		
05 50 00	Metal Fabrications	1 thru 2
DIVISION 06 WOOD, PLASTICS, AND COMPOSITES		
06 10 00	Rough Carpentry	1 thru 2
DIVISION 09 FINISHES		
09 90 00	Painting and Coating	1 thru 5

FACILITY SERVICES SUBGROUP

DIVISION 26 ELECTRICAL		
26 05 00	Common Work Results for Electrical	1 thru 18
26 05 33	Above-Grade Raceway	1 thru 6
26 05 43	Below Grade Raceway	1 thru 7
26 32 13	Diesel Engine-Driven Generators	1 thru 17
26 50 00	Lighting	1 thru 5

SITE AND INFRASTRUCTURE SUBGROUP

DIVISION 31 EARTHWORK		
31 10 00	Site Clearing	1 thru 2

Section	Title	Page
31 22 00	Grading	1 thru 3
31 22 19	Finish Grading	1 thru 1
DIVISION 32 EXTERIOR IMPROVEMENTS		
32 15 00	Aggregate Surfacing	1 thru 1
DIVISION 33 UTILITIES		
33 42 00	Culverts	1 thru 1
33 79 00	Grounding and Bonding for Electrical Systems	1 thru 5

DRAWINGS

DRAWING LIST	SHEET NO.
TITLE	TITLE SHEET
G - 1	OVERVIEW, INDEX & SUMMARY SHEET
SC - 1	SURVEY CONTROL SHEET
RD-01 TO RD-19	ROADWAY PLAN AND PROFILE SHEETS
CS-01 TO CS-16	CROSS SECTION SHEETS
SP-01 TO SP-09	SITE PLAN SHEETS
DT-01 TO DT-02	DETAIL SHEETS
E - 01	ELECTRICAL DETAILS

PART 1 GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS

- A. Work of this Agreement comprises general construction of Counter Improvised Explosive Device (CIED) training facilities located at Camp Williams, Utah for the Utah Army National Guard.
- B. Major Work items shall include (base bid and alternates);
 - 1. Approximately 4 miles of roadway grading, aggregate surfacing and drainage improvements.
 - 2. Clearing, grubbing, rough and finish grading for approximately 4.5 acres over 9 training sites.
 - 3. Transport, placement, exterior wood finish and painting of approximately 125 CONEX units.
 - 4. Electrical improvements to the existing training classroom building.
 - 5. Miscellaneous erosion control and site restoration items.

1.02 WORK BY OTHERS

- A. Work on Project which will be executed prior to start of Work of this Agreement, and which is excluded from this Agreement, as follows:
- B. Work on Project which will be executed after completion of Work of this Agreement, and which is excluded from this Agreement, as follows:
 - 1. Purchase of CONEX units.
 - 2. Transport of CONEX units to Camp Williams.

1.03 WORK SEQUENCE

- A. Construct Work in stages to accommodate Owner's use of premises during construction period; coordinate construction schedule and operations with Owner's Representative and Camp Williams Range Operations.
 - 1. Schedule Work to minimize interruptions to utility service or use of street barricades and detours.
 - 2. Coordinate all work schedules and transportation routes with Camp Williams Range Control.
- B. Construct Work in stages to provide for Owner's convenience.
 - 1. Do not close off roadway access to range facilities until completion of one stage of construction will provide alternative route(s).

1.04 CONTRACTOR USE OF PREMISES

- A. Coordinate use of premises under direction of Range Control. Contractor shall confine construction equipment, storage of materials and equipment and operations of workers to areas permitted by law, ordinances, permits, or requirements of Contract Documents, and shall not unreasonably encumber premises with construction equipment or other material or equipment.
- B. The work area is located within a historic military training and operations area. There may be unexploded ordnance (UXO) within the work area that has not been identified. All of Contractor's personnel who will be working on site shall complete UXO training from Camp Williams Range Control prior to accessing the site. Contractor's personnel shall follow procedures and regulations provided by Range Control during execution of the Work.
- C. Assume full responsibility for protection and safekeeping of items under this Agreement, stored on Site.
- D. Move any stored items, under Contractor's control, which interfere with operations of Owner or separate contractor.
- E. Obtain and pay for use of additional storage or Work areas needed for operations.

1.05 OWNER OCCUPANCY

- A. Owner will occupy premises during entire period of construction for conduct of its normal operations. Cooperate with Owner's Representative in all construction operations to minimize conflict, and to facilitate Owner usage.
 - 1. Maintain existing Wood Hollow Road in substantially continuous operation during construction, making and removing temporary one-lane bypasses as necessary. Do not construct temporary bypass roads that will result in an increase in land disturbance – all bypasses must remain within roadway footprint without prior specific approval from the Owner's representative.
 - 2. Access for emergency, firefighting, and range operations personnel shall be maintained continuously throughout construction without prior specific approval from the Owner's representative.

1.06 OWNER-FURNISHED ITEMS

- A. Products furnished and paid for by Owner:
 - 1. CONEX units to be provided by Owner to a staging site at Camp Williams. Contractor to transport CONEX from staging site to final location(s), grade and prepare pad, and set in place.
 - 2. Training Classroom Site Signage: Owner to provide information display case at a staging site at Camp Williams. Contractor transport display cased to final location and install.
 - 3. C-IED Training Aids. Owner will furnish and install.
- B. Owner's responsibilities:
 - 1. Arrange for and deliver necessary Shop Drawings and Samples to Contractor.
 - 2. Arrange and pay for product delivery to Site, in accordance with construction schedule.
 - 3. Inspect deliveries jointly with Contractor.
 - 4. Submit claims for transportation damage.
 - 5. Arrange for replacement of damaged, defective, or missing items.
- C. Contractor's responsibilities:
 - 1. Designate delivery date for each product in Construction Schedule.
 - 2. Review Shop Drawings and Samples. Submit to Engineer with notification of any discrepancies or problems anticipated in use of product.
 - 3. Receive and unload products at Site.
 - 4. Promptly inspect products jointly with Owner, record shortages, damages, or defective items.
 - 5. Protect products from damage.
 - 6. Assemble, install, connect, adjust, and finish products, as stipulated in respective Section of Specifications.
 - 7. Repair or replace items damaged by Contractor.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

PART 1 GENERAL

1.01 BUILDING CODES AND PERMITS

- A. Work shall comply with Utah State Building Rules and Regulations of the Division of Facilities Construction and Management (DFCM) local Municipal Ordinances and other Statutory Provisions pertaining to this class of Work; such rules, regulations, and ordinances are to be considered part of Contract Documents.
- B. Fees for permits and licenses shall be paid by Contractor.
- C. Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for prosecution of Work, which are applicable at time of opening of Bids. Contractor shall pay all charges of utility service companies for connections to Work, and Owner shall pay all charges of such companies for capital costs related thereto.
- D. Contractor shall give all notices and comply with all laws, ordinances, building and construction codes, rules, and regulations applicable to Work. If Contractor observes that Specifications or Drawings are at variance therewith, Contractor shall give Engineer prompt written notice thereof, and any necessary changes shall be adjusted by appropriate Modification. If Contractor performs any Work knowing or having reason to know that it is contrary to such laws, ordinances, rules, and regulations, and without such notice to Engineer, Contractor shall bear all costs arising therefrom; however, it shall not be Contractor's primary responsibility to make certain that Specifications and Drawings are in accordance with such laws, ordinances, rules, and regulations.
- E. Obtain and pay for NPDES permit coverage for Project under Utah Department of Environmental Quality "Storm Water Discharges Associated with Industrial Activity for Construction Activities." Contractor shall be responsible for all aspects of permit application process including, but not limited to:
 - 1. Prepare effective Storm Water Pollution Prevention Plan in accordance with Utah DEQ requirements.
 - 2. Prepare and file complete Utah DEQ "Notice of Intent for NPDES Coverage under General Permit."

1.02 TAXES

- A. Contractor shall pay all sales, consumer, use and other similar taxes required to be paid by it in accordance with law of place of Project.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

PART 1 GENERAL

1.01 RELATED SECTIONS

- A. Conditions of Agreement: Inspections and testing required by laws, ordinances, rules, regulations, orders or approvals of public authorities.
- B. Respective sections of Specifications: Certification of products.
- C. Each Specification section listed: Laboratory tests required, and standards for testing.
- D. Testing laboratory inspection, sampling, and testing required for:
 - 1. Section 32 15 00 – Aggregate Surfacing
 - 2. Section 32 23 00 – Excavation and Fill

1.02 TESTING LABORATORY SERVICES

- A. Owner will employ and pay for services of independent testing laboratory to perform specified testing.
 - 1. Contractor shall cooperate with laboratory to facilitate execution of its required services.
 - 2. Employment of laboratory shall in no way relieve Contractor's obligations to perform Work of Agreement.

1.03 QUALIFICATION OF LABORATORY

- A. Meet "Recommended Requirements for Independent Laboratory Qualifications," published by American Council of Independent Laboratories.
- B. Meet basic requirements of ASTM E329, "Standards of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction."
- C. Authorized to operate in state in which Project is located.
- D. Submit copy of report of inspection of facilities made by Materials Reference Laboratory of National Bureau of Standards during most recent tour of inspection, with memorandum of remedies of any deficiencies reported by inspection.
- E. Testing equipment:
 - 1. Calibrated at reasonable intervals by devices of accuracy traceable to either:
 - a. National Bureau of Standards.
 - b. Accepted values of natural physical constants.

1.04 LABORATORY DUTIES

- A. Cooperate with Engineer and Contractor; provide qualified personnel after due notice.
- B. Perform specified inspections, sampling, and testing of materials and methods of construction:
 - 1. Comply with specified standards.
 - 2. Ascertain compliance of materials with requirements of Contract Documents.
- C. Promptly notify Engineer and Contractor of observed irregularities or deficiencies of Work or products.
- D. Promptly submit written report of each test and inspection; one copy each to Engineer, Owner, Contractor, and one copy to record documents file. Each report shall include:
 - 1. Date issued.
 - 2. Project title and number.
 - 3. Testing laboratory name, address, and telephone number.

4. Name and signature of laboratory inspector.
5. Date and time of sampling or inspection.
6. Record of temperature and weather conditions.
7. Date of test.
8. Identification of product and Specification section.
9. Location of sample or test in Project.
10. Type of inspection or test.
11. Results of tests and compliance with Contract Documents.
12. Interpretation of test results, when requested by Engineer.

E. Perform additional tests as required by Engineer or Owner.

1.05 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

A. Laboratory is not authorized to:

1. Release, revoke, alter, or enlarge on requirements of Contract Documents.
2. Approve or accept any portion of Work.
3. Perform any duties of Contractor.

1.06 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory personnel, provide access to Work and to manufacturer's operations.

B. Secure and deliver to laboratory adequate quantities of representational samples of materials proposed to be used and which require testing.

C. Furnish copies of products test reports as required.

D. Furnish incidental labor and facilities:

1. To provide access to Work to be tested.
2. To obtain and handle samples at Project Site or at source of product to be tested.
3. To facilitate inspections and tests.
4. For storage and curing of test samples.

E. Notify laboratory sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests. When tests or inspections cannot be performed after such notice, reimburse Owner for laboratory personnel and travel expenses incurred due to Contractor's negligence.

F. Employ and pay for services of separate, equally qualified independent testing laboratory to perform additional inspections, sampling, and testing required:

1. For Contractor's convenience.
2. When initial tests indicate Work does not comply with Contract Documents.

G. Make arrangements with laboratory and pay for additional samples and tests required for Contractor's convenience.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

PART 1 GENERAL

1.01 TEMPORARY ELECTRICITY

- A. Provide and pay for power service required from as needed for construction operation.
- B. Complement existing power service capacity and characteristics as required.
- C. Provide power outlets for construction operations, with branch wiring and distribution boxes located as required. Provide flexible power cords as required.
- D. Provide power outlets for construction operations as required by Work. Outlets shall be GCFI-rated and fed from a dedicated minimum 115-volt, 20-ampere circuit. Number of outlets per circuit shall be in accordance to the NEC. Provide flexible power cords as required. Power outlets provided shall be properly sized and rated to operate in tunnel ambient temperature and conditions.
- E. Provide main service disconnect and overcurrent protection at generator.
- F. Permanent convenience receptacles may not be used during construction.
- G. Contractor shall provide each supply fan, exhaust fan, and sump pump a dedicated service with local disconnect. Feeder circuits shall be GFCI protected. Power feed and disconnect shall be sized to match motor FLA in accordance to the NEC. Power feed disconnects and GCFI shall be sized and rated to operate in tunnel ambient temperature and conditions.

1.02 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

- A. Provide and maintain lighting for construction operations.
- B. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.
- C. Maintain lighting and provide routine repairs.
- D. Permanent building lighting may be used during construction.

1.03 TEMPORARY HEATING

- A. Provide heating devices and heat as needed to maintain specified conditions for construction operations.

1.04 TEMPORARY COOLING

- A. Provide cooling devices and cooling as needed to maintain specified conditions for construction operations.

1.05 TEMPORARY VENTILATION

- A. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

1.06 TELEPHONE SERVICE

- A. Provide, maintain, and pay for telephone service to field office at time of project mobilization.

1.07 FACSIMILE SERVICE

- A. Provide, maintain and pay for facsimile service to field office at time of project mobilization.

1.08 TEMPORARY WATER SERVICE

- A. Provide suitable quality water service as needed to maintain specified conditions for construction operations.

1.09 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Existing facility use is not permitted. Provide at time of project mobilization.

1.10 FIELD OFFICES AND SHEDS

- A. Designated existing spaces may be used for storage:
 - 1. Owner-supplied CONEX units.
- B. Office: Weather tight, with lighting, electrical outlets, heating, and cooling equipment, and equipped with sturdy furniture and drawing display table*.
- C. Provide space for Project meetings, with table and chairs to accommodate 6 persons.
- D. Permanent facilities shall not be used for field offices or for storage.
- E. Construction: Portable or mobile buildings, or buildings constructed with floors raised above ground, securely fixed to foundations with steps and landings at entrance doors.
 - 1. Construction: Structurally sound, secure, weather tight enclosures for office and storage spaces. Maintain during progress of Work; remove at completion of Work.
 - 2. Temperature transmission resistance of floors, walls, and ceilings: Compatible with occupancy and storage requirements.
 - 3. Lighting for offices: 50 ft C (538 lx) at desktop height, exterior lighting at entrance doors.
 - 4. Fire extinguishers: Appropriate type fire extinguisher at each office and each storage area.
 - 5. Interior Materials in Storage Sheds: As required to provide specified conditions for storage of products.
- F. Environmental control:
 - 1. Heating, cooling, and ventilating for offices: Automatic equipment to maintain comfort conditions.
 - 2. Storage spaces: Heating and ventilation as needed to maintain products in accordance with Contract Documents; adequate lighting for maintenance and inspection of products.
- G. Storage areas and sheds: Size to storage requirements for products of individual Sections, allowing for access and orderly provision for maintenance and for inspection of products to requirements of Section 01 60 00.
- H. Preparation: Fill and grade sites for temporary structures to provide drainage away from buildings.
- I. Maintenance and cleaning:
 - 1. Weekly janitorial services for offices; periodic cleaning and maintenance for office and storage areas.
 - 2. Maintain approach walks free of mud, water, and snow.
- J. Removal: At completion of Work remove buildings, foundations, utility services, and debris. Restore areas.

1.11 VEHICULAR ACCESS

- A. Construct temporary access roads from public thoroughfares to serve construction area, of a width and load bearing capacity to provide unimpeded traffic for construction purposes.
- B. Construct temporary bridges and culverts to span low areas and allow unimpeded drainage.
- C. Extend and relocate as Work progress requires, provide detours as necessary for unimpeded traffic flow.
- D. Provide unimpeded access for emergency vehicles.
- E. Provide means of removing mud from vehicle wheels before entering streets.
- F. Designated existing on-site roads shall be used for construction traffic.

1.12 PARKING

- A. Provide temporary parking areas to accommodate construction personnel.
- B. Locate as approved by Owner
- C. When site space is not adequate, provide additional off-site parking.
- D. Tracked vehicles not allowed on paved areas.
- E. Do not allow heavy vehicles or construction equipment in parking areas.
- F. Do not allow vehicle parking on existing pavement.
- G. Maintenance:
 - 1. Maintain traffic and parking areas in a sound condition
 - 2. Maintain existing paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original, or specified, condition.
- H. Removal, repair:
 - 1. Repair existing facilities damaged by use, to original condition.
- I. Mud from site vehicles: Provide means of removing mud from vehicle wheels before entering streets.

1.13 PROGRESS CLEANING AND WASTE REMOVAL

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Collect and remove waste materials, debris, and rubbish from site weekly and dispose off-site.

1.14 PROJECT IDENTIFICATION

- A. Project identification sign:
 - 1. One painted sign of size, construction, and design as shown on Drawings.
 - 2. Size lettering to provide legibility from at least 30' (9 m) distance.
 - 3. Content:
 - a. Project title, and name of Owner as indicated on Contract Documents.
 - b. Name and title of DFCM project manager
 - c. Name and title of Engineer

- d. Name of prime Contractor and major Subcontractors.
- 4. Lettering: Series C Standard Alphabet for Highway Signs, Public Roads Administration, Federal Works Agency.
- B. Sign painter: Experienced as a professional sign painter for minimum 3 years.
- C. Finishes, painting: Adequate to withstand weathering, fading, and chipping for duration of construction.
- D. Installation:
 - 1. Install project identification sign within 15 days after date fixed by Notice to Proceed.
 - 2. Erect at designated location.
 - 3. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind loadings.
 - 4. Install sign surface plumb and level, with butt joints. Anchor securely.
 - 5. Paint exposed surfaces of sign, supports, and framing.
- E. Maintenance: Maintain signs and supports clean, repair deterioration and damage.
- F. Removal: Remove signs, framing, supports, and foundations at completion of Project and restore area.

1.15 TRAFFIC REGULATION

- A. Quality assurance:
 - 1. U. S. Department of Transportation Federal Highway Administration "Manual on Uniform Traffic Control Devices for Streets and Highways," 1989 Edition, as amended.
- B. Traffic control devices may be new or used, but shall meet standards of UDOT Standard Specification.
- C. Portable generators shall not be used to power traffic control devices within 300' of residential dwellings, including apartments, between hours of 10:00 pm and 7:00 am.
- D. Monitor condition of traffic control facilities at all times, including nonwork hours. Repair or replace as necessary.
- E. Flaggers: Provide trained and equipped flaggers to regulate traffic when construction operations or traffic encroach on public traffic lanes.
- F. Flares and lights: Use flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.
- G. Haul routes:
 - 1. Consult with authority having jurisdiction, establish public thoroughfares to be used for haul routes and site access. Determine haul roads with approval of agency having jurisdiction over proposed roadway.
 - 2. Confine construction traffic to designated haul routes.
 - 3. Provide traffic control at critical areas of haul routes to regulate traffic, to minimize interference with public traffic.
 - 4. Make condition survey of haul roads prior to use and document with necessary photographs and written descriptions.
 - 5. Keep reasonably free from dirt, dust, mud, and other debris from construction operations.
 - 6. Clean a minimum of twice a week.
 - 7. Repair damaged haul routes to match existing conditions before use.

- H. Removal:
 - 1. Remove equipment and devices when Work is completed.
 - 2. Repair damage caused by installation.

1.16 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations.
- B. Provide protection for plants designated to remain. Replace damaged plants.
- C. Protect nonowned vehicular traffic, stored materials, site, and structures from damage.

1.17 SECURITY

- A. Entry control:
 - 1. Restrict entrance of persons and vehicles into Project site.
 - 2. Allow entrance only to authorized persons with proper identification.
 - 3. Maintain log of workers and visitors, make available to Owner on request.
 - 4. Owner will control entrance of persons and vehicles related to Owner's operations.
 - 5. Coordinate access of Owner's personnel to site in coordination with Owner's security forces
- B. Restrictions:
 - 1. Do not allow cameras on site or photographs taken except by written approval of Owner.
 - 2. Do not work on days wherein Owner has scheduled operations that will conflict with construction activities. Coordinate schedule of planned range closures with Owner's representative.

1.18 WATER CONTROL

- A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.

1.19 DUST CONTROL

- A. Execute Work by methods to minimize raising dust from construction operations.
- B. Provide positive means to prevent air-borne dust from dispersing into atmosphere.

1.20 EROSION AND SEDIMENT CONTROL

- A. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.
- B. Minimize amount of bare soil exposed at one time.
- C. Provide temporary measures such as berms, dikes, and drains, to prevent water flow.
- D. Construct fill and waste areas by selective placement to avoid erosive surface silts or clays.
- E. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.

1.21 POLLUTION CONTROL

- A. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations.

1.22 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Final inspection.
- B. Clean and repair damage caused by installation or use of temporary work.
- C. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Providing and installing erosion and sediment control measures required to protect off-site areas from sediment transport.
- B. Work includes:
 - 1. Flexible ditch liner
 - 2. Riprap inlet and outlet protection

1.02 ACTION SUBMITTALS

- A. Samples: Submit prior to being used. Verify compliance with local, state and federal regulations.

1.03 QUALITY ASSURANCE

- A. Installer qualifications:
 - 1. Installer shall be certified by manufacturer as an approved installer.
 - 2. Certification shall be considered current if appropriate identification is shown at time of application.
- B. Select product as necessary for water flow and movement instead of use as growing media.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Flexible ditch liner: North American Green, PROPEX or approved equivalent.

2.02 SYSTEM DESCRIPTION

- A. Flexible ditch liner shall provide road side ditch and soil erosion protection at Project Site.
- B. Flexible ditch liner is not required if site ditch bed material is rocky. In such areas, liner shall not be required with engineer's concurrence.

2.03 Flexible Ditch Liner

- A. All flexible ditch liners must meet FHWA FP-03.
- B. For slopes less than 3.00%, use North American Green SC150 or approved equivalent, where indicated on Drawings.
- C. For slopes between 3.01% and 6.00%, use North American Green P300 or approved equivalent, where indicated on Drawings.
- D. For slopes between 6.01% and 9.00%, use North American Green P550 or approved equivalent, where indicated on Drawings.
- E. For slopes greater than 9.00%, use PROPEX TRM LANDLOK 300, where indicated on Drawings.

2.04 Loose Riprap

- A. Durable, angular, hard, stone that is free from seams, cracks, or other structural defects.
- B. Maximum wear not greater than 40 percent when tested. Refer to AASHTO T 96.

- C. Maximum 16 percent weighted loss tested according to AASHTO T 104.
- D. Stones graded in size so as to produce a dense mass. The greatest dimension of fifty percent of the stone to be at least two-thirds times, but not more than one and one-half times, the specified thickness of the riprap layer. Not more than ten percent of the rock will have a dimension of less than one-tenth the indicated thickness of the riprap.
- E. Size: $D_{50} = 8$ in.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Flexible Ditch Liner
 1. Complete and approve all required grading, topsoil placement, and seeding in areas to receive flexible ditch liner before placing the product.
 2. Replace eroded material and rework the soil before installing the liner if a precipitation event occurs creating soil erosion before the liner is installed.
 3. Place at locations shown on Drawings.
 4. Staple the liner using manufacturer's specifications. Staple requirements vary according to the steepness and length of the slope.
 5. Place additional staples in areas such as swales, base of humps, against rock outcrops, and as required to achieve maximum contact between the liner and the soil.
 6. Allow the liner to lay loosely on the soil to achieve maximum soil contact. Remove roots, branches, or other loose objects that cause the liner to "tent." Place roots and branches on areas already lined. Do not stretch the liner during installation.
 7. Install ditch liner to allow runoff to flow directly to the centerline of ditch, not undermining or bypassing the lined ditch.
- B. Riprap
 1. Remove all brush, trees, stumps, and other objectionable materials.
 2. Provide a firm foundation by excavating to a dressed uniform surface conforming to the lines and grades shown in the Drawings.
 3. Do not over-excavate and disturb compacted foundations or undisturbed soils outside of the required lines and grades shown on the Drawings.
 4. Distribute and manipulate the stones in a manner that the larger rock fragments are uniformly distributed and the smaller rock fragments serve to fill the spaces between the larger fragments. Place in a manner that results in un-segregated, densely placed, uniform layers of riprap of the thickness indicated on the plans.
 5. Excavate at the toe of the slope and embed riprap as shown on the Drawings to protect against undercutting

3.02 CLEANING

- A. Maintain ditch in functional condition at all times. Routinely inspect and repair ditch liners.
- B. Remove sediment collected at base of ditch when sediment reaches 1/3 of exposed height of ditch.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cast-in-place concrete including formwork, reinforcing steel and miscellaneous materials.

1.02 QUALITY ASSURANCE

- A. Product data. Unless otherwise indicated, submit for each type of product provided under work of this Section:
- B. Quality assurance data:
 - 1. Tests, or certificates of compliance with standards specified in this Section at least 14 days prior to commencing concrete placement for:
 - a. Cement: From each car from which cement will be used.
 - b. Fly ash: From each separate shipment from which fly ash is being used.
 - c. Aggregates: For each size aggregate from each source of aggregate, for grading, deleterious substances and soundness.
 - 2. Testing laboratory reports required at least 14 days prior to commencing concrete placement for each class of concrete and each size aggregate:
 - a. Proposed concrete design mix.
 - b. Tests on concrete cylinders from trial batch of proposed mix.
 - 3. Testing laboratory reports for tests on concrete cylinders taken in field.
- C. Owner shall retain services of qualified independent testing laboratory to perform the following tests:
 - 1. Obtaining, making samples and trial batches and performing laboratory testing specified.
 - 2. Establish proposed concrete design mix proportions on basis of either field experience and/or trial mixtures in accordance with ACI 318, Chapter 5, except specific requirements shall conform to requirement of these specifications. Determine and submit supporting data, standard deviation, trial batch tests, required average strength, proportions, air content, and slump range for each mix.
- D. Perform Work in accordance with ACI 117 and 301.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Cement: Keep clean, dry, and free from weather damage.
- B. Aggregates: Stockpile each gradation separately on clean, noncontaminating surface.

PART 2 PRODUCTS

2.01 CEMENT

- A. Portland cement: ASTM C150, Type II
- B. High-early-strength portland cement: ASTM C150, Type III. May be used instead of Type II cement at Contractor's option, unless specified otherwise, to achieve 28-day strength at 7 days. Do not use in concrete where least dimension of concrete section exceeds 3'-0" (900 mm).*
- C. White cement: Nonstaining, ASTM C150, Type I.
- D. Use only 1 brand of each type of cement.

2.02 AGGREGATE

- A. Regular aggregate: Strong, durable, well-graded minerals conforming to ASTM C33 requirements for grading, deleterious substances and soundness.
- B. Aggregates not conforming exactly to above specifications may be used provided:
 - 1. Special tests or actual service establish that such aggregates will produce concrete of quality specified.
 - 2. An Addendum to Specifications is issued prior to receipt of Bids; no deviations will be permitted after receipt of Bids.
- C. Coarse aggregate nominal size:
 - 1. 1-1/2" to No. 4 (38 mm to 4.75 mm): Use for all concrete unless specified otherwise.
 - 2. 3/4" to No. 4 (19 mm to 4.75 mm): Use for slabs and thin sections and areas where clear spacing between reinforcing bars is less than 3" (75 mm).

2.03 FLY ASH

- A. Comply with ASTM C618;
- B. Fly ash for total Project shall be obtained from single source.
- C. Design concrete mixes to include fly ash in amount of approximately 15% to 20% of cement by weight.
- D. May be used at Contractor's option for all concrete,

2.04 SILICA FUME

- A. Comply with ASTM C1240.

2.05 WATER

- A. Clean, fresh, free from injurious amounts of oil, alkali, acid, salts, organic materials, or other substances that may be deleterious to concrete or steel. Mix water shall comply with ASTM C1602.

2.06 ADMIXTURES

- A. Water-reducing and set-controlling admixture, ASTM C494/C494M, type as required. Use for all concrete.
- B. Air entraining agent, ASTM C260. Use in accordance with manufacturer's recommendations.

2.07 REINFORCING

- A. Bars:
 - 1. ASTM A615/A615M, Grade 60 (420) deformed bars.
 - 2. Bend bars cold to conform to required details.
- B. Welded wire fabric: ASTM A185 plain wire

2.08 VAPOR BARRIER

- A. Polyethylene film, clear: In accordance with ASTM E1745.
- B. Minimum 10 mil (0.25 mm) thickness.

2.09 FORMWORK

- A. Wood forms:
1. Douglas fir, exterior type, concrete form plywood, 5/8" (15 mm) thick minimum, conforming to DOC PS 1, Grade B-B, Class I or II.
 2. Removable metal forms with surfaces equal to Douglas fir, exterior type, concrete form plywood.
 3. Fiber tube forms: Cylindrical fiber reinforced forms.
- B. Carton forms:
1. Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete until initial set.
- C. Form ties: Type leaving no metal within 1" (25 mm) of finished surface after removal of forms.
- D. Form coating:
1. Wood forms: Nonstaining mineral oil or commercially produced form-release agent that will not bond with, stain, or adversely affect concrete surfaces and curing, and will not impair bond or adhesion of subsequent treatment of concrete surfaces, "Nox-Crete Form Coating," by Nox-Crete Chemicals, or equal.
 2. Metal forms: Treat surfaces as recommended by manufacturer before placing reinforcing.
 3. Fiber tube forms: Treat surfaces as specified for wood forms or as recommended by manufacturer.

2.10 CURING MATERIALS

- A. Liquid membrane-forming compound:
1. ASTM C309, Type 1 with fugitive dye, except Type 2 with white pigment for surfaces exposed to direct rays of sun.
 2. Do not use compounds containing wax, oil, resin, varnish, or other bases that will prevent bonding of finishes
 3. Use for curing at Contractor's option except where other products are specified for particular application.
- B. Plastic film:
1. Polyethylene plastic film, white, nonstaining, conforming to ASTM D2103.
 2. Minimum 4-mil (0.1 mm) thickness.
 3. Use for curing at Contractor's option except where other products are specified for particular application.
- C. Absorptive mat:
1. Cotton fabric, burlap fabric, or burlap-polyethylene material woven or bonded to prevent separation.
 2. Material shall be clean and nondetrimental to concrete or finish.
 3. Use for curing at Contractor's option except where other products are specified for particular application.

2.11 CONCRETE DESIGN AND USE

- A. Each concrete design mix shall be established in strict accordance with ACI 318 by proportioning on basis of either experience and/or trial mixtures.
- B. Strength classifications:

Class	Specified Compressive Strength, f'c	Required Average Compressive Strength, f'cr
A	4,000 psi	5,200 psi
B	2,500 psi	3,500 psi

C	3, 000 psi	4, 200 psi
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- C. Required average compressive strengths: Produce concrete of average strengths noted above unless test results substantiate a lower permissible average strength based on standard deviation criteria set forth in ACI 318. Strengths listed above are 7-day strengths for concrete using high-early-strength cement and 28-day strengths for concrete using other type cements.
- D. Maximum water-cement ratio: 0.48 by weight except for Class B concrete. Where pozzolan fly ash is used, water-cement plus pozzolan ratio shall not exceed specified ratio.
- E. Air entrainment: Concrete shall contain entrained air within following limits.

Nominal Maximum Size of Coarse Aggregate, In.	Total Air Content,% By Volume
3/4"	4 to 8
1-1/2"	3 to 6

- F. Workability:
 - 1. Proportions of concrete shall produce a mixture, suited to placement methods, which will work readily into corners and angles of forms and around reinforcement and embedded items. Segregation of materials or presence of free water will not be permitted.
 - 2. Slump of concrete: Use minimum practical; vary within limits given to suit placement conditions; in no case is slump to be increased by addition of water in excess of design mix quantity:

Type of Construction	Slump, in.	
	Minimum	Maximum
All concrete unless noted otherwise	2	5
Building columns	3	5

- G. Concrete use:
 - 1. Class A: Not used
 - 2. Class B: Use for fill concrete and thrust blocks.
 - 3. Class C: Not used

2.12 READY-MIX CONCRETE

- A. Provide concrete from an established, approved ready-mix plant. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC-3.
- B. Equipment and methods: Conform to ASTM C94/C94M.

2.13 ACCESSORIES

- A. Curing compounds, sealers, and coatings:
 - 1. Water-based.

PART 3 EXECUTION

3.01 PREPARATION

- A. Construct forms strong, straight, adequately braced and securely fastened.

- B. Remove laitance from previously placed or existing concrete; thoroughly clean surface before placing additional concrete.
- C. Apply form coating on formwork in accordance with manufacturer's instructions. Apply prior to placing reinforcing steel, anchoring devices, and embedded items.

3.02 PLACING CONCRETE

- A. Clean transporting equipment, reinforcing, and embedded items before placing concrete. Remove water and debris from places to be occupied by concrete.
- B. Place no concrete until forms, reinforcing, and embedded items have been verified as adequately supported and accurately placed. Place no concrete over water-covered, muddy, or frozen soil.
- C. Immediately remove concrete where water, soils, or other deleterious substances are permitted to mix with concrete, form or embedded item movement occurs, or inadequate consolidation is obtained.
- D. Hot weather concreting:
 - 1. Applies to concrete placed when ambient temperature exceeds 90°F (32°C).
 - 2. Conform to ACI 305R recommendations and requirements.
- E. Cold weather concreting:
 - 1. Applies to concrete placed when ambient temperature is below 40°F (4°C).
 - 2. Conform to ACI 306R recommendations and requirements.
 - 3. If temporary heating facilities used are of type which produce an atmospheric condition of high carbon dioxide content, seal off concrete in such manner that no damage will result to concrete surface.
- F. Employ best industry practices to prevent segregation during placing. Do not drop concrete more than 5' (1500 mm). Use tremied or pumped concrete to provide proper placement. Place in layers approximately 18" (450 mm) deep.
- G. Place concrete continuously in each section until completed. Permit not more than 30 minutes between depositing adjacent layers of concrete within each section, unless an acceptable set retarder is used in concrete mix.
- H. Thoroughly compact, puddle, and vibrate concrete into corners and around reinforcing and embedded items. Use internal vibration where size of section permits.
- I. Maintain concrete placing temperature between 50°F (11°C) and 90°F (32°C) except as specified for hot and cold weather concreting.
- J. Place sections of concrete in sequence that eliminates shrinkage effects to greatest extent practicable.
- K. Protect concrete from injury due to sun, cold weather, running water, construction operations, and other causes until properly cured.

3.03 REINFORCEMENT PLACEMENT

- A. Remove scale, loose flaky rust, dirt, grease, curing compound, and other coatings that would impair bond.
- B. Install slab-reinforcing bars in correct position by use of preformed bolsters and spacers, except concrete blocks may be used to position bars in concrete placed on grade. Concrete block shall have compressive strength equal to that of surrounding concrete.

- C. Space bars properly and tie securely in position before placing concrete. Tack welding to keep reinforcing in place is not permitted.

3.04 EMBEDDED ITEMS

- A. Install items required under this contract to be embedded in concrete. Install items required by others for embedding in concrete, if so instructed before placing concrete.
- B. Fasten embedded items securely in proper position before placing concrete.
- C. Conduit or pipe embedded in slabs or walls:
 - 1. Locate in center of slab or wall and space not closer than 3 diameters on center; locate to avoid impairing strength of concrete.
 - 2. Coordinate placing of reinforcing with conduit or pipe location. Do not cut reinforcing to clear conduit or pipe.
- D. Aluminum pipe shall not be embedded in concrete. Where aluminum projects into or rests against surface of concrete, coat surfaces of aluminum to prevent direct contact with concrete.

3.05 FINISHING

- A. Flatwork:
 - 1. Tamp concrete to force coarse aggregate down from surface.
 - 2. Screed with straightedge, eliminate high and low places, bring surface to required finish elevations
 - 3. Dusting of surface with dry cement or sand during finishing operations is not permitted.
 - 4. Apply curing compounds and similar materials in accordance with manufacturer's instructions
 - 5. Finish surfaces within following tolerances as measured with a 10' (3 m) straightedge:
 - a. Sidewalks: 5/16" (8 mm).
 - b. Other slabs: 3/16" (5 mm).
 - c. Top surfaces of structures other than slabs: In accordance with ACI 117.
 - 6. Broomed or belted finish:
 - a. Float surface to true, even plane.
 - b. Steel trowel to smooth, uniform surface.
 - c. Broom with fiber brush or drag burlap belt across surface in direction transverse to traffic flow.
- B. Formed surfaces:
 - 1. Remove fins, projections, and loose material.
 - 2. Clean surfaces of form oil.
 - 3. Patch honeycomb, aggregate pockets, voids, and holes as follows:
 - a. Chip out until sound concrete is exposed to minimum depth of 1" (25 mm).
 - b. Prepare patching mortar with approximately 2 parts normal portland cement, one part white cement, 9 parts fine aggregate; vary proportions of cement as necessary to match color of adjacent concrete.
 - c. Saturate surfaces with water and fill cavities with patching mortar.
 - 4. Fill holes left by form ties with patching mortar.
 - 5. Cure patches as specified for concrete.

3.06 FORM REMOVAL

- A. Minimum time before removal after placing concrete, unless permitted otherwise:
 - 1. Footings: 24 hours.
 - 2. Walls, piers, and columns: 48 hours (24 hours for metal-lined forms).
 - 3. Self-supported beams and slabs: 14 days.
 - 4. Time specified above represents cumulative time during which temperature of concrete is maintained above 50°F (11 °C) and for concrete without set-controlling admixtures.
- B. Reduce removal time by half for high-early-strength cement concrete.

- C. In any event, do not remove supporting forms and shoring until concrete has acquired sufficient strength to safely support own weight plus construction loads.
- D. Take care when removing forms that concrete is not marred or gouged and that corners are true, sharp and unbroken.
- E. Reshoring and backshoring: Conform to requirements of Section 2, ACI 301.

3.07 CURING

- A. Cure all concrete; begin curing as soon as possible after placement of concrete.
- B. Use of liquid membrane-forming curing compound permitted for all concrete except where product would impair bond of other applied materials to surface
- C. Plastic film curing:
 - 1. Dampen surface of concrete and lay plastic film with minimum 6" (150 mm) side laps and free of wrinkles; tape side laps.
 - 2. Hold film in place with lumber or use similar provisions to prevent exposure of concrete for 7 days after placing.
 - 3. Immediately repair tears in film.
- D. Water curing:
 - 1. Keep concrete continuously wet for 7 days after placing.
 - 2. Use on concrete surfaces not receiving compound or plastic film curing.
 - 3. Clean, nonstaining absorptive mat may be used with water curing.
 - 4. Do not use for curing cold weather concrete.

3.08 WASTE MANAGEMENT

- A. Formwork: Reuse forms to greatest extent possible without damaging structural integrity of concrete and without damaging aesthetics of exposed concrete.
- B. Mixing equipment: Return excess concrete to supplier; minimize water used to wash equipment.
- C. Moisture curing: Prevent water run-off.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES.

- A. Expansion anchors.
- B. Welded studs.
- C. Shop painting.

1.02 INFORMATIONAL SUBMITTALS

- A. Product Data: List of manufactured materials proposed, identifying manufacturer and type.
- B. Quality assurance data: ICC-ES evaluation reports for anchor rods and expansion anchors provided to verify conformance to specifications.

1.03 QUALITY ASSURANCE

- A. Perform welding in accordance with AWS D1.1 "Structural Welding Code"

PART 2 PRODUCTS

2.01 MATERIALS

- A. Secondary steel plates and shapes: ASTM A36/A36M. Weld in conformance to requirements of AWS D1.1.
- B. Galvanizing: ASTM A123/A123M.
- C. Standard bolts: ASTM A307.
- D. High-strength bolts: ASTM A325/A325M, Types 1 or 3.

2.02 EXPANSION ANCHORS

- A. Torque controlled wedge-type with expanding cone or undercut anchor.
- B. Use galvanized steel, except where stainless steel is indicated on Drawings.
- C. Size and locations: As shown or required for equipment installation.
- D. Expansion anchors shall be ductile, Category 1, and approved for use in seismic applications and for cracked and uncracked concrete and shall have ICC approval in accordance with AC 193.
- E. Manufacturer: "Kwik-Bolt TZ", "HSL-3," or "HDA Undercut Anchors" by Hilti; or equal.

2.03 WELDED STUDS

- A. Material: ASTM A108.
- B. Type: "Nelson Fluxed Headed Anchor Studs," by Nelson Stud Welding Division, or equal.
- C. Automatically end weld in accordance with manufacturer's recommendations.

PART 3 EXECUTION

3.01 ERECTION

- A. Anchor top and bottom sills and miscellaneous items securely to structural steel framing, concrete or masonry.
- B. Field weld studs to members if required by state or local regulations. In absence of regulations, Contractor may exercise option as to attachment of studs in shop or field.
- C. Install expansion anchors in accordance with manufacturer's recommendations.

3.02 FIELD PAINTING

- A. Apply one field coat of primer to cleaned surfaces of bolts, new welds and abrasions to shop coat after erection.
- B. Field finish painting: As specified in Section 09 90 00.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Plywood sheathing and backing panels.
- B. Rough hardware and accessory materials.

1.02 RELATED REQUIREMENTS

- A. Section 05 50 00 – Metal Fabrications – sheathing support and framing.

1.03 QUALITY ASSURANCE

- A. Regulatory requirements: Conform to applicable codes for fire retardant treatment of wood surfaces for flame/fuel/smoke ratings.
- B. Lumber: Comply with PS-20-70. Provide lumber species grade marked and complying with grading rules of following associations:
 - 1. Southern pine: 1977 Standard Grading Rules for Southern Pine Lumber, published by Southern Pine Inspection Bureau (SPIB).
 - 2. Douglas fir, Western larch and hemlock: Western Lumber Grading Rules, 91 published by Western Wood Products Association (WWPA), or Standard Grading Rules for West Coast Lumber, Number 16, 1989, published by West Coast Lumber Inspection Bureau (WCLIB).
 - 3. Western spruce, pine, and fir: Western Spruce-Pine-Fir Association (WSPFA) and current Canadian Grading Rules by National Grades Association Canada.
- C. Plywood: Grade marked and manufactured in accordance with PS-1-83 or one of APA/EWA- APA - The Engineered Wood Association performance standards.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Keep materials dry and undamaged during delivery and site storage. Protect against weather exposure and contact with damp or wet surfaces. Stack rough carpentry materials to ensure proper drainage and ventilation. Protect from weather damage and deterioration.
- B. Store and protect rough carpentry accessories and hardware from weather damage and deterioration.
- C. Store shop-fabricated items indoors in well ventilated area with temperature and humidity stabilized and maintained at minimum of 60°F (16°C) temperature and maximum of 60% humidity.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Plywood: Concealed performance-rated panels. Provide in thickness indicated on Drawings
 - 1. Exterior CONEX wall sheathing. APA/EWA type B-C exterior adhesives. Finished side out.

2.02 ACCESSORY MATERIALS

- A. Rough hardware:
 - 1. Provide bolts, plates, anchors, hangers, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork and for anchoring or securing woodwork to concrete, masonry, or wood structures.
 - 2. Provide manufactured or fabricated items of sizes, shapes and dimensions required.
 - 3. Bolts: ASTM A307. Provide with double washers.

4. Steel: ASTM A36.
5. Fasteners and anchorages: Provide size, type, material, and finish required for nails, screws, bolts, nuts, washers and anchoring devices. Provide hot-dip galvanized finish for exterior locations, high humidity locations and treated wood; plain finish for other interior locations; size and type to suit application.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Set carpentry work accurately to required lines and levels with members plumb, true and accurately aligned, cut and fit. Work shall be performed in conformance with good trade practice, recommendations of manufacturer, building codes and specifications.
- B. Securely attach carpentry work to substrate by anchoring and fastening as required to support applied loading, in accordance with recognized standards.
 1. Provide washers under bolt heads and nuts.
 2. Use fasteners of proper size that will not penetrate members where opposite side will be exposed to view or receive finish materials.
 3. Do not drive threaded friction type fasteners.
 4. Tighten bolts and lag screws at installation and retighten as required.
 5. Nails, screws, and bolts used in connection with preservative treated wood shall be galvanized.
- C. Provide treated wood grounds, nailers, blocking, sleepers, and furring where required for screeding or attachment of other work and surface applied items. Attach to substrate as required to support applied loading.
 1. Material: Framing lumber.
 2. Nominal size: Match adjacent framing lumber, unless otherwise shown on Drawings.
 3. Extent of Work: Provide blocking behind wall-supported loads, including cabinets, wardrobe rods, siding, roofing, sheet metal flashing and trim, doors, windows, finish hardware including door stops, railings, toilet room accessories, mirrors, miscellaneous specialties, building equipment, window traverse rods and shades, and mechanical and electrical work; verify exact locations.

3.02 SHEATHING AND BACKING PANELS

- A. Install plywood sheathing where indicated.

3.03 CLEANING

- A. Clean up debris and cutting on regular periodic basis. Remove and dispose of excess materials and debris created by carpentry work.
- B. Maintain buildings and site free of accumulations of cutting and waste materials in neat orderly condition.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. On-site surface preparation and painting.

1.02 RELATED REQUIREMENTS

- A. Section 05 50 00 - Miscellaneous Metal Fabrications:
- B. Section 06 10 00 – Rough Carpentry

1.03 INFORMATIONAL SUBMITTALS

- A. Product Data:
 - 1. Schedule of products proposed for each system.
 - 2. Product data sheets, if other than products specified in schedule.

1.04 HEALTH AND SAFETY REQUIREMENTS

- A. Work shall comply with applicable federal, state, and local laws and regulations including analyses of potential impact of painting operations on painting personnel and on others involved in and adjacent to work zone.
- B. Worker exposures: Exposure of workers to chemical substances shall not exceed limits as established by American Conference of Governmental Industrial Hygienists: Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, ACGIH-02 or as required by a more stringent applicable regulation.
- C. Toxic compounds: Toxic compounds having ineffective physiological properties, such as odor or irritation levels, shall not be used unless approved by Owner.
- D. Training: Workers having access to affected work area shall be informed of contents of manufacturer's current printed product description, Material Safety Data Sheets (MSDS) and technical data sheets for each coating system and shall be informed of potential health and safety hazard and protective controls associated with materials used on Project. Affected work area is one that may receive mists and odors from painting operations. Workers involved in preparation, painting and clean-up shall be trained in safe handling and application, and exposure limit, for each material which worker will use in Project. Personnel having a need to use respirators and masks shall be instructed in use and maintenance of such equipment.
- E. Provide documentation stating that paints proposed for use meet Volatile Organic Compound (VOC) regulations of local air pollution control districts having jurisdiction over geographical area in which Project is located.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint materials in sealed original labeled containers, bearing manufacturer's name, type of paint, brand name, color designation and instructions for mixing and/or reducing.
- B. Provide adequate storage facilities. Store paint materials at minimum ambient temperature of 45°F (7°C) in well ventilated area.
- C. Take precautionary measures to prevent fire hazards and spontaneous combustion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Benjamin Moore Paints.
- B. ICI Paints (Devoe/Dulux).
- C. Pittsburg Paints.
- D. Sherwin-Williams Co.
- E. Materials and colors referenced in this Section are as manufactured by Sherwin Williams Co., unless noted otherwise.

2.02 MATERIALS

- A. Paint accessory materials: Linseed oil, shellac, turpentine and other materials not specifically indicated herein but required to achieve finishes specified of high quality and approved manufacturer.
- B. Paints: Ready-mixed, except field catalyzed coatings. Pigments fully ground maintaining soft paste consistency, capable of readily and uniformly dispersing to complete homogeneous mixture.
- C. Paints to have good flowing and brushing properties and be capable of drying or curing free of streaks or sags.
- D. Dry mil thickness of paint shall comply with manufacturer's recommendations for materials specified for prevailing substrates and Project conditions.
- E. Paints containing lead in excess of 0.06% by weight of total nonvolatile content (calculated as lead metal) shall not be used.
- F. Paints containing zinc chromate or strontium chromate pigments shall not be used.
- G. VOC content: Paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards and shall conform to restrictions of local air pollution control authority.

PART 3 EXECUTION

3.01 INSPECTION

- A. Thoroughly examine surfaces scheduled to be painted prior to commencement of Work. Report in writing to Engineer, any condition that may potentially affect proper application. Do not commence until such defects have been corrected.
- B. Correct defects and deficiencies in surfaces that may adversely affect work of this Section.

3.02 PROTECTION

- A. Adequately protect other surfaces from paint and damage. Repair damage as a result of inadequate or unsuitable protection.
- B. Furnish sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.

- C. Place cotton waste, cloths, and material that may constitute a fire hazard in closed metal containers and remove daily from site.
- D. Remove electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items are to be carefully stored, cleaned, and replaced on completion of work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.

3.03 PREPARATION

- A. Remove mildew, by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry completely.
- B. Iron and steel surfaces:
 - 1. Cleaning methods: Conform to applicable requirements of SSPC and NACE:
 - a. Solvent cleaning: SSPC-SP1.
 - b. Power tool cleaning: SSPC-SP3.
 - c. Commercial blast cleaning: SSPC-SP6 or NACE 3.
 - d. Power tool cleaning to bare metal: SSPC-SP11.
 - 2. Blast cleaning requirements: Nonsubmerged shall be SSPC-SP6 or SSPC-11 for areas where abrasive blast is prohibited.
 - 3. Cleaning for other field painting: SSPC-SP3.
 - 4. Removal of materials such as grease and oil: SSPC-SP1. Apply treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned. Prime surfaces to indicate defects, if any. Paint after defects have been remedied.
 - 5. Surface irregularities from blasting shall be approximately 25% of total paint system dry mil thickness.
 - 6. Sand and scrape shop primed steel surfaces to remove loose primer and rust. Feather out edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.
- C. Wood surfaces: Wipe off dust and grit from miscellaneous wood items and millwork prior to priming. Spot coat knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried and sand between coats.
- D. Wood siding, exterior: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with exterior calking compound after prime coat has been applied.
- E. Prepare surfaces to be finished in conformance to recommendations of finish manufacturer.

3.04 ENVIRONMENTAL REQUIREMENTS

- A. Ensure surface temperatures and surrounding air temperature is above 45°F (7°C) before applying finishes. Minimum application temperatures for latex paints are 45°F (7°C) for interior work and 50°F (10°C) for exterior work. Minimum application temperature for varnish finish is 65°F (18°C).
- B. Do no exterior painting while surfaces are damp or during rainy or frosty weather.
- C. Do no exterior spray painting while wind velocity is above 13 mph (20 km/h).
- D. Provide adequate continuous ventilation and sufficient heating facilities to maintain temperatures above 45°F (7°C) for 24 hours before, during and 48 hours after application of finishes.
- E. Provide adequate lighting on surfaces to be finished.

3.05 APPLICATION

- A. Apply each coat at proper consistency. Materials shall be evenly spread and applied smoothly without runs or sags, by skilled workers. Do painting under conditions suitable to production of high quality work. Follow manufacturer's directions on container label.
- B. Each coat of paint shall be slightly darker than preceding coat unless otherwise approved by Engineer.
- C. Sand lightly between coats to achieve smooth finish on wood or metal surfaces.
- D. Do not apply finishes on surfaces that are not sufficiently dry.
- E. Allow each coat of finish to dry before following coat is applied, unless directed otherwise by manufacturer.
- F. Where clear finishes are specified, ensure tint fillers match wood. Work fillers well into grain before set. Wipe excess from surface.
- G. Back-prime exterior woodwork and siding to receive paint finish.
- H. Back-prime interior and exterior woodwork, which is to receive stain and/or varnish finish, with gloss varnish reduced 25% with mineral spirits.
- I. Prime top and bottom edges of wood and metal doors when they are to be painted.
- J. Prime top and bottom edges of wood doors with gloss varnish when they are to receive stain or clear finish.
- K. Previously finished existing surfaces: Where scheduled to be finished, finish same as designated for new surfaces, except initial (prime) coat may be deleted. Spot-prime damaged or defective existing finish as required to provide uniform finished surface.
- L. Where interior or exterior wood or metal are primed in mill or shop, material shall be that specified for such surfaces and shall be used in accordance with manufacturer's directions for first or prime coat. In such case, no prime coat will be required on job, except for touch-up.

3.06 CLEANING

- A. As work proceeds and upon completion, promptly remove paint where spilled, splashed, or spattered.
- B. During progress of work, keep premises free from any unnecessary accumulation of tools, equipment, surplus materials and debris.
- C. Upon completion of work, leave premises neat and clean.

3.07 SURFACES EXCLUDED FROM PAINTING

- A. Surfaces not requiring painting:
 - 1. Interior surfaces of CONEX containers.
 - 2. Training Classroom Building (all)

3.08 PAINT SYSTEMS SCHEDULE

- A. System A: Metals, exterior.
 - 1. Primer on ferrous metals: "Kem Bond" HS B50Z series.
 - 2. Primer, on galvanized metal and aluminum: "Pro-Cryl" universal primer B66_310.
 - 3. Finish coats: 2 coats "Metalatex" semi-gloss coating B42 series.

- B. System B: Metals, exterior.
 - 1. Primer: 1 coat "Pro-Cryl" universal primer B66_310.
 - 2. Finish: 1 coat "Acrolon" 218 HS acrylic polyurethane semi-gloss B65_650/B65V600.

- C. System F: Wood, exterior, surfaces to be painted.
 - 1. Primer: 1 coat A-100 exterior latex wood primer B42W41.
 - 2. Finish coats: 2 coats A-100 exterior latex satin house and trim A82 series.
 - 3. Finish coats: 2 coats "Metalatex" semi-gloss coating B42 series.

3.09 COLOR SCHEDULE

- A. CONEX Units – a non-uniform color is desirable for training site villages. Provide minimum of three (3) color variations between CONEX units within a training site. Generally, colors similar to the following are to be used: (Sherwin Williams Colors)
 - 1. Pottery Urn – SW2162
 - 2. Canoe – SW2043
 - 3. Boulevard Beige – SW2045

- B. Provide color samples to Owner's representative for selection of final color(s)

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General electrical requirements for equipment and services including, but not limited to:
 - 1. Factory wiring.
 - 2. Low voltage field wiring.
 - 3. Low voltage splices and terminations.
 - 4. Low voltage cabinets and electrical enclosures.
 - 5. Equipment safety grounding.
 - 6. Low voltage fuses and fuse blocks.
 - 7. Low voltage circuit breakers and disconnect switches.
 - 8. Auxiliary power transformers.
 - 9. Outlet, pull, and junction boxes.
 - 10. Plates and covers.
 - 11. Wiring devices,
 - 12. Panelboards.
 - 13. Welding.
 - 14. Shop finish.
 - 15. Rust-inhibiting compounds.
 - 16. Galvanizing.
 - 17. Nameplates.
 - 18. Grounding and bonding.
 - 19. Fireproofing and fire ratings.
 - 20. Testing and demonstration.

1.02 INFORMATIONALSUBMITTALS

- A. Submit with Bid: Description of manufacturer's standard factory test procedure for logic systems.
- B. Product Data:
 - 1. List of proposed material identifying manufacturer, type and model number for equipment to be provided for complete job.
 - 2. Manufacturer's catalog sheets marked to indicate specific type, model or catalog number of equipment to be provided.
 - 3. Equipment drawings, elementary diagrams, schematics, wiring, performance curves, instruction manuals, and all other documentation necessary for complete description of material being supplied and as required to support installation, commissioning and maintenance of equipment. Manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted.
 - 4. Manufacturer's technical descriptions, product data sheets, and applicable manuals for use in protective device system coordination including:
 - a. Fuse manufacturer, type, ratings, and protection curves.
 - b. Circuit breaker manufacturer, type, trip setting ranges, and protection curves.
 - c. Relay trip device ranges, curves, and setting manuals.
 - d. Transformer damage curves.
 - e. CT ratios and saturation curves.
 - f. VT ratings.
 - 5. List of recommended spare parts required for equipment start-up, commissioning and operation.
 - 6. List of special maintenance tools required for installation and operation of equipment.
 - 7. If necessary, provide additional data to clearly demonstrate that proposed alternate equipment meets or exceeds equipment as specified.
 - 8. When requested by Engineer, submit system information, including but not limited to, utility feeders, existing relays, circuit breakers, fuses, and transformers.

1.03 CLOSEOUT SUBMITTALS

- A. Operation and maintenance manuals. Provide at minimum:
 - 1. Itemized equipment list.
 - 2. General description and technical data.
 - 3. Receiving, storage, installation, and testing instructions.
 - 4. Operating and maintenance procedures.
 - 5. Complete set of final drawings requiring no further action.
 - 6. Complete documentation of inspections and tests performed, including logs, curves, and certificates. Documentation shall note any replacement of equipment or components that failed during testing.
 - 7. Spare parts list.
 - 8. Lubrication recommendations.
 - 9. Warranty information.

1.04 QUALITY ASSURANCE

- A. Manufacturer qualifications:
 - 1. Manufacturer of equipment specified shall be recognized in industry for normally supplying this type of equipment.
 - 2. Manufacturer shall be ISO certified.
 - 3. When requested by Engineer, provide list of similar equipment installations that have employed identical equipment from manufacturer.
- B. Installer qualifications:
 - 1. Installer shall be skilled in trade and shall have thorough knowledge of products and equipment specified.
 - 2. Cutting, drilling, trenching, or channeling necessary to properly install equipment shall be performed by competent skilled crafts people in safe, professional manner.
- C. Regulatory requirements: Perform electrical construction in accordance with NEC, local and state codes as applicable to job site.
- D. Materials and equipment furnished for permanent installation shall be new, unused, and undamaged.
- E. Asbestos not allowed.
- F. Parts shall be manufactured to American industry standard sizes and gages to facilitate maintenance and interchangeability. Metric sized components not allowed unless specifically requested and approved.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Pack, ship, handle, and store in accordance with manufacturer's requirements.
- B. Ship equipment completely factory assembled unless physical size, arrangement, configuration, or shipping and handling limitations make this impracticable. Shipping splits and required field assembly shall be identified with equipment submittals.
- C. Costs associated with sections, accessories, or appurtenances requiring field assembly shall be Contractor's responsibility.
- D. Separately packaged parts and accessories shall be consolidated and shipped together with equipment. Mark each container clearly to identify contents and as belonging with main equipment.
 - 1. Provide individual weatherproof itemized packing slips attached to outside of each container for contents included. Provide duplicate inside each container.
 - 2. Attach master packing list, covering accessory items for equipment, to main piece of equipment.

- 3. Mark each container with project identification number for equipment and container number followed by total number of containers.
- E. Equipment shall be suitably protected during shipment, handling, and storage. Damage incurred during shipment shall be repaired at not cost to Owner.
- F. Protect coated surfaces against impact, abrasion, and discoloration.
- G. Electrical equipment and insulation systems shall be protected against ingress of moisture. Use space heaters if necessary to protect against moisture.
- H. Exposed threads shall be greased and protected.
- I. Pipe, tube, and conduit connections shall be closed with rough usage plugs. Seal and tape open ends of piping, tubing, and conduit.
- J. Equipment openings shall have covers, and taped to seal equipment.
- K. Store materials in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.

1.06 WARRANTY

- A. Electrical equipment shall be provided with manufacturer's standard warranty, but not less than 1 year.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA

- A. Service conditions: Provide equipment and material suitable for intended service and installation at location indicated.
- B. Low-voltage auxiliary and control power.
 - 1. Electrical power for ac control and instrumentation equipment:
 - a. Provide devices necessary for proper operation and protection of equipment during electrical power supply and ambient temperature fluctuations specified.
 - b. Design for continuous operation at any voltage from 85% to 110% of nominal voltage. Dropout voltage shall be 60% of nominal for relays and 75% for contactors and starters.
 - 2. Electrical power for dc devices:
 - a. Design for continuous operation on ungrounded station battery system, capable of maintaining operation at any voltage from 80% to 112% of nominal voltage.
 - b. Electrical devices served shall not impose ground connection on supply.
- C. Auxiliary power: Design auxiliary equipment for low voltage service, with electrical power designed to operate from one of nominal electrical power sources as follows and as indicated on Drawings:

Volts	Phase	Frequency
480Y/277	3 or 1	60
208Y/120	3 or 1	60
120/240	1	60
125	1	Dc

2.02 FACTORY WIRING

- A. Select cable for electrical and environmental conditions of installation, and suitable for unusual service conditions where encountered.
 - 1. Proper temperature application cable shall be used throughout, but shall be not less than 90°C rated.
 - 2. Conductors routed over hinges shall use extra-flexible stranding.
 - 3. Cable insulation shall be rated for maximum service voltage used, but not less than 600 volts.
 - 4. Splices not allowed.
- B. Panel, control cabinet, switchboard, motor control center, and switchgear wiring shall use flame retardant cross-linked polyethylene (XLP) or flame retardant ethylene-propylene rubber (EPR) insulation that meet or exceed requirements of UL 44 for Types SIS, and XHHW.
 - 1. Minimum size: No. 14 AWG (1.5 mm²).
 - 2. Conductors: Annealed bare copper Class B stranding passing IEEE 1202 and UL VW-1 flame test.
- C. Terminations:
 - 1. Conductor terminal connectors shall be insulated, ring tongue, compression type connectors properly sized for conductor and terminal.
 - a. Connectors shall be constructed of copper and shall be tin-plated.
 - b. Interior surface of connector wire barrel shall be serrated; exterior surface of connector wire barrel shall be furnished with crimp guides.
 - 2. Noninsulated terminal connectors shall be used for conductors terminated on devices equipped with individual fitted covers, such as, but not limited to, control switches and lockout relays.
 - 3. Connections requiring disconnect plug and receptacle type devices shall be provided with factory-terminated conductors on each plug and receptacle.
 - a. Plugs and receptacles shall be factory wired into junction boxes containing terminal blocks for external connections.
 - b. Conductors on disconnect portion of plug-receptacle assemblies shall be in common jacket.
 - 4. Prior to shipment of equipment, remove temporary wiring installed in factory for equipment testing.
 - 5. Current transformers shall terminate on shorting type terminal blocks. Ship with shorting jumpers installed.
- D. Identification and labeling:
 - 1. Provide conductor identification sleeve on each end of each internal conductor. Mark each sleeve with opposite end destination identification with nonsmudging, permanent black ink. Sleeves shall be UV-resistant self-adhesive type or PVC, not less than 1/2" long.
 - 2. Permanently label each terminal block, terminal, conductor, relay, breaker, fuse block, and other auxiliary devices to coincide with identification indicated on manufacturer's drawings.

2.03 FIELD WIRING

- A. Nationally or internationally recognized cable manufacturer shall produce cable provided.
 - 1. Metal-clad cable, NEC Type MC, may not be substituted in place of cable and conduit unless specified otherwise, or unless approved in writing.
 - 2. Comply with code and Project requirements directly associated with use of each cable type.
- B. Cables specified are for voltages 600 volts and below.
- C. Wiring shall be bare copper with not less than 98% conductivity, unless specified otherwise.
- D. General-purpose building conductor used on interior lighting circuits and general-purpose branch circuits routed entirely in conduit shall be single conductor.
 - 1. Voltage rating: 600-volt.
 - 2. Conductor: Class B, solid or stranded, annealed, uncoated copper, minimum size No. 12 AWG (4.0mm²).
 - 3. Insulation: PVC complying with physical and electrical requirements of UL for type THHN/THWN.

4. Jacket: Overall clear nylon jacket applied over conductor insulation, UL-listed as gasoline and oil resistant.
 5. Provide conductor sizes No. 8 AWG and smaller in colors to match wire color-codes. Sizes No. 6 AWG and larger shall be color-coded with field-applied tape.
 6. Rated continuous operating temperature shall be 90°C in wet and dry locations for operation at maximum 75°C.
- E. Single-conductor, low-voltage power cable for motors, feeders, branch circuits, and dc circuits routed in conduit, duct bank, or cable tray:
1. Voltage rating: 600-volt.
 2. Conductor: Annealed, bare copper, Class B, stranded, minimum size No. 12 AWG (4.0mm²).
 3. Insulation: Ethylene propylene rubber (EPR), complying with physical and electrical requirements for NEC Type RHH or RHW-2.
 4. Jacket: Flame-retardant, heat, moisture, and sunlight resistant; cross-linked low-smoke, nonhalogen polyolefin (XLPO).
 5. Conductor sizes No. 8 AWG and smaller shall be provided in colors to match wire color-codes. Sizes No. 6 AWG and larger may be color-coded with field applied tape.
 6. Wire shall be identified by surface marking indicating manufacturer, conductor size, conductor material, voltage rating, UL symbol, and listed type.
 7. Cables smaller than No. 1/0 AWG (50 mm²) shall be routed entirely in conduit and duct bank in. Sizes No. 1/0 AWG (50 mm²) and larger may be routed in cable tray, if so rated.
 8. Conductors shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and UL VW-1 vertical flame test.
 9. Temperature rating shall be 90° C for normal operation in wet or dry locations.
- F. Multiconductor, low-voltage power cables for motors, feeders, and branch circuits routed in cable tray, conduit or duct bank:
1. Voltage rating: 600-volt.
 2. Conductors: Annealed, bare copper, Class B, stranded, minimum size No. 12 AWG (4.0mm²).
 3. Insulation: Flame-retardant, cross-linked polyethylene (XLPE) or cross-linked polyolefin (XLPO), complying with physical and electrical requirements for NEC Type XHHW-2.
 4. Jacket: Flame-retardant, heat, moisture, and sunlight-resistant; cross-linked, low-smoke, nonhalogen polyolefin (XLPO).
 5. Phase conductors shall be cabled together with Class B stranded, uncoated copper grounding conductor and fillers. Ground wire size shall comply with requirements of UL 1277.
 6. Cover cable assembly with helically applied polyester binder tape with minimum 10% overlap.
 7. Marking: Insulated phase conductors shall be black and shall have printed numbers in accordance with ICEA Method 4. Each cable shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, metal, voltage rating, and UL listing as suitable for cable tray use.
 8. Cables shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and individual conductors UL VW-1 vertical flame test.
 9. Conductors shall be temperature rated for 90°C maximum continuous operating temperature in wet or dry locations.

2.04 SPLICES AND TERMINATIONS

- A. Splices, except as in lighting and general purpose power circuits specified below, not allowed unless specifically indicated on Drawings or required for connection to equipment.
- B. Temperature rating of splices and terminations shall be rated no less than 75°C.
- C. Splices allowed in lighting and general-purpose power circuits.
1. Provide wire and cable connectors of high-conductivity, corrosion-resistant material with contact area equal to at least current carrying capacity of wire or cable.
 2. General lighting and general-purpose building power circuits:
 - a. Twist-type, insulated spring connectors for splices on solid or stranded conductors smaller than No. 6 AWG.

- b. Use indent, hex screw, or bolt clamp-type connectors, with or without tongue for splices on solid or stranded conductors No. 6 AWG and larger.
 - c. Apply insulating 600-volt tape.
- D. Insulating tapes and compounds for terminations and splices shall be UL-listed for intended use, location, and voltage by manufacturer.
- E. Termination of conductors to equipment with bolted connections:
 - 1. Use compression type lugs:
 - 2. Compression lugs for cables 250 kcmil and larger shall have at least 2 clamping elements of compression indents, and provision for at least 2 bolts for joining to apparatus terminals.
 - 3. Crimping hand tools used for securing conductors in compression type connectors or terminal lugs shall be made for purpose and conductor sizes involved.
 - 4. Crimping tools shall be ratchet-type preventing tool from opening until crimp action is completed.
 - 5. Tools shall be product approved by connector manufacturer.
- F. Terminals:
 - 1. Conductors No. 10 AWG and smaller: Marathon 1500 Series.
 - 2. Conductors larger than No. 4/0 AWG: Terminate to tinned copper bus bar drilled and tapped with standard NEMA sized and spaced holes.
- G. Coordinate sizes and types of conductor terminals for 600-volt power cable terminations in equipment with furnished conductor and terminal connector data.
- H. Provide 600-volt rated terminal blocks for instrumentation and control conductors for connection to circuits external to specified equipment, and for internal circuits crossing shipping splits.
 - 1. Use crimp-on terminals matching termination point terminations in manufacturer-furnished panels. Splices not allowed.
 - 2. Terminal blocks for thermocouple extension wire: Buchanan "Medium Duty" with thermocouple contacts or Marathon 200 Series with Omega Engineering, Inc. Type TL terminal lugs.
 - 3. Furnish with white marking strips.
 - 4. Where permitted by safety codes and standards, provide without covers. Neither step-type terminal blocks nor angle mounting of terminal blocks allowed.
 - 5. Fuses may be mounted on terminal blocks.
 - 6. Maximum 2 conductors in accordance with termination point.
- I. Terminal blocks for external connections shall leave from centrally mounted location, not from individual devices in enclosure.
 - 1. Group-in instrument and control compartment for easy accessibility.
 - 2. Provide sufficient space on each side of each terminal block to allow orderly arrangement of leads to be terminated on block.
 - 3. Locate auxiliary equipment in compartments, enclosures, or junction boxes so service personnel will have direct access without interference from structural members and instruments without removal of barriers, cover plates, or wiring.
 - 4. Do not mount terminal blocks in compartments containing cables or buses operating at voltages above 600 volts.
 - 5. Size for wire sizes of incoming conductors as necessary.
- J. Install shorting-type terminal blocks nearest current transformer in accessible location for each set of CTs supplied with equipment furnished, no other shorting-type terminal blocks allowed, unless specified otherwise.
- K. Install din-rail mounted miniature circuit breakers (MCB) for protection of VT circuits on line and load side. Breakers shall have alarm contacts wired to terminal blocks.
- L. Terminate each conductor in multiconductor control cable or as shown on Drawings. Provide 10% spare terminals for circuit modifications.

- M. Each control switch and lockout relay shall have minimum of 4 spare normally open and 4 spare normally closed contacts wired out to terminal blocks.
- N. Circuit identification number listed on either circuit schedule or panel schedule shall be used to identify circuit, positioned as near as possible to end of each conductor on multiple single wire circuits and on cable jacket for multiconductor cables.
- O. Cable designations shall be visible after installation without requiring physical movement of cable.

2.05 ELECTRICAL ENCLOSURES

- A. Size junction boxes, pull boxes, and enclosures in accordance with requirements of NEC.
- B. Junction boxes and pull boxes 4" (100 mm) trade size or smaller in any dimension shall be galvanized malleable iron, or cast ferrous metal NEMA rated for installed location. Do not use concentric knockouts.
- C. Junction boxes, pull boxes, and electrical enclosures larger than 4" (100 mm) trade size in any dimension shall be as follows, unless required otherwise.
 - 1. NEMA rating for electrical enclosures installed in nonhazardous locations:
 - a. Indoor:
 - 1) Dry environmentally controlled area: NEMA 12.
 - 2) Noncorrosive wet or hose-down area: NEMA 4.
 - 3) Corrosive wet or hose-down area: NEMA 4X
 - b. Outdoor:
 - 1) Corrosive area: NEMA 4X.
 - 2) Noncorrosive area hose-down or spray area: NEMA 4.
 - 3) Noncorrosive area nonhose-down area NEMA 3R.
 - 2. Construct noncast-metal electrical enclosures from reinforced steel plate capable of supporting devices mounted on or within enclosure without deflection. Steel plate thickness shall conform to UL requirements.
 - 3. Enclosures shall be of adequate strength to support mounted components during shipment and installation.
 - 4. Conduit entrances shall be field drilled.
 - 5. Electrical enclosures located in outdoor, wet, or hose down areas shall be provided with space heaters. Provide space heaters completely wired within enclosure. Provide following:
 - a. Space heater.
 - b. Adjustable thermostat with set point temperature indicator.
 - c. One miniature circuit breaker protective device.
 - d. Space heaters, thermostat, and protection shall not interfere with cable into or out of enclosure, or with maintenance or replacement of devices within enclosure.
 - e. Use of space heaters shall not change or discolor any painted surface.
 - f. Space heater capacity shall maintain enclosure internal temperature above dew point under specified service conditions.
 - g. Space heaters shall be rated for 240 volts ac minimum, and shall be sized for operation on applied voltage of 120 volts ac.
- D. Outdoor electrical enclosures with ventilating openings:
 - 1. Louver on outdoor electrical equipment and protect in accordance with NEMA type.
 - 2. Equip openings on outdoor electrical equipment with fine mesh filters and stainless steel bug screens.

2.06 OUTLET BOXES

- A. Outlet boxes for concealed wiring systems shall be sheet metal, galvanized or cadmium plated.

- B. Boxes shall be minimum 4" (100 mm) square, 1-1/2" (38 mm) deep, sized to accommodate devices and number of conductors in accordance with NEC. Equip with plaster ring or cover as necessary for flush finish.
- C. Exposed conduit systems shall have surface-mounted boxes unless specified otherwise. Boxes for exposed wiring in nonhazardous, noncorrosive, and nonweatherproof locations shall be malleable iron, cadmium finish or cast aluminum alloy, minimum 4" (100 mm) square, 1-1/2" (38 mm) deep.
- D. Enclosures shall be as required for areas in which they are installed and as specified.
 - 1. Boxes shall be installed flush in masonry construction and be designed for intended use.
 - 2. Recessed boxes where fixture will be mounted shall be minimum 4" (100 mm) and octagonal in shape or 4" (100 mm) square by 1-1/2" (38 mm) deep with round plaster ring. Where used as junction box, boxes shall be minimum 4" (100 mm) square by 2-1/8" (53 mm) deep.
 - 3. Outlet boxes for wall concealed telephone and signaling systems shall be 4" (100 mm) square by 1-1/2" (38 mm) deep, minimum. Furnish with plaster ring and cover plate.
 - 4. Floor boxes for floor outlets shall be cast-metal with threaded conduit entrances, brass flange ring and brass duplex flap cover plate. Boxes shall be watertight and have leveling and adjustment screws for adjusting cover plate to finished floor. Boxes shall be minimum 4" (100 mm) diameter and 3-1/2" (88 mm) deep with approved gasket or seal between adjusting ring and box.
 - 5. Floor outlets for combination signaling, data, and power outlets shall be constructed of steel base, PVC housing, and steel bracket to allow feed through wiring as well as activation load-bearing support. Box construction shall meet UL 514A requirements.
 - a. Entire housing shall be removable for unrestricted access.
 - b. Once assembled, PVC housing shall be capable of carrying 6,000 lb (2722 kg) load.
 - c. Coordinate outlet requirements with communication system requirements.
 - 6. Floor boxes in 2-hour rated floors shall be secured in cored hole and shall be UL classified and listed for 2-hour rated floors.

2.07 PULL AND JUNCTION BOXES

- A. Furnish junction boxes and pull boxes where shown on Drawings, and where necessary to facilitate pulling wires and cables without damage.
- B. Above ground boxes shall be formed from sheet steel, with corners folded in and securely welded with inward flange on each of 4 edges.
- C. Drill box for mounting and attachment of cover; galvanize after fabrication.
- D. Cover shall be made of one-piece galvanized steel and provided with stainless steel round head machine screws.
- E. Box and cover shall be made of code gage steel, or heavier if shown on Drawings.
- F. Boxes shall be minimum 4-1/2" (113 mm) deep. Size shall be in accordance with NEC. Use next larger standard size when necessary in accordance with manufacturer standard sizes.
- G. Pull and junction boxes shall be furnished without knockouts for field drilling.
- H. Enclosures shall be as required for areas in which installed and in accordance with requirements specified.
- I. Underground boxes shall be specifically designed and constructed for intended installed location, and shall be either pre-formed concrete or PVC. Covers shall be capable of withstanding, without failure, type of traffic in general area.
- J. If pull and junction boxes are exposed in and around architecturally finished surfaces, paint box to match finish of nearby surfaces, unless indicated otherwise.

- K. Bolt-on junction box covers 3'-0" (900 mm) square or larger, or heavier than 25 lb. (11 kg) shall have permanent rigid handles. Covers larger than 3'-0" x 4'-0" (900 mm x 1200 mm) shall be split.

2.08 EQUIPMENT SAFETY GROUNDING

- A. Install exposed raceway electrically continuous. Conduit and tray shall not be considered to be only ground conductor.
- B. Furnish equipment that is part of integral shipping unit or assembly with bare copper ground conductor extending to central ground connection lug. Lug shall be suitable for field connection to local ground. Electrical equipment shall be considered any device that is energized.
- C. Single-point ground connections required for proper operation of electronic equipment shall be insulated from equipment safety ground. Such connections shall be extended, using insulated cable, to single insulated termination point suitable for field connection to appropriate ground system.
- D. Conduits that contain power circuits shall have ground conductor installed inside conduit. Ground conductor shall be bonded to equipment or tray or duct ground at both ends.
- E. Provide ground bushing on each conduit containing power circuit. Connect ground bushings together inside enclosure and to enclosure ground lug or ground bus.
 - 1. Use No. 8 AWG conductor for ground bushings trade size 1-1/2" (38 mm) and smaller.
 - 2. Ground bushings larger than 1-1/2" (38 mm) shall be sized in accordance with requirements of NEC, but in no case shall they be smaller than No. 8 AWG.
- F. Ground conductor: Uninsulated, Class B standard, round soft drawn uncoated copper as defined in ICEA S-19-81, unless specified otherwise.
- G. Hardware: Clamps, bolts, washers, nuts, and other hardware used with grounding conductor shall be copper, copper alloy, high copper alloy, or silicon bronze.

2.09 PIN AND SOCKET CONNECTORS

- A. Unless shown on Drawings, not allowed.

2.10 FUSES AND FUSE BLOCKS

- A. Modular-type, Class H screw terminal fuse blocks with Bakelite frame and reinforced retaining clips. Blocks shall be similar in construction and by same manufacturer.
- B. Slow blow fuses: Bussmann Type MDL or Gould Shawmut Type GDL with ampere ratings of 1/4, 1/2, 1, or 2.
- C. Fast acting fuses: Bussmann Type NON or Gould Shawmut Type OT with ampere ratings of 1, 3, 6, 10, 15, 20, or 30.
- D. Extremely fast acting fuses: Bussmann Type KAB with ampere ratings of 1, 3, 6, 10, 15, 20, or 30.

2.11 LOCAL SEPARATE CIRCUIT BREAKERS

- A. Provide 3-pole, molded-case, separately enclosed circuit breakers of not less than interrupting rating shown on Drawings at rated voltage.
 - 1. Provide with thermal and instantaneous trip elements.
 - 2. Breakers shall use high-conductivity copper for current carrying parts. Breaker enclosures shall have NEMA type enclosure as specified.

- B. Each breaker shall be manually operated with quick-make, quick-break, and trip-free toggle mechanism. Thermal elements shall withstand sustained overloads and short-circuit currents without injury and without affecting calibration.
- C. Circuit breakers shall have "On," "Off," and "Tripped" indication and shall be pad-lockable with 3 padlocks in "On" and "Off" position.
 - 1. Breakers rated over 70 amperes shall be rated 100% and have adjustable electronic trip units.
 - 2. Breakers shall be capable of adding alarm, lockout, shunt trip, and under-voltage as options.

2.12 LOCAL SEPARATE DISCONNECT SWITCHES

- A. Three-pole, nonfusible, heavy-duty, rated 600-volt with continuous current rating as shown on Drawings and as required by load.
 - 1. Type: Either molded-case or blade.
 - 2. Switches shall use high-conductivity copper for current carrying parts.
- B. Switches shall be positive, quick-make, and quick-break mechanisms.
 - 1. Switch assembly plus operating handle shall be integral part of enclosure base.
 - 2. Each switch shall have handle whose position is easily recognizable and which can be locked in "On" and "Off" position with 3 padlocks. "On" and "Off" positions shall be clearly marked.
- C. Switches shall be UL-listed and horsepower rated. Where applicable, switches shall have defeatable door interlocks that prevent door from being opened while operating handle is in "On" position.

2.13 AUXILIARY POWER TRANSFORMERS

- A. Provide separately mounted transformers as shown on Drawings.
- B. Windings shall be copper.
- C. Transformers shall be self-air-cooled, dry-type, capable of wall- or floor-mounting, and enclosed for wiring connection by conduit. In areas where dust and dirt may be normally present, use encapsulated-type transformers.
- D. NEMA enclosure type protection shall be as specified herein.
- E. Provide at least 2 full KVA capacity voltage taps above and 2 full KVA capacity taps below nominal rating. Each tap shall be 2.5% step.
- F. Transformer shall be capable of at least 150°C rise above rated site maximum ambient without degrading transformer life.
- G. Transformers shall be capable of continuous operation at rated kVA with normal life expectancy as defined in ANSI C57.
- H. Sound level shall not exceed NEMA maximum average sound level.
- I. Enclosure shall be sheet steel with corrosion-resistant finish and manufacturer's standard color.

2.14 PLATES AND COVERS

- A. Provide finish plates and covers of appropriate type and size for wiring and control devices, signal, and communication outlets.
- B. Mark each plate and cover to show circuit and panel designation. Unless indicated to be engraved plate, use self-sticking, clear membrane, UV-resistant labels with typed black letters. Handwritten labels not allowed.

- C. Coordinate color with adjacent surfaces.
- D. Raised cover galvanized steel plates shall be acceptable for use on surface-mounted outlet boxes in unfinished areas where weatherproof plates are not required.
- E. For weatherproof installations, cover plates shall be gasketed and rated for NEMA Type 4 installation.
- F. Device plate mounting hardware shall be countersunk and finished to match plate.

2.15 WIRING DEVICES

- A. Where more than one flush device is indicated in same location, mount devices in gangs under common plate.
- B. Switches for control of ac lighting panel load circuits, single-pole, 3-way, and 4-way, shall be premium, heavy-duty specification-grade, and meet FS W-S-896E. Switches shall be rated for use at 120 or 277 volts and 20 amperes minimum.
- C. Device color, if not shown on Drawings, shall be coordinated to match adjacent finishes.
- D. Wall switches requiring pilot light indication shall have red LED pilot light when toggled "On."
- E. Pulse control of lighting contactors shall be 20 amperes, 120/277 volts, momentary, double-throw, and center "Off."
- F. Standard convenience outlets: Premium, heavy-duty, specification-grade, duplex, 3-wire, grounding, 20-ampere, 125-volt for 120-volt circuits, and rated 250-volts for 240 or 208-volt circuits.
- G. Ground fault circuit interrupter (GFI) receptacles: Duplex, 20-ampere, and 125 volts, feed-through type.
- H. Isolated ground (IG) outlets: Duplex, 3-wire, with isolated grounding terminal, 20-ampere, and 125 volts. Outlets shall be orange in color, unless specified otherwise.

2.16 WELDING

- A. If special welding requirements are required for any piece of equipment during installation, requirements shall be stated on manufacturer's shop drawing of affected part.
- B. Furnish detailed welding requirements with equipment shipment.

2.17 PANELBOARDS

- A. Dead-front, circuit breaker type, rated for voltage, phase, with main lugs or main breaker as indicated on panel schedules.
- B. Enclosure shall be NEMA-rated for installation location and capable of flush or surface mounting.
- C. Enclosure cover and access door shall be hinged with breaker operating handles accessible through latchable and lockable door.
- D. Typed panel directory located inside door shall have panel and circuits function clearly identified. Handwritten panel schedules not allowed.
- E. Provide main and neutral buses insulated from cabinet with separate ground bus. Bus material shall be copper. Ground bus shall be similar to neutral bus in size and number of conductor terminating positions.

1. Bond ground bus to panelboard enclosure by copper ground strap or copper conductor of appropriate size. Bond neutral bus to ground bus in accordance with requirements of NEC.
2. Grounding bus connection to enclosure by removable screws not allowed.
3. Bus shall be capable of terminating clamp type lugs for neutral cable in each supply conduit, and connections for neutral cable in each load circuit.
4. Neutral bus shall be fully rated, unless specified otherwise.
5. Isolated ground panelboards: As specified above, except isolated ground bus shall be bonded, by insulated ground conductor, back to source of separately derived system. Do not bond isolated ground bus to panelboard enclosure unless this is first point of grounding for separately derived system.

2.18 CIRCUIT BREAKERS

- A. Molded-case, thermal-magnetic, bolt-in, individually front replaceable, and shall visibly indicate "On," "Off," and "Tripped" position.
- B. Branch circuit breakers used for lighting circuits shall be switch duty rated, "SWD."
- C. Breakers having multiple poles shall be manufactured as common trip type.
- D. Interrupting rating shall be not less than interrupting rating of panelboards, and not series rated to achieve required short circuit interrupting rating.
- E. Provide handle clips for 10%, or minimum of 2 whichever is greater, for breakers to prevent casual operation. If no breakers are indicated for installation, then provide on breakers labeled as spare.
- F. Breakers, and provisions for future breakers, shall be provided in quantities, poles, and ampere ratings shown on Drawings.
- G. Molded-case circuit breakers used in ac and dc panelboards and ac load centers shall be bolt-on type, G-frame size.

2.19 FINISHES

- A. Manufacturer's standard coating systems shall be factory-applied. Coating systems shall provide resistance to corrosion caused by weather and industrial environments.
 1. Surfaces inaccessible after factory or field assembly shall be protected for life of equipment.
 2. Painted surfaces shall be filled to provide smooth, uniform base for painting.
 3. Surfaces requiring field welds shall not be coated within 3" (75 mm) of field weld.
- B. Coating material and application techniques shall conform to regulations of air quality management agency having jurisdiction.
- C. Exterior surfaces of control and electrical equipment, including panels, cabinets, switchgear, transformers, and motors shall be manufacturer's standard colors unless specified otherwise.
- D. Apply high-temperature coating systems to uninsulated equipment operating at temperatures at or above 200°F (93°C).

2.20 RUST-INHIBITOR COMPOUNDS

- A. Uncoated machined and ferrous surfaces subject to corrosion shall be protected with rust-inhibitor compounds.
- B. Rust-inhibitor compounds used to protect surfaces of equipment and piping exposed to feedwater or steam shall be completely water-soluble.

- C. Surfaces to be field welded shall be coated with consumable rust-inhibitor compounds that will not affect quality of weld.
- D. External gasket surfaces, flange faces, couplings, rotating equipment shafts and bearings shall be thoroughly cleaned and coated with rust-inhibitor compounds.

2.21 GALVANIZING

- A. Galvanized structural steel members and steel assemblies shall be pickled after fabrication. Remove scale, rust, grease, and other impurities, then hot-dip galvanized in accordance with ASTM.
- B. If galvanized member is to be bolted, structural bolts shall be galvanized in accordance with ASTM.

2.22 EQUIPMENT NAMEPLATES

- A. Laminated white-over-black plastic such that face is white with black letters, with 1/8" (3 mm) engraved letters securely fastened with minimum of 2 self-tapping, stainless steel screws.
- B. Motor starters, either separately mounted or contained in motor control centers, shall have nameplates identifying related equipment. Where separate control and indicating lights are used, starters shall have engraved or etched legends ("start", "stop", etc.) as shown on Drawings.
- C. Provide control stations with nameplates identifying related equipment. Control and indicating lights shall have engraved or etched legends as shown on Drawings.
- D. Circuit breakers within main switchboards and distribution switchboards shall be provided with nameplates identifying related equipment being served.
- E. Fused and nonfused switches shall have 2 front cover-mounted nameplates.
 - 1. Nameplate containing permanent record indicating switch type, manufacturer's name, catalog number, and appropriate rating for equipment served.
 - 2. Provide additional nameplate to identify associated equipment.
- F. Panelboards shall have front cover-mounted nameplates identifying panelboard, matching information shown on Drawings and associated panel schedule. Nameplate shall have at least 4 lines of text consisting of:
 - 1. Line 1: Panel equipment identification number.
 - 2. Line 2: IEEE Voltage Designation.
 - 3. Line 3: Appropriate description from which power is derived, (i.e. fed from HP1 through XFMR-LP1).
 - 4. Line 4: Location of power source, (i.e. PP-1, NW wing).
- G. Lighting and auxiliary power transformers shall have front cover-mounted nameplates identifying transformer, matching information shown on Drawings. Nameplate shall have at least 2 lines of text that consist of:
 - 1. Line 1: Transformer equipment identification number.
 - 2. Line 2: Location of derived power source (i.e. fed from MDB, Elec Rm Basement).
- H. Nameplates shall meet requirements of NFPA 70E

2.23 HARDWARE

- A. Provide hardware including, but not limited to, anchor bolts, nuts, washers, expansion anchors, wire nuts needed for installation.
- B. Hardware smaller than 3/4" (19 mm) shall match NEMA standard size bolt holes on motors and electrical equipment.

PART 3 EXECUTION

3.01 EXAMINATION OF SITE

- A. Contractor shall be responsible for familiarity with Project Site conditions. Equipment furnished and installed shall be capable of withstanding most severe conditions that will be encountered.

3.02 PROTECTION OF WORK

- A. Protect installed Work and provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- B. Damage occurring to building or equipment during installation shall be repaired or replaced to conditions existing prior to damage at no additional cost or delay to project or Owner.

3.03 INSTALLATION

- A. Install equipment and materials in accordance with manufacturer's recommendations and Drawings.
- B. Details for equipment and systems installed in accordance with industry standard techniques will not be furnished.
- C. Installation details furnished on Drawings shall be followed unless found to be unsafe, inappropriate for equipment specified, or unachievable due to site conditions.
- D. Install equipment indicated on Drawings as furnished by others, unless noted as installed by others, including but not limited to:
 - 1. Medium-voltage switchgear.
 - 2. Medium-voltage bus duct.
 - 3. Secondary unit substations.
- E. Except as otherwise specified or indicated on Drawings, equipment shall be installed plumb, square, and level.
- F. Sheet metal junction boxes, equipment enclosures, sheet metal raceways, and similar items mounted on earth-bearing walls shall be separated from wall not less than 1/4" (6 mm) by corrosion-resistant spacers.
- G. Substations, switchgear, motor control centers, and similar equipment located outdoors shall be permanently sealed at base. Openings into equipment shall be screened or sealed as to prevent entrance of birds, rodents, and insects the size of wasps and mud daubers.
 - 1. Sealing material at base shall be concrete grout.
 - 2. Small cracks and openings shall be sealed from inside with silicone sealant.
 - 3. Large openings shall use galvanized screen mesh.

3.04 TRIP SETTING COORDINATION

3.05 CABLE

- A. Prior to installation of each cable or cable group into assigned raceway, verify that raceway has been correctly sized.
 - 1. Where raceway is not indicated in circuit schedule or on Drawings, size in accordance with requirements of NEC.
 - 2. If raceway size indicated on Contract Documents is inadequate, notify Engineer.
- B. Replace cables pulled into wrong raceway or cut too short to rack and train.

- C. Do not reinstall cables installed in wrong raceway and removed. Discard cables unless inspected and accepted by Owner's Representative in writing.
- D. Carefully lay or pull circuits in cable tray so neither cables nor tray is damaged.
- E. Protect cables from dirt, water, oil, damaging chemicals, and from physical injury prior to, and during installation.
- F. Cables shall be cut sufficiently long to conform to contour of trays, with particular attention paid to vertical inside bends.
- G. Remove excessive slack so cables lie parallel to sides of trays.
- H. Multiple single-conductor power cables No. 1/0 AWG (50 mm²) or larger installed in cable tray that constitute single power circuit shall be grouped together in triplexed or quadriplexed arrangement. Maintain cable spacing to be 2.15 x O.D. of largest conductor in group or adjacent group.
- I. Multiconductor power cables No. 4/0 AWG (120 mm²) or larger installed in cable tray shall be installed in single layer with maintained spacing of not less than 1 cable diameter of largest cable.
- J. Fasten cables to cable tray with rated nylon ties to hold cables in place.
- K. Perform fishing and pulling with flexible round metal tape, CO₂ propelled polyethylene cord, nylon rope, or manila rope.
- L. Cable damage caused by improper pulling tension and excessive sidewall pressures shall be considered for any cable pulls that require use of mechanized cable pulling machine, whether installed underground or overhead.
 - 1. NEC requirements shall be used as guideline. Calculations shall be performed for duct bank runs over 300' (90 m), and for installations in conduit over 100' (30 m).
 - 2. Monitor pulling tension during installation of cable. Tension shall not exceed maximum recommended by cable manufacturer.
 - 3. To avoid damage from excessive sidewall pressure at bends, pulling tension shall not exceed cable manufacturer's recommendation.
 - 4. Pulling mechanisms, manual or power type, shall have rated capacity in tons legibly marked on mechanism.
 - 5. During installation, observer shall constantly watch dynamometer and record maximum tension achieved during pull.
 - a. If excessive strain develops, stop pulling operation at once. Determine difficulty and correct.
 - b. Provide records of dynamometer readings to Engineer.
 - c. Inform Owner prior to cable pulls.
 - 6. Do not use woven wire cable grips. Use only pulling eyes for pulling cables.
 - 7. As soon as cable is pulled into place, remove pulling eyes and reseal cable.
- M. Insert reliable nonfreezing type of swivel or swivel connection between pulling rope and eye to prevent twisting under strain.
- N. Only use lubricants as recommended by cable manufacturer. Water-based lubricants not allowed.
- O. Outside of each cable reel shall be carefully inspected. Remove protruding nails, fastenings, or other objects that might damage cable.
 - 1. Perform visual inspection for flaws, breaks, or abrasions in cable sheath as cable leaves reel. Pulling speed shall be slow enough to permit inspection.
 - 2. Damage to sheath or finish of cable shall be sufficient cause for rejecting cable.
 - 3. Cable damaged during installation shall be replaced at no expense to Owner.

- P. Permanent radius of each bend after cable installation shall be in accordance with manufacturer's recommendations.
- Q. Cable supports and securing devices shall have bearing surfaces located parallel to surfaces of cable sheath. Install to provide adequate support without deformation of cable jackets or insulation.
- R. Provide adequate cable end lengths. Properly install in junction boxes and manholes to avoid longitudinal strains and distorting pressures on cable at conduit bushings and duct end bells.
- S. Final inspection shall be made after cables are in place. Where supports, bushings, and end bells deform cable jacket, provide additional supports.
- T. Splices, joints, and connections shall be made only in accessible junction boxes in accordance with methods specified and instructions of cable manufacturer. Splices not allowed unless shown on Drawings.
- U. Rough-in wiring terminated in junction boxes shall have at least 8" (200 mm) of free conductor coiled in box for connection to equipment and receptacles.
- V. Circuit information for circuits originating from panelboards is indicated on panel schedules. Other circuits are identified on circuit schedule.
 - 1. Do not combine receptacle loads with lighting loads.
 - 2. Circuits fed from panelboards shall not be combined with circuits from circuit schedule.
- W. Panelboard circuits are indicated as individual runs. Circuits may be combined into common conduits in accordance with rules of NEC. Perform work associated with combining of circuits at no additional cost to Owner.

3.06 WIRING DEVICES, BOXES, AND FITTINGS

- A. Install galvanized or cadmium plated, threaded, malleable iron boxes and fittings in:
 - 1. Embedded in concrete walls, ceiling, and floors.
 - 2. Outdoor exposed faces of masonry walls.
 - 3. Locations where weatherproof cover is required by code or this specification.
- B. Install galvanized or cadmium plated sheet steel boxes in:
 - 1. Indoor exposed faces of masonry walls.
 - 2. Interior partition walls.
 - 3. Joist supported ceilings.
- C. Rigid PVC device boxes shall be installed in exposed nonmetallic conduit systems.
- D. Telephone and communication conduit systems shall have separate junction boxes and pull fittings.
- E. Install fire system wiring in dedicated conduit system.
- F. Finish openings so standard sized cover plates can be used. Oversized plates not allowed.
- G. Mount wall switches 3'-6" (1050 mm) above finished floor or grade unless specified otherwise. After circuits are energized, test wall switches for proper operation.
- H. Outlets:
 - 1. Standard mounting height: 18" (450 mm) above finished floor, unless specified otherwise.
 - 2. Outlets outdoors, garages, basements, shops, storerooms, and other rooms where equipment may be hosed down: 4'-0" (1200 mm) above finished floor or grade.
 - 3. Surface-mount welding receptacles 4'-0" (1200 mm) above finished floor or grade.
 - 4. After circuits are energized, test each receptacle for correct polarity.

5. Test GFCI receptacles for proper operation.
 6. Mount wall thermostats 5'-6" (1650 mm) above finished floor unless noted otherwise. Thermostats mounted shall be suitably insulated from wall temperatures.
- I. Communication outlets shall be 18" (450 mm) above finished floor unless required otherwise. Outlets outdoors, garages, basements, shops, storerooms, and rooms where equipment may be hosed down shall be 4'-0" (1200 mm) above floor.
 - J. Clock outlets shall be located 7'-0" (2.13 m) above finished floor or grade.

3.07 GROUNDING AND BONDING

- A. Electrical system and equipment grounding shall be installed in accordance with NEC and shall conform to following, where applicable:
 1. Ground conductors shall be bare or green-insulated in accordance with NEC.
 2. Cable shall be soft-drawn copper or copper bar, sized in accordance with drawings and NEC, but not smaller than No. 12 AWG.
 3. Ground cable splices and joints inaccessible upon completion of construction shall meet requirements of IEEE 837 and shall be exothermic weld or compression system type.
 4. Ground cable through exterior building walls not in conduit shall enter within 3' (1 m) below finished grade and shall be provided with water stop. Installation of water stop shall include filling space between strands with solder and soldering 12" (300 mm) copper disc over cable.
 5. Ground cable near base of structure shall be in undisturbed earth and as far from structure as excavation permits, but not closer than 6" (150 mm).
 6. Copper ground conductor in addition to conduit connection shall ground each piece of electrical equipment.
 7. Copper or high-conductivity copper alloy ground lugs or clamps shall make ground connections to equipment and ground buses. Connections to enclosures not provided with ground buses or ground terminals shall be made by clamp-type lugs added under permanent assembly bolts or under new bolts drilled and added through enclosures other than explosionproof, or by grounding locknuts or bushings. Ground cable connections to anchor bolts; against gaskets, paint, or varnish; or on bolts holding removable access covers not permitted.
 8. Bond grounding system to water piping by connection to first flange inside building from main that will form good ground connection. Make connection with copper bar or strap by drilling and tapping flange and providing bolted connection.
 9. Ground conductors on equipment shall be formed to contour of equipment and firmly supported.
 10. Ground rods not described elsewhere shall be minimum 5/8" (16 mm) diameter by 10' (3.0 m) long, with copper jacket bonded to steel core.
 11. Make connections to ground grid where shown on Drawings.
 12. Verify connections by performing continuity checks.

3.08 FIRE PROOFING AND FIRE RATINGS

- A. Maintain fire-resistive integrity during construction.
- B. Penetrations through fire-resistive structures shall be sealed with fire-resistive material compatible with construction penetration.
- C. Where required by codes, local building officials, or fire marshal, furnish UL fire sealing systems and install in accordance with manufacturer's recommendations.

3.09 STARTUP AND TESTING

- A. Clean equipment interiors and exteriors prior to start-up and testing.
- B. Unless specified otherwise, tests performed shall be standard tests listed by ANSI/IEEE for intended equipment.

- C. Equipment shall be checked and placed in service ready for operation.
- D. Circuits shall be electrically tested after installation. Test power and motor circuits prior to final connection to equipment. Splices shall be complete prior to testing.
 - 1. Provide equipment and labor required for testing.
 - 2. Circuit failing to test satisfactorily shall be replaced or repaired, and retested at no additional cost to Owner.
 - 3. Check power and motor circuits, dc power, and control circuits for:
 - a. Correct terminations.
 - b. Continuity.
 - c. Unintentional shorts and grounds.
 - 4. Check power conductors for correct phasing.
 - 5. Motor circuits shall be checked for proper rotation and motors "bumped" to verify correct machine rotation.
 - 6. Control, instrumentation, and thermocouple wire shall be checked for correct termination, continuity, freedom from shorts or grounds, and identification.
 - 7. Current transformer wiring shall be loop checked by injecting current at one end of loop and checking with clip-on ammeter at each field termination point to assure continuity and phase identification.
 - 8. Voltage transformer wiring shall be tested by applying voltage at one point and checking with voltmeter phase rotation meter and phase angle meter at each field termination point to assure continuity, identification and phase shift.

3.10 DEMONSTRATION

- A. Final start-up and check out shall be completed prior to Owner acceptance of project.
- B. Electrical installation shall be complete in every detail and capable of normal operation in presence of Owner or Owner's Representative to verify its readiness.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Above grade conduit, wireway, boxes, and associated accessories for support, securing, and protection of electrical wiring.

1.02 INFORMATIONAL SUBMITTALS

- A. Product Data:
 - 1. List of proposed materials identifying manufacturer and type to be furnished.
 - 2. Manufacturer's catalog sheets, marked as necessary to indicate specific type, model or catalog number for equipment to be furnished for project.
- B. Quality assurance data:
 - 1. Component and accessories data sheets.
 - 2. Installation information.
- C. Such other similar information as Engineer may request.

1.03 QUALITY ASSURANCE

- A. Manufacturer's qualifications:
 - 1. Manufacturer shall be manufacturer of major components within assembly and shall be ISO certified.
 - 2. Manufacturer shall have produced similar equipment for a minimum period of 5 years.
- B. Regulatory requirements
 - 1. Equipment shall be designed and manufactured in accordance with applicable requirements of following: NFPA 70; ANSI C80.1, C80.3, C80.4, C80.5; UL 1, UL 6, UL 360, UL 651, UL 797, UL 870, UL 1242; and NEMA TC2, TC3, TC6, TC9, and RN1.
 - 2. Standards of foreign organizations shall not be used without written approval from Engineer.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Raceway systems and accessories shall include, but not be limited to:
 - 1. Exposed and concealed conduit.
 - 2. Elbows, fittings, and accessories.
 - 3. Hardware for support, securing, and protection.
 - 4. Wireways.

2.02 RIGID METAL CONDUIT, STEEL, POLYVINYL CHLORIDE COATED (PVC-RGS)

- A. Requirements of article "Rigid Metal Conduit - Steel (RGS)" shall apply.
- B. Coating: Apply minimum 40-mil, gray polyvinyl chloride (PVC) coating over exterior and apply urethane coating uniform and consistent to interior of conduit. Internal coating shall be nominal 2 mil thickness. Conduit having areas with thin or no coating, not acceptable. Protect conduit threads by urethane coating. PVC coating shall have been investigated by UL as providing primary corrosion protection for rigid metal conduit.
- C. Fittings, and conduit bodies: Threaded type, PVC-coated. PVC coating on outside of conduit couplings shall have series of longitudinal ribs, 40 mils in thickness, to protect coating from tool damage during installation. Manufacturer of couplings, fittings, and conduit bodies shall be same as

conduit manufacturer. Hazardous location fittings shall be manufactured prior to application of plastic coating, and shall be UL-listed.

- D. PVC exterior and urethane interior coatings applied to conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30°F (-1°C).

2.03 FLEXIBLE METAL CONDUIT (FMC)

- A. Material: Galvanized mild steel.
- B. Construction: One continuous length of steel strip of uniform weight and thickness and shaped in interlocking convolutions; fabrication shall result in smooth interior and exterior surfaces, reduced or full wall.
- C. Fittings: Cadmium-plated steel, malleable iron, or zinc alloy. Screw in type, 1/2" (13 mm) and 3/4" (19 mm) shall have high-density polypropylene liners.

2.04 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Material: Mild steel, galvanized.
- B. Construction: One continuous length steel strip of uniform weight and thickness and shaped in interlocking convolutions; fabrication shall result in smooth interior surface.
- C. External coating: Provide outer jacket of tough extruded polyvinyl. Jacket shall be positively locked to steel core and be sunlight resistant and listed as oil resistant.
- D. Continuous integral grounding strip: Required in sizes 1-1/4" (31 mm) and smaller. Ground wire shall be required for larger sizes.
- E. Fittings: Cadmium or zinc-plated steel or malleable iron. Compression type with tapered hub and synthetic rubber gasket and ground ferrule for making positive ground contact with steel core, designed to prevent outer jacket from pulling away from steel core. Connectors shall have insulated insert in throat. Suitable for grounding through 1-1/4" (31 mm) trade size, provide ground wire lug for sizes 1-1/2" (38 mm) and larger.

2.05 RIGID NONMETALLIC CONDUIT, POLYVINYL CHLORIDE (PVC)

- A. Material: PVC Schedule 40, and Schedule 80. Schedule 40 shall be rated for above-grade installation.
- B. Fittings, elbows, and accessories: Connect to conduit by solvent-type cement process. Material shall be same as conduit.
- C. Transition for connection of plastic conduit to rigid metal conduit shall be threadless solvent-type cement connection to PVC, with threaded connection to rigid metal conduit.

2.06 PULLBOXES AND JUNCTION BOXES

- A. General use areas, protected or indoor: Galvanized sheet steel with a metal thickness meeting UL 50. Provide removable covers attached with round head silicon bronze machine screws.
- B. Process or wet locations, indoor or outdoor: Galvanized steel or aluminum with gasketed covers attached with stainless steel hardware using raintight hubs.
- C. Hazardous areas: UL-approved for area classification.

- D. Where required for elbows, fittings, and accessories to be furnished by same manufacturer as conduit, boxes shall also be furnished by conduit manufacturer or by supplier approved by manufacturer.

2.07 WIREWAY

- A. Metal gage thickness shall conform to NEC.
- B. NEMA 1: Minimum 16-gage steel with baked enamel finish, hinged or removable covers with captive stainless steel screws.
- C. NEMA 3R: Minimum 16-gage galvanized steel with baked enamel finish, gasketed drip-shield cover, with stainless steel screws, weatherproof.
- D. NEMA 4X: Minimum 14-gage Type 304 stainless steel with neoprene gasket, hinged cover, stainless steel external screw clamps, and external mounting tabs.
- E. NEMA 12: Minimum 16-gage steel with baked enamel finish with gasketed, hinged cover with stainless steel screws, dust-tight.
- F. Screws shall be guarded to prevent damage to wire installation.
- G. Provide fittings, supports, end plates, and accessories as required.

2.08 SURFACE METAL RACEWAY AND MULTIOUTLET ASSEMBLY

- A. Material: Sheet metal channel with fitted cover. Provide pre-wired receptacles suitable for use as multioutlet assembly where required.
- B. Protective coating: Gray enamel finish, manufacturer's standard paint application.
- C. Fittings: Couplings, elbows, outlet and device boxes, and connectors necessary.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Coordinate timing of installation and locations of raceway with other trades. Do not block access or impede construction.
- B. Locations of above grade raceway indicated on Drawings are approximate. Coordinate actual locations in field to avoid conflicts with other equipment.
- C. Areas designated for, but not limited to; access, maintenance, hatchway, tube removal, and expansion shall be kept clear of field-routed raceway.
- D. Exposed raceway runs shall be installed parallel or perpendicular to dominant surfaces with right-angle turns made with symmetrical bends or fittings.
- E. Install exposed raceway minimum of 6" (150 mm) from outside surface of insulation and lagging on hot water pipes, steam pipes, and other heat sources. Install minimum of 12" (300 mm) from uninsulated heat sources. Avoid long runs parallel to heat sources.
- F. Use expansion fittings where necessary. When expansion or deflection will be greater than 6" (152 mm) or greater than fitting is designed to accommodate, provide junction boxes solidly mounted on each side of expansion joint and connect with flexible, liquidtight conduit, or adjust conduit sections to limit expansion to less than 6" (152 mm).

- G. Support raceway independently from equipment, and temporary or movable structures.
- H. At minimum, identify raceways at both ends with raceway numbers provided by Engineer. Markers shall be adhesive, UV-resistance type with 1" (25 mm) high lettering.

3.02 USES AND LIMITATIONS

- A. Refer to NEC for guidelines regarding use, and limitation of each type of conduit. Follow NEC except as specified otherwise herein, or as shown on Drawings.
- B. PVC-RGS: Acceptable for corrosive areas. Install conduit system in accordance with manufacturer's installation manual. Installer shall be certified by manufacturer to install coated conduit.
- C. IMC: Use only for circuits rated 600 volts or less. Do not use in areas deemed corrosive.
- D. EMT: Use for concealed wiring in finished areas associated with lighting and small power circuits rated 600 volts or less. Do not use outdoors in concrete, or in damp or wet locations. Acceptable for use in nonhazardous, indoor, unfinished areas for lighting and communication, and specialty wiring.
- E. FMC: 1/2" (13 mm) minimum size. Use only in dry, interior, noncorrosive, and concealed locations. Maximum length shall be 3' (1 m) for general use, and up to 6' (1.6 m) to light fixtures in concealed locations.
- F. PVC: Do not use schedule 40 PVC for exposed runs. Schedule 80 PVC sunlight-resistant conduit may be used for exposed runs if approved by Engineer.
- G. Surface metal raceway and multioutlet assembly: Use in dry, general-purpose areas where shown on Drawings.

3.03 RIGID CONDUIT

- A. Conduits not shown on Drawings shall be sized in accordance with NEC.
- B. Conceal conduit in finished areas.
- C. Drainage: Avoid water pockets in conduit runs; provide suitable fittings at low spots in exposed conduit where pockets cannot be avoided. Weep holes not permitted in conduit.
- D. Conduit ends:
 - 1. Cap spare conduits with fittings designed for intended use.
 - 2. Conduit terminating in panels or enclosures where exposed to entrance of foreign material shall be plugged with commercial duct-sealing compound around conductors.
 - 3. Cap conduit ends during construction to prevent entrance of foreign material.
- E. Where practicable, provide 3" (75 mm) stubbed up conduit for conduit entering into bottom of freestanding equipment. Coordinate locations with equipment. Terminate with grounding bushings.
- F. Clean and swab inside of conduit by mechanical means to remove foreign materials and moisture before wires or cables are installed. Cleaning method shall not damage interior surface of conduit.
- G. Bushings: Provide at termination of conduit not terminated in hubs and couplings. Insulating bushings with 150°C rated insulating inserts in metal housings shall be provided on conduit 1-1/4" (31 mm) and larger. Insulating bushings shall be grounding type. Standard bushings shall be galvanized.
- H. Apply coat of zinc chromate to zinc-coated conduits where protective coating is damaged.
- I. Couplings and unions:

1. Threaded conduit couplings shall join metal conduit with conduit ends butted. Where standard threaded couplings cannot physically be used, join metal conduit using conduit unions or split couplings.
 2. Use ground-seat type, watertight unions where union may be submerged.
 3. Install coupling nut in upper-most union to prevent entrance of water into union when used in vertical or inclined conduit runs.
- J. Bends: Run of conduit shall not contain more than equivalent of three 90° bends, including offsets at outlets or fittings. Use only manufacturer-approved conduit bending equipment. Do not use deformed or crushed conduits.
- K. Threads: Cut ends of conduit with saw; do not use wheel cutter. Conduit end shall have same number of threads as present from factory. Apply coat of zinc chromate to steel conduit threads and apply anti-seize compound containing powdered zinc or lubricating graphite to aluminum conduit threads.
- L. Use expansion joints as required such that no more than 6" (152 mm) allowance for expansion or contraction of conduit occurs.

3.04 FLEXIBLE CONDUIT

- A. Connect equipment that moves due to vibration, normal operation of mechanism, or thermal expansion, in relation to supported conduit using flexible conduit. Install junction boxes as required. Provide green ground wire.
- B. Flexible metal conduit 1-1/2" (38 mm) and larger shall be installed with external lugs and external grounding conductor.

3.05 SPECIAL FITTINGS

- A. Hazardous areas: Rigid conduit shall be used in areas designated as Class 1 areas classified as hazardous locations in accordance with NEC.
- B. Fittings installed outdoors or in damp locations shall be weathertight. Outdoor fittings shall be of heavy-duty construction.

3.06 CONDUIT SUPPORTS

- A. Supports of structural steel or manufactured framing members shall be fabricated from lightweight channel approved by manufacturer for intended use, provide required rods, anchors, inserts, clamps, spacers, shims, bolts and accessories.
- B. Clamps: Galvanized malleable iron 1-hole straps, beam clamps, or other device with necessary bolts and expansion shields.
- C. Adjustable hangers: Use to support horizontal runs only. Use trapeze-type supports for parallel runs of conduit. Install U-bolts at end of each run and at each elbow. Install conduit clamps every third intermediate hanger for each conduit. Hanger rods shall be 3/8" (10 mm) minimum diameter threaded galvanized steel rods.
- D. Conduits supports mounted on concrete surfaces: Fasten with self-drilling tubular expansion shell anchors with externally split expansion shells, single cone expanders, and annular break-off grooved chucking cones.

3.07 PENETRATIONS

- A. Provide required penetrations in floors, walls, or roofs. Penetrations shall be kept to minimum, as small as possible, and installed in neat manner. Surrounding surfaces damaged during installation of penetrations shall be included as part of this work.
- B. Seal penetrations in walls, floors, ceilings, and enclosures. Provide fire stops for electrical raceway penetrations. Maintain original fire rating that existed prior to commencement of work. Do not install fire seal for wire openings until interconnecting wiring of equipment is proven to operate properly.
- C. Sleeves:
 - 1. Provide for passage of conduits through walls, floors, or partitions. Set sleeves in masonry during construction; set sleeves through concrete before placement begins.
 - 2. Material: Rigid conduit or pipe securely fastened in position.
 - 3. Cut sleeve flush with floor where conduit enters equipment enclosure otherwise extend sleeve 3" (75 mm) above floor.
 - 4. Sleeves through exterior building walls: Install conduit in center of sleeve. Pack interior and exterior annular space around conduit with plastic backer rod sized to fit annular space in compression as recommended by backing manufacturer. Seal interior and exterior of joint with acrylic polymer sealant.
 - 5. Sleeves through waterproof construction shall be flanged type.
- D. Penetrations required after walls, floors, or ceilings are constructed shall be provided and grouted or sealed. Openings shall be core-drilled, do not jackhammer.
- E. Patch and finish openings made in existing walls and floors to match original material in composition and appearance.
- F. Cut or punch penetrations in wall panels. External penetration shall be flashed and calked to provide weather tight seal.
- G. Limit penetrations in roofs to applications where required for connection to specific piece of equipment. When required, flash and apply seal material after installation of conduit to provide weathertight bond and seal. Materials shall be compatible with roofing system.

3.08 WIREWAY AND BOXES

- A. Installed in accordance with manufacturer's recommendations.
- B. Connections shall be made such that they maintain NEMA rating of enclosure and system.
- C. Locations and quantities shown on Drawings are approximate. Make adjustments as required to eliminate field interferences or to meet requirements of NEC. Provide Engineer with information regarding new locations.
- D. To access interior, locate to permit full removal of covers, or such that doors can be opened more than 100°. Mount at height as indicated, or as required by NEC, whichever is more restrictive.
- E. Support wireways and boxes independently of conduits by means of bolts, screws, rod hangers, and other suitable means.

3.09 MULTIOUTLET ASSEMBLY

- A. Space receptacles in multioutlet assemblies at 12" (300 mm) on center or as indicated otherwise. Adjacent receptacles shall be wired on different circuits.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Below-grade conduit, boxes, and associated accessories for support, securing, and protection of electrical wiring.

1.02 INFORMATIONAL SUBMITTALS

- A. Product Data:
 - 1. List of proposed materials identifying manufacturer and type to be furnished.
 - 2. Manufacturer's catalog sheets, marked as necessary to indicate specific type, model or catalog number for equipment to be furnished for project.
- B. Quality assurance data:
 - 1. Component and accessories data sheets.
 - 2. Installation information.
- C. Such other similar information as Engineer may request.

1.03 ACTION SUBMITTALS

- A. Shop Drawings: Manhole and hand hole dimensional layouts.

1.04 QUALITY ASSURANCE

- A. Manufacturer's qualifications:
 - 1. Manufacturer shall be manufacturer of major components within assembly and shall be ISO certified.
 - 2. Manufacturer shall have produced similar equipment for a minimum period of 5 years.
- B. Regulatory requirements
 - 1. Equipment shall be designed and manufactured in accordance with applicable requirements of following; NFPA 70; ANSI C80.1, C80.3, C80.4, C80.5; UL 1, UL 6, UL 360, UL 651, UL 797, UL 870, UL 1242; and NEMA TC2, TC3, TC6, TC9, and RN1.
 - 2. Standards of foreign organizations shall not be used without written approval from Engineer.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Raceway systems and accessories include, but shall not be limited to:
 - 1. Direct buried ducts.
 - 2. Concrete encased ducts.
 - 3. Cable trench.
 - 4. Elbows, fittings, and accessories.
 - 5. Hardware for support, securing, and protection.
 - 6. Manholes and handholes.
 - 7. Trenching and backfilling.

2.02 RIGID METAL CONDUIT, STEEL (RGS)

- A. Material: Mild steel tube with continuous welded seam in accordance with ANSI C80.1, and UL 6.

- B. Exterior and Interior protective coating: Metallic zinc applied by hot-dip galvanizing or electro-galvanizing. Apply final coat of transparent zinc chromate to exterior. Exterior and interior coatings applied to conduit shall afford sufficient flexibility to permit field bending without cracking or flaking.
- C. Conduits shall be available in standard trade sizes, 3/4" (21 mm) minimum.
- D. Thread pitch shall conform to ANSI/ASME B1.20.1. Taper shall be 3/4"/ft (62.5 mm/m).
- E. Each length of conduit shall have UL listing label.
- F. In areas designated as corrosive, conduit shall meet NFPA 70.
- G. Couplings, unions, and fittings: Threaded-type, galvanized steel.
- H. Conduit bodies: Threaded-type, cast metal or malleable iron type with zinc or cadmium coating. Covers shall have solid gaskets and captive screw fasteners.
- I. Running thread not acceptable.

2.03 RIGID METAL CONDUIT, STEEL, POLYVINYL CHLORIDE COATED (PVC-RGS)

- A. Requirements of NEC article "Rigid Metal Conduit - Steel (RGS)" shall apply.
- B. Coating: Apply minimum 40-mil, gray polyvinyl chloride (PVC) coating over exterior and apply urethane coating uniform and consistent to interior of conduit. Internal coating shall be nominal 2 mil thickness. Conduit having areas with thin or no coating, not acceptable. Protect conduit threads by urethane coating. PVC coating shall have been investigated by UL as providing primary corrosion protection for rigid metal conduit.
- C. Fittings, and conduit bodies: Threaded type, PVC-coated. PVC coating on outside of conduit couplings shall have series of longitudinal ribs, 40 mils in thickness, to protect coating from tool damage during installation. Manufacturer of couplings, fittings, and conduit bodies shall be same as conduit manufacturer. Hazardous location fittings shall be manufactured prior to application of plastic coating, and shall be UL-listed.
- D. Conduit shall meet NFPA 70 in areas designated as corrosive.
- E. PVC exterior and urethane interior coatings applied to conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30°F (-1 °C).

2.04 RIGID NONMETALLIC CONDUIT, POLYVINYL CHLORIDE (PVC)

- A. Material: PVC Schedule 40, and Schedule 80. Schedule 40 shall be rated for underground installation; underground shall be either direct buried or encased in concrete. When encased in concrete, underground conduits shall be rated for cables operating up to 90°C installed within.
- B. Fittings, elbows, and accessories: Connect to conduit by solvent-type cement process. Material shall be same as conduit. Provide belled end fittings at each manhole and wall entrance.
- C. Transition for connection of plastic conduit to rigid metal conduit shall be threadless solvent-type cement connection to PVC, with threaded connection to rigid metal conduit.

2.05 RIGID NONMETALLIC UNDERGROUND CONDUIT (EB)

- A. Material: PVC, designed for concrete encased applications. Comply with NEMA TC-6 and TC-8, and ASTM F512 for utility duct, and ETL-listed.

- B. No special cutting or tapering devices required.
- C. Joints shall be made with solvent-type cement.
- D. Provide duct end bells for termination into manholes.
- E. Fittings, elbows, and accessories, shall be manufactured by conduit manufacturer, and be of same material.

2.06 PULLBOXES AND JUNCTION BOXES

- A. Hazardous areas: UL-approved for area classification.
- B. Where required for elbows, fittings, and accessories to be furnished by same manufacturer as conduit, boxes shall also be furnished by conduit manufacturer or by supplier approved by manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Coordinate timing of installation and locations of raceway with other trades. Do not block access or impede construction.
- B. Locations of raceway indicated on Drawings are approximate. Coordinate actual locations in field to avoid conflicts with other equipment.
- C. Top of duct banks shall be a minimum of 24-inches below grade.
- D. Areas designated for, but not limited to; access, maintenance, hatchway, equipment removal, and expansion shall be kept clear of field-routed raceway.
- E. Conduit embedded in concrete slabs: Minimum 3" (75 mm) from outer edge of conduit to top and bottom of slab. Conduit outside diameter shall be no more than 1/3 of slab thickness. Space conduit minimum three times outer diameter of larger conduit center to center.
- F. Use expansion fittings where necessary. When expansion or deflection will be greater than 6" (152 mm) or greater than fitting is designed to accommodate, provide junction boxes solidly mounted on each side of expansion joint and connect with flexible, liquidtight conduit, or adjust conduit sections to limit expansion to less than 6" (152 mm).
- G. Support raceway independently from equipment, and temporary or movable structures.
- H. At minimum, identify raceways at both ends with raceway numbers provided by Engineer. Markers shall be adhesive, UV-resistance type with 1" (25 mm) high lettering.

3.02 USES AND LIMITATIONS

- A. Refer to NEC for guidelines regarding use, and limitation of each type of conduit. Follow NEC except as specified otherwise herein, or as shown on Drawings.
- B. RGS: Do not use underground except as stub-ups and apply corrosion protection. Do not mix aluminum fittings with steel conduit and vice versa.
- C. PVC-RGS: May be used for conduits installed underground, direct buried, or for slab-on-grade construction. Acceptable for corrosive areas. Install conduit system in accordance with

manufacturer's installation manual. Installer shall be certified by manufacturer to install coated conduit.

- D. PVC and EB: Use Schedule 80 PVC conduit encased in concrete for installation under heavy traffic areas.

3.03 RIGID CONDUIT

- A. Conduits not shown on Drawings shall be sized in accordance with NEC. Minimum size: 3/4" (19 mm).
- B. Conceal conduit in finished areas.
- C. Drainage: Avoid water pockets in conduit runs; provide suitable fittings at low spots in exposed conduit where pockets cannot be avoided. Weep holes not permitted in conduit.
- D. Conduit ends:
 - 1. Cap spare conduits with fittings designed for intended use.
 - 2. Conduit terminating in panels or enclosures where exposed to entrance of foreign material shall be plugged with commercial duct-sealing compound around conductors.
 - 3. Cap conduit ends during construction to prevent entrance of foreign material.
- E. Where practicable, provide 3" (75 mm) stubbed up conduit for conduit entering into bottom of freestanding equipment. Coordinate locations with equipment. Terminate with grounding bushings.
- F. Clean and swab inside of conduit by mechanical means to remove foreign materials and moisture before wires or cables are installed. Cleaning method shall not damage interior surface of conduit.
- G. Bushings: Provide at termination of conduit not terminated in hubs and couplings. Insulating bushings with 150°C rated insulating inserts in metal housings shall be provided on conduit 1-1/4" (31 mm) and larger. Insulating bushings shall be grounding type. Standard bushings shall be galvanized.
- H. Apply coat of zinc chromate to zinc-coated conduits where protective coating is damaged.
- I. Couplings and unions:
 - 1. Threaded conduit couplings shall join metal conduit with conduit ends butted. Where standard threaded couplings cannot physically be used, join metal conduit using conduit unions or split couplings.
 - 2. Use ground-seat type, watertight unions where union may be submerged.
- J. Bends: Run of conduit shall not contain more than equivalent of three 90° bends, including offsets. Use only manufacturer-approved conduit bending equipment. Do not use deformed or crushed conduits.
- K. Threads: Cut ends of conduit with saw; do not use wheel cutter. Conduit end shall have same number of threads as present from factory. Apply coat of zinc chromate to steel conduit threads and apply anti-seize compound containing powdered zinc or lubricating graphite to aluminum conduit threads.
- L. Use expansion joints as required such that no more than 6" (152 mm) allowance for expansion or contraction of conduit occurs.

3.04 SPECIAL FITTINGS

- A. Hazardous areas: Rigid conduit shall be used in areas designated as Class 1 areas classified as hazardous locations in accordance with NEC.

3.05 CONDUIT SUPPORTS

- A. Supports of structural steel or manufactured framing members shall be fabricated from lightweight channel approved by manufacturer for intended use, provide required rods, anchors, inserts, clamps, spacers, shims, bolts and accessories.
- B. Clamps: Galvanized malleable iron 1-hole straps, beam clamps, or other device with necessary bolts and expansion shields.
- C. Adjustable hangers: Use to support horizontal runs only. Use trapeze-type supports for parallel runs of conduit. Install U-bolts at end of each run and at each elbow. Install conduit clamps every third intermediate hanger for each conduit. Hanger rods shall be 3/8" (10 mm) minimum diameter threaded galvanized steel rods.
- D. Conduits supports mounted on concrete surfaces: Fasten with self-drilling tubular expansion shell anchors with externally split expansion shells, single cone expanders, and annular break-off grooved chucking cones.

3.06 PENETRATIONS

- A. Provide required penetrations in floors and walls. Penetrations shall be kept to minimum, as small as possible, and installed in neat manner. Surrounding surfaces damaged during installation of penetrations shall be included as part of this work.
- B. Seal penetrations in floors and enclosures. Provide fire stops for electrical raceway penetrations. Maintain original fire rating that existed prior to commencement of work. Do not install fire seal for wire openings until interconnecting wiring of equipment is proven to operate properly.
- C. Sleeves:
 - 1. Provide for passage of conduits through walls, floors, or partitions. Set sleeves in masonry during construction; set sleeves through concrete before placement begins.
 - 2. Material: Rigid conduit or pipe securely fastened in position.
 - 3. Cut sleeve flush with floor where conduit enters equipment enclosure otherwise extend sleeve 3" (75 mm) above floor.
 - 4. Sleeves through exterior building walls: Install conduit in center of sleeve. Pack interior and exterior annular space around conduit with plastic backer rod sized to fit annular space in compression as recommended by backing manufacturer. Seal interior and exterior of joint with acrylic polymer sealant.
 - 5. Sleeves through waterproof construction shall be flanged type.
- D. Penetrations required after footings, walls, or floors are constructed shall be provided and grouted or sealed. Openings shall be core-drilled, do not jackhammer.
- E. Patch and finish openings made in existing walls and floors to match original material in composition and appearance.

3.07 CONDUIT INSTALLED UNDERGROUND

- A. Direct-buried conduit:
 - 1. Direct-buried, underground or below slab conduit shall be RNMC unless indicated otherwise and installed to yield completely corrosion protected conduit system.
 - 2. Slope conduits for drainage.
 - 3. Depth: Minimum as required by NEC.
- B. Plastic-coated, rigid steel conduit:
 - 1. Use procedures recommended by manufacturer to prevent damage to PVC coating.
 - 2. Use strap wrenches for tightening threaded joints.

3. If protective coating is damaged, repair by application of patching compound as recommended by manufacturer.
- C. Concrete encased underground duct may be Type EB, unless noted otherwise. Verify by calculation that hydraulic force on bottom duct does not exceed theoretical collapse pressure of duct. Use thicker wall duct as required, unless a sequential pour technique is used.
- D. Elbow that stubs up at end of a conduit run shall be RGS conduit and shall be bonded to grounding system. Provide required fittings and accessories for connection of RGS conduit to nonmetallic conduit.
- E. Install duct runs and manholes at elevations consistent with project requirements. Top of duct banks shall be not less than 30" (750 mm) below finished grade elevation, unless indicated otherwise. Provide extension rings on manholes as required to bring opening flush with finished surface.
- F. Utilize duct spacers, both vertically and horizontally, to support runs of concrete encased ducts. Install duct spacers 8' (2.4 m) maximum on center, unless specified otherwise. Brace duct runs during concrete placement to prevent floating. Wood spacers or braces in concrete encasement are not acceptable, and iron ties or straps shall not be used around single ducts, but may be used around whole duct run.
- G. Crown duct runs between manholes at midpoint of run to allow drainage back into manholes. Slope shall be minimum of 1/32" per foot (0.8 mm per meter) of slope. Duct runs from stub-ups back to manholes shall maintain same slope. Provide end bell fittings at terminations of conduits into manholes.
- H. Install ground cable and connect to ground system on both ends of duct bank. Place ground cable in concrete, and above direct buried conduits.
- I. Concrete work:
 1. Duct bank concrete shall be poured without forming, provided trench walls do not cave; otherwise, use forms. Make trench no wider than necessary to provide nominal size concrete thickness.
 2. Tie down conduits to prevent floating during concrete pouring.
 3. Remove foreign substances from conduits before pouring concrete.
 4. Use splashboard to divert flow of concrete away from trench sides, and avoid dislodging soil and stones. Prevent loose excavated material from falling into trench during concrete pouring.
 5. Pour each section of duct bank complete in one operation; if this is not feasible, provide construction joint using rigid steel conduit 5' (1.5 m) on each side of joint.
 6. Begin concrete pouring at 1 end of duct bank, working toward other end, to allow free end to move. Do not pour concrete from each end toward center.
 7. Do not use mechanical vibrators.
 8. Provide red coloring in concrete.
- J. Adjust duct footage at each tie-in to account for expansion and contraction due to variations in temperature anticipated during installation. Backfill terminated duct runs from tie-in point toward other end. If trench must be left open, do not terminate run. Consult with manufacturer for coefficient of thermal expansion properties.
- K. Use expansion joints as required such that no more than 6" (150 mm) allowance for expansion or contraction of conduit occurs.
- L. After construction of duct bank is complete, pull mandrel through each duct. Mandrel shall be 1/4" (6 mm) smaller in diameter than duct. If obstruction is encountered, or if there is evidence of water pocket, that section of duct bank shall be located, removed, and rebuilt with no schedule delay and additional cost to Owner.
- M. Underground utility marking tape for below grade raceway systems:

1. Provide solid aluminum foil core tapes for protection, location, and identification of underground utility installations.
 2. Meet or exceed industry standards for APWA color code.
 3. Resist degradation from acids and alkalis found in soil.
 4. Contain environmentally safe lead-free pigments and organic lead-free ink identifying type of utility line it protects.
 5. Provide width of tape appropriate for detection of conduit at required depth of installation.
- N. Support wireways and boxes independently of conduits by means of bolts, screws, rod hangers, and other suitable means.

3.08 MANHOLES AND HANDHOLES

- A. Install in accordance with manufacturer's instructions.
- B. Remove material as required for proper alignment and elevation of work. Backfill and grade area to match final grade elevations.
- C. Provide extension rings as required to meet final finished elevations.

END OF SECTION

- 1) TSL
- 2)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Power diesel generator set, including accessories and enclosures.

1.02 WORK BY OTHERS

- A. Generator set foundations and supports.
- B. Receiving, unloading and storing.
- C. Final placement and assembly.
- D. Connection to external fuel source.
- E. Filling lube oil system if shipped dry.
- F. Filling cooling system if shipped dry.
- G. External power, control, and grounding connections.

1.03 INFORMATIONAL SUBMITTALS

- A. Submit with Bid:
 - 1. Completed Data Sheets.
 - 2. List of recommended start-up parts, spare parts and maintenance tools.
 - 3. List of items requiring field installation and required special equipment.
 - 4. Guaranteed sound levels and fuel consumption at rated load.
 - 5. Drawings with proposed overall estimated dimensions, weight, enclosure construction, and general layout of equipment and accessories.
 - 6. List of equipment shipped loose requiring field installation.
- B. Product Data:
 - 1. List of instruments and accessories by manufacturer, model number, and operating ranges.
 - 2. Nameplate information.
 - 3. Complete list of manufacturer recommended spare parts, with unit pricing for each spare part including special equipment, tools and accessories required for installation or maintenance.
 - 4. Recommended long term and short term storage requirements and procedures, submitted at least 30 days prior to shipment.
- C. Quality assurance data:
 - 1. Engineering, procurement, manufacturing, testing and shipping schedule.
 - 2. Notice of any cancellation, delay, material change, or schedule impact upon knowledge of information.
 - 3. Time overcurrent characteristic curves and thermal damage curve for alternator, demonstrating effectiveness of protection provided.
 - 4. Generator capability curves.
 - 5. Certified production test reports.
 - 6. Test reports for previous design, and documentation showing previous design ratings and configurations.
 - 7. Warranty data.
 - 8. Notification of inspection and test schedule 30 days prior to testing.

1.04 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Dimensioned equipment arrangement plan view and elevation drawings that include, weight, lifting points, center of gravity, enclosure construction, and layout of accessories.
 - 2. Piping and instrumentation layout and interfaces.
 - 3. Interconnection wiring drawings with terminal points clearly labeled.
 - 4. Interface coordination details, including foundation attachments or anchors, cable termination limitations, conduit penetration recommendations and access limitations.
 - 5. Complete dimensional drawings for sliding bases, if required.
- B. Quality assurance data:
 - 1. Complete and accurate Data Sheets.
 - 2. Master submittal drawing index.
 - 3. Bill of Materials.
 - 4. List of operating loads to be powered from external sources.
 - 5. List of external cable connections and maximum power requirements.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance manuals. Provide, at a minimum:
 - 1. General description and technical data.
 - 2. Receiving, storage, installation, and testing instructions.
 - 3. Operating and maintenance procedures.
 - 4. Complete set of final drawings, Product data, and quality assurance data as listed above.
 - 5. Complete documentation of inspections and tests performed, including any logs, curves, and certificates. Documentation shall note any replacement of equipment or components that failed during testing.
 - 6. Spare parts lists.
 - 7. Installation field reports.
 - 8. Data sheets updated to reflect field installation conditions.

1.06 MAINTENANCE MATERIALS

- A. Ship with unit spare parts required for complete start-up, field commissioning and testing including special tools required for same purpose. Special tools shall become property of Owner as part of final acceptance.
- B. Provide spare parts during warranty period at no cost to Owner including, but not be limited to, freight and shipping charges.
- C. It will be Owner's option to purchase additional spare parts at unit pricing for one year after end of warranty period.
- D. Spare parts shall be clearly identified with unique equipment identification numbers that can be easily cross referenced to manufacturer's drawings furnished for review.

1.07 QUALITY ASSURANCE

- A. Manufacturer's qualifications:
 - 1. Manufacturer shall be manufacturer of major components and shall be ISO certified.
 - 2. Manufacturer shall have produced similar equipment for minimum period of 5 years.
 - 3. When requested by Engineer, provide acceptable list of similar equipment installations complying with requirements of this Section.
- B. Regulatory requirements:

1. Primary standards covering this equipment are ANSI C50.13, IEEE 115, IEEE 446, IEEE519, NEMA MG 1, NFPA 110, CSA 282, and NFPA 70.
2. Certifications: UL 2200
3. Standards of foreign organizations shall not be used without written approval from Engineer.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate transportation with requirements of pertinent authorities.
- B. Prepare detailed packing lists and shipping notification.
- C. Fill lube oil and cooling systems, if shipped dry.
- D. Ship equipment to job site as completely assembled as practical.
- E. Equipment and accessories shall be covered and protected from damage during shipment.
- F. During delivery and storage, handle equipment to prevent damage, denting, or scoring.
- G. Store equipment and components in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.
- H. Space heaters shall be connected to temporary source of power and shall be monitored.

1.09 WARRANTY

- A. Manufacturer shall provide 2-year minimum standard warranty on major components from date of final acceptance of Owner.
- B. Maintenance contract:
 1. In addition to required warranty, at Owner's option, provide 5-year maintenance contract to cover routine and major overhaul operations. Submit maintenance requirements in relation to operating hours.
 2. Include labor, equipment, tools and any other special requirements in cost of maintenance contract.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Caterpillar.
- B. Generac.
- C. Kohler.
- D. Cummins/Onan.

2.02 SYSTEM DESCRIPTION

- A. Provide completely assembled, wired, tested and operational skid-mounted unit, required accessories and enclosure including, but not limited to:
 1. Diesel engine prime mover directly coupled to synchronous generator (DEG).
 2. Solid-state controls and control devices.
 3. Permanent magnet generator design.
 4. Annunciator and control panel.
 5. Exhaust system.

6. Cooling system using skid-mounted radiator.
7. Batteries, battery rack, and battery charger.
8. Skid-mounted fuel tank.
9. Skid-mounted main disconnect with load bank connectors.
10. Remote outlet for exhaust.

- B. Rating of engine-generator set shall be based on operation of set with auxiliary systems operational under specified ambient temperature, and elevation above sea level.
- C. Auxiliary systems shall include, but not be limited to; radiator(s), fan(s), air cleaner, lube oil pump, fuel transfer pump, fuel injection pump, jacket water pump, governor, regulator, charging alternator, alternating current generator, space heaters, lube oil heaters, and all fluids.
- D. Arrange so standby/emergency loads are automatically transferred to engine generator upon loss of normal power, after engine generator has reached normal running speed and voltage.
- E. Upon return of normal power, systems return to normal operation, and reset for next operation.
- F. When indicated on Data Sheets, provide on-site start-up, testing, and training.

2.03 ENVIRONMENTAL REQUIREMENTS

- A. Generator set shall be capable of operating and providing full power output in accordance with Data Sheet for installed location, including ambient temperature, altitude and seismic conditions.

2.04 ENCLOSURE SYSTEM

- A. Enclosure shall be weather protective, reinforced steel housing with lockable, hinged doors and panels.
- B. Enclose and protect to prevent dust from entering active mechanical and electrical parts of equipment.
- C. Guards and shields shall protect personnel from moving parts.
- D. Cooling system shall be sufficient to provide full protection over life of generator set at site conditions.
- E. Enclosure shall contain adequate space for components, connections and area for accommodating cables for field connections. Enclosure shall be sized to facilitate inspection and maintenance of enclosed equipment and access to control panel.
- F. Steel base shall incorporate vibration isolation system mounting for engine generator set.
- G. Manufacturer shall provide required hardware and shims to permanently mount unit to concrete pad.
- H. Grounding pads or lugs shall be provided inside termination boxes. A minimum of 2 NEMA 2-hole ground pads shall also be provided to ground skid to grounding grid.
- I. Enclosure shall provide sound attenuation such that operating decibel level shall not exceed sound regulatory requirements at site location.
- J. Provide lifting lugs on major components.
- K. Enclosures shall be UL-listed.

2.05 ENGINE

- A. Engine break horsepower shall be sufficient to deliver full rated generator set kVA when operated at rated rpm and equipped with required mounted parasitic and external loads.
- B. Torque and horsepower shall be sufficient to carry alternator load with all dynamic parameters.
- C. Crankshafts shall be forged in 1 piece from steel, heat treated, and dynamically balanced.
- D. Main and connecting rod bearings shall be of precision insert type, steel or bronze backed, babbitt or other such alloy linings.
- E. Power pistons shall be heavy section contour ground, oil-cooled with floating piston pins.
- F. Camshafts shall be made of heat-treated steel, accurately machined, ground to size and fitted for forced-feed lubrication.
 - 1. Connecting rods shall be made of forged steel with I-beam design.
 - 2. Valves shall be of forged alloy steel with 4 valves per cylinder. Valves shall be accessible for adjusting and grinding. Valve seats shall be replaceable.
 - 3. Cylinder block shall have replaceable wet liners. Cylinder heads shall be interchangeable. Provide base-type oil pan with access opening that provides sufficient area to permit inspection of main and connecting rod bearings.
 - 4. Engine speed shall not exceed rated rpm at normal full-load operation.
- G. Accessories:
 - 1. Fuel strainer and filter one each, mounted between engine fuel pump and base tank along with water separator and clear sight glass indicator. Provide indicating pressure gauges on both upstream and downstream side of strainer and filter.
 - 2. Lube oil filter shall be conveniently located for servicing; equipped with a spring loaded bypass valve to ensure oil circulation if filters are clogged. Provide an oil drain extension line positioned to permit most convenient possible servicing of unit as installed. Provide oil drip pan for mounting underneath engine. Provide bayonet-type oil level dip stick.
 - 3. Intake air filter shall be one or more heavy-duty, dry-type, replaceable element type rated for normal service with restriction indicators that indicate service life of element.
 - 4. Fuel transfer pump shall be positive-displacement, engine-driven type. Relief valve shall be provided to prevent build up of excessive pressures if discharge line becomes clogged.
 - 5. Water pump shall be engine-driven, centrifugal type with thermostatic valve to maintain engine at recommended temperature level. Provide spin-on type engine water filters to treat coolant and prevent corrosion and scale deposits within cooling system.
 - 6. Pre-lube oil pump shall be electric-driven, continuously operating type for continuous circulation to ensure proper lubrication for automatic engine starts.
 - 7. Lube oil pump shall be gear type for supplying oil under predetermined constant pressure to main bearings, pistons, piston pins, timing gears, camshaft bearings and valve mechanism.
 - 8. Turbocharger lubrication shall be accomplished downstream of lube oil filtration assembly.
 - 9. Lube oil heater shall be an immersion-type with thermostatic control installed in crankcase. Size heater in accordance with manufacturer's recommendations to maintain engine lube oil to preset temperature for warm starts. Size to prevent charring of lube oil. Furnish pre-wired lockout to disconnect lube oil heater when engine starts.

2.06 GOVERNOR

- A. Provide isochronous type to maintain engine speed within $\pm 0.5\%$, steady state, and 5% during no load to full load application with recovery within 2 seconds after sudden load changes, with provisions for manual operation and adjustment.
- B. Governor shall be integrated into engine-generator control panel by engine generator manufacturer, and include, but not be limited to:
 - 1. Actuator.

2. Governor control module.
 3. Separate magnetic pickup not to be used to operate any other device but governor.
 4. Idle/run switch for warm-up after maintenance.
 5. 3-phase isochronous load sharing module.
 6. Auto synchronizer.
- C. Speed sensor and decoupling system for start up motor shall prevent coupling of flywheel while in motion.

2.07 ENGINE START-UP SYSTEM

- A. Include pre-charged, heavy-duty, gel-cell, maintenance free diesel starting storage battery, of adequate capacity to accommodate not less than six 10-sec starting attempts for specified Site ambient range.
- B. Provide with required cables, cell interconnection ties, rack, and battery heater blanket.
- C. Battery tray shall be plastic-coated metal or wooden tray treated for electrolyte resistance, constructed to contain spillage of electrolyte.
- D. Battery charger shall be constant potential, solid-state, current-limiting type, dual rate, designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell.
1. Full wave rectifier.
 2. Charge rate, float and equalizing charge potential to conform to battery manufacturer's recommendations.
 3. Provide low battery voltage alarm contacts for remote annunciation.
 4. Overload protection.
 5. Dc voltmeter and ammeter.
 6. Built-in adjustable equalizer charge timer.
 7. Provide enclosure to meet NEMA 250, Type 1 requirements.
 8. Breaker protection on input.
- E. Provide solenoid activated starter motor, and jacket water heater designed for quick engine starting.
- F. In event of false start, design start up system to restart starter only after restart motor has stopped.
- G. Protection for prolonged start-ups shall include circuit interrupter to stop cranking after 75 seconds.
- H. Provide separate red LEDs for loss of ac power, loss of battery voltage, and high battery voltage, and green LED for power "ON".

2.08 COOLING SYSTEM

- A. Furnish engine with cooling system having sufficient capacity for cooling engine when generator set is delivering full rated load in ambient conditions including air cleaner and inlet silencer.
- B. Equip engine with engine-driven, centrifugal-type water circulating pump and thermostatic valve to maintain engine at recommended temperature level.
- C. Engine shall be equipped with readily accessible cooling radiator and fan. Fan shall be of type to draw air across engine-generator set and exhaust it through radiator. Size fan to maintain safe operation when fully loaded, within ambient conditions.
- D. Provide ventilated rigid guard to enclose fan and belts and pulleys necessary to prevent personnel injury.
- E. Design of radiator fan shall be for stationary power applications only. One-piece cast aluminum "truck type," stamped steel or riveted fans not acceptable.

- F. Fill engine cooling system with manufacturer's recommended solution. Incorporate rust inhibitor in solution.
- G. Furnish immersion-type jacket water heater to warm water in engine cooling system. Heater shall maintain water temperature at 120°F at site minimum ambient conditions by automatic thermostat control. In event more than 1 jacket water heater is required, no single unit shall require electrical circuit greater than 20-ampere ampacity.
- H. Engine shall shut down on high temperature cooling liquid, low coolant, low oil level, low oil pressure or over speed signal.
- I. Cooling system controls shall be factory set to allow for operation of generator assembly without load after transfer to normal load.
- J. Provisions shall be made for filling and draining radiator. Location shall be easily accessible.
- K. Provide expansion tank with pressure cap, level indicator, and low level alarm switch.
- L. Provide connecting pipes and hoses between motor and radiator.

2.09 EXHAUST SYSTEM

- A. Furnish horizontally-mounted, critical grade exhaust silencer (muffler) with companion bolted flanges including flexible, stainless steel, bolted flange fitting. Size according to engine manufacturer's recommendation.
- B. Mount exhaust silencer and mounting hardware, inlet and outlet piping.
- C. Furnish low-point drain plug or petcock in exhaust silencer to drain condensation.
- D. Furnish rain cap at exhaust outlet.

2.10 FUEL SYSTEM

- A. Fuel supply system shall be integral with engine consisting of transfer pump, camshaft driven injection pumps, tubing, hoses, valves, fittings, and vents in accordance with applicable codes and standards.
- B. Provide direct injection system capable of operating on winter blend of No. 1 and No. 2 fuel oil.
- C. Pumps shall be variable displacement type to alter volume of fuel delivered to spray nozzles according to load. Nozzles shall inject fuel directly into cylinder in combustion.
- D. Provide pipe, valves and fittings associated with fuel storage and connections in accordance with requirements of NFPA 30 and NFPA 37.
- E. Provide UL-listed, double-wall, heavy-gage steel tank installed between engine-generator structural steel frame rails, double-contained, with baffles integral to primary containment, all-welded steel. Size secondary containment volume to hold total contents of primary containment volume in accordance with API-650.
- F. Secondary containment volume shall be alarmed with solid-state electronic leak detection with audible alarm.
- G. Manual fuel fill tube with screw-on vented-type cap shall be 2" (50 mm) in diameter and welded into primary fuel containment tank. Locate fill cap so as not to be covered or obstructed by snow, dirt, or other equipment. Furnish removable fuel strainer over fuel inlet.

- H. Furnish 1" (25 mm) NPT capped, threaded drain and fill line connections at base of base tank for primary and secondary containment volume fuel drain and/or external pumped fill connections.
 - 1. Route connections to easily accessible connection points as near as practicable to manual fill tube location.
 - 2. Identify each connection clearly by 1/2" (13 mm) high stamped or welded bead lettering on structural steel frame through which lines protrude.
- I. Furnish positive measuring fuel level assembly in primary containment volume. Furnish low and high/full level alarm annunciation contacts prewired to furnished junction box.
- J. Fuel lines from base tank to engine components for supply and return shall be wire reinforced, flexible, fuel grade lines with threaded swivel connections for all connection points. Neatly dress and secure flexible lines.
- K. Furnish diesel engine manufacturer's standard engine-mounted replaceable spin-on fuel filter conveniently located for servicing.
- L. Furnish immersion-type, thermostatically-controlled electric fuel warming heater in primary fuel containment volume. Prewire to junction box within weatherproof enclosure. Terminate on identified terminal strips.
- M. Furnish low-fuel lockout controller integrated with fuel level sensing specified elsewhere herein to prevent fuel warming heater from burnout under low fuel conditions.
- N. Provide for remote shutdown of engine and remote shutdown of fuel supply as required by NFPA 37.
- O. Fuel transfer pump, injection pumps, and timing mechanism shall be maintenance and adjustment free for life of equipment.
- P. Fuel filter shall not require replacement more frequently than once a year or 250 hours of operation, whichever comes first.
- Q. If equipped with fuel water separators, system shall not require draining more frequently than once per week.

2.11 GENERATOR

- A. Generator shall be capable of withstanding 3-phase load of 300% rated current for 10 seconds, and sustaining 150% of continuous load current for 2 minutes with field set for rated load excitation.
- B. Generator set design shall withstand full voltage phase to ground short circuit at generator terminals when generator neutral is a solid ground.
- C. Provide close-coupled, dripproof, and guarded design. Construct to NEMA 1 and IP 22 protection standards with single sealed bearing, salient pole, revolving field, synchronous generator directly connected to engine shaft through flexible drive coupling for permanent alignment. Secure using SAE Grade 8 hardware.
- D. Windings: Copper magnet wire coated with underlay of polyester resins and superimposed heavy coat of resin. Insulation shall be Class H.
- E. Rotor winding: Layer wound with thermosetting epoxy between each layer and final coat of epoxy for moisture and abrasion resistance.
 - 1. Amortisseur windings integral with rotor coil.
 - 2. Support shaft bearing shielded type with provisions for easy servicing through grease pipes which extend to exterior of generator frame.
 - 3. Single bearing type designed for minimum B-10 bearing life of 40,000 hours.

4. Dynamically balanced for up to 25% overspeed.
- F. Stator winding: Nonintegral pitch design to eliminate third harmonic waveform distortion and minimize harmful neutral circulating current when operating in parallel (2/3 pitch).
 1. Windings shall have 5 dips and bakes of varnish and final coating of epoxy for moisture and abrasion resistance.
 2. Waveform harmonic distortion not over 5% THD rms, measured line to line at rated load.
- G. Rotating brushless exciter shall incorporate a full wave, 3-phase rotating rectifier with hermetically sealed, metallic type, silicon diodes to supply main field excitation. Connect multi-plate selenium surge protectors across diode network to protect it against transient conditions.
 1. Voltage regulation: $\pm 0.5\%$ from no load to 100% full load.
 2. Size exciter to handle 125% of maximum alternator output.
 3. Mount exciter for vibration isolation.
 4. Enclosure shall meet NEMA MG 1 standards, self-ventilated, and drip-proof.
- H. Telephone influence factor shall not exceed limits of balanced TIF established by ANSI C50.13 and NEMA MG 1.
- I. Temperature rise shall not exceed 80°C during continuous operation and 105°C when operating at 10% overload in a 40°C ambient as measured by resistance.
- J. Equip with space heaters to keep internal windings dry when unit is not in use. Logic to control heaters shall be furnished completely installed.
- K. Provide surge arresters to protect from voltage spikes.

2.12 MOUNTING

- A. Assemble engine generator to common base by manufacturer. Design and construct base to resist deflection, maintain alignment, and minimize resonant linear vibration.
- B. Construct base of Form C section steel members. Incorporate flexible fuel lines, external oil and coolant drains, and external crankcase fumes disposal hose.
- C. Support cross members shall add rigidity and allow installation of vibration isolators between fuel tank base and generator set.
- D. Isolators: High-resilient rubber compound resistant to weather, heat, and aging. Isolators shall be impervious to oil, water, and antifreeze. Incorporate dual-spring rate for nonabrupt displacement.
- E. Provide required space for ground stub-ups between members. Include bottom mounting holes.
- F. Furnish skid-mounted connection box with load-break switch, such that load conductors can enter bottom of junction box.

2.13 VOLTAGE REGULATOR

- A. Microprocessor design shall be suitable for handling shock and vibration associated with mounting within generator assembly.
- B. Provide volts/hertz regulator capable of sensing line-line phases of generator output voltage. Generator voltage shall be maintained within 1% of rated value for any load variation between no-load and full load.
- C. For addition of load up to 90% of rated load, dip shall not exceed 20% of rated voltage. Voltage shall recover to and remain within steady band in not more than 1.5 seconds.

- D. Isochronous frequency regulation from no load to full load shall be in line with engine governor performance. For any addition of load up to 90% of rated load, frequency shall recover to steady-state band within 5 seconds.
- E. Include manual controls to adjust voltage droop, $\pm 10\%$ voltage level. Voltage droop during motor starting shall not exceed 15%.
- F. Provide capability for include voltage build-up, overcurrent protection, and remote voltage control.
- G. Voltage regulation from no load to rated load shall be less than $\pm 1\%$ of rated voltage. Steady-state voltage stability shall remain within 0.5% band of rated voltage. Steady-state voltage modulation shall not exceed 1 Hz per second.
- H. Alternator system: Tropicalized; self-ventilated; drip-proof construction.
- I. Equip alternator housing with space heater to prevent moisture condensation.
- J. Provide protection against loss of voltage sensing and long-term overcurrent conditions. Overcurrent protection function shall automatically reset where regulator is de-energized. Regulator shall not be damaged or result in unsafe operation when subjected to power or shorted input due to sensing loss, or short to ground on adjacent conductor.
- K. Electrical connections shall be through labeled screw terminals.

2.14 MAIN POWER CONNECTIONS

- A. Size load-break, molded-case main breaker in accordance with manufacturer's recommendations. Locate switch in NEMA 3R termination box attached to connection enclosure on engine-generator assembly.
- B. Interrupting capacity shall be based on allowable fault duty available from generator.
- C. Breaker:
 - 1. Manual operation for isolation during maintenance.
 - 2. Thermal-magnetic, protective, quick-make, quick-break, trip-free from handle, and trip indicating.
 - 3. Provide electronic trip unit that operates to protect alternator under all overcurrent conditions, or thermal-magnetic trip with other overcurrent protection devices that positively protect alternator under overcurrent conditions.
- D. Generator phase conductors shall be brought out to isolated phase buses securely mounted within conductor termination box. Size phase bus bars for 100% of main breaker rated ampacity. Phase busses shall be tin or silver-plated copper, drilled, tapped, and furnished with lugs for copper conductors preinstalled with bolts and spring washers. Lugs shall be compression-type.
- E. Generator conductor termination box shall have 100% capacity ground bus mounted inside. Ground bus shall be solidly connected to engine-generator frame rails with a properly sized NEC bonding jumper, and solidly connected to grounding electrode(s) at generator pad in accordance with NEC requirements. Mount to inside cabinet in accessible location. Furnish predrilled and tapped holes to match NEMA standard copper lug terminations for NEC-sized ground conductors. Furnish compression-type lugs preinstalled with bolts and spring washers.
- F. Generator neutral conductors shall be brought out to isolated neutral bus mounted securely within conductor termination box. Neutral bus shall be tin or silver-plated copper, drilled, tapped, and furnished with lugs for copper conductors preinstalled with bolts and spring washers. Lugs shall be compression-type.

- G. Neutral or grounded conductors shall not be bonded together at any location in emergency power distribution system except at service disconnecting means from which automatic transfer switch receives its normal source of power.
- H. Grounding: Provide clamp-type terminal on end of generator base suitable for 4/0 AWG stranded copper wire.
- I. Torque terminations to final settings in accordance with manufacturer's recommended values.

2.15 CONTROL PANEL

- A. Controls shall be microprocessor-based with integrated control and protection. Design shall incorporate menu-driven digital display screen with membrane-style buttons and nonrotary style switches.
- B. Control panel enclosure shall be constructed with steel, mounted in an easily readable and accessible location on generator set. Mount on vibration isolators.
- C. Digital voltage regulation and engine speed governing, synchronizing, and load sharing. Include import/export controls for paralleling with infinite bus.
- D. Digital starting control shall provide functions for fuel ramping, failure to crank, temperature dynamic governing, digital excitation control and cycle cranking. Selectable number of cycles, cranking, and off time periods.
- E. Protection of alternator and power system shall be protected from overcurrent, over/under voltage, over/under frequency, and over load conditions.
- F. Comprehensive display of engine and alternator data
- G. Self diagnostics and circuit boards diagnostic LED's.
- H. Pushbuttons:
 - 1. Local-Off-Auto.
 - 2. Start.
 - 3. Stop.
 - 4. Reset.
 - 5. Menu.
- I. 3-phase digital meters:
 - 1. Percent of current, amperes.
 - 2. Percent of load meter, kW.
 - 3. Frequency meter, ac.
 - 4. Voltage meter, volts ac.
- J. Network communications for future twisted, shielded pair connection to master paralleling control unit.
- K. Panel shall provide protective functions to prevent damage to generator.

2.16 ALARM MODULE

- A. NFPA 110 requirements shall be satisfied by microprocessor alarm module mounted in panel. Provide auxiliary contacts for NFPA 110 panel alarms.

2.17 ISOLATORS

- A. Clearly indicate complete assembled unit center of gravity (CG) on frame rails on both sides and provide CG information on Shop Drawings from datum points.

- B. Mount engine and generator on common structural steel frame sufficiently rigid to prevent deflection between vibration isolators. Mount structural steel frame on minimum 4" (100 mm) deflection open-type spring vibration isolators and independent snubbers. Isolators shall be individually selected from each load bearing location to maintain equal deflection without compensation.
- C. Spring isolators shall be adjustable, freestanding, stable, open spring mounting of specified minimum static deflection with combination leveling bolt and equipment fastening bolt. Spring shall be rigidly attached to spring mounting baseplate and compression plate. Spring element shall have a 50% overload capacity. The overall diameter of spring shall be not less than 0.8 times operating height of spring.
- D. Fabricate snubbers of steel plate to limit horizontal and vertical motion of isolated equipment. Affix minimum 1/4" (6 mm) thick neoprene pad at point of contact. There shall be no contact between snubbers and inertia base or equipment support frame during normal operation. Provide minimum of 1 snubber per side, 4 total, on each base.
 - 1. Do not install snubbers until vibration isolators are in place and adjusted with actual operating loads.
 - 2. Design snubbers to provide seismic restraint as required. Provide seismic calculations to demonstrate compliance with code requirements for Seismic Zone compliance criteria.

2.18 WIRING

- A. Manufacturer shall pre-install all equipment, enclosures, internal wiring, wire markers, terminal blocks, raceways and accessories required for system ready for field installation and terminations.
- B. Each interconnecting wire shall be identified at both ends with sleeve type wire markers.
- C. Terminate control and monitoring circuits exiting generator set on terminal blocks specified for control circuits.

2.19 IDENTIFICATION AND TAGGING

- A. Securely attach nameplates with self-tapping stainless steel screws or rivets. Adhesive nameplates not acceptable.
- B. Lettering shall be black on white background.
- C. Terminal blocks shall be clearly identified for wiring.
- D. Boxes, enclosures, transfer switches, generators and power panels for emergency circuits shall be permanently marked and readily identified as emergency equipment.
- E. In addition to requirements of Section 26 05 00, nameplate shall contain standard information in accordance with IEEE/ANSI C57.12.01 and serial number and year of manufacture.

2.20 SOURCE QUALITY CONTROL

- A. Perform factory tests to confirm requirements of this specification and applicable authorities. Acceptance tests shall successfully demonstrate following:
 - 1. 100% resistive load carrying capability.
 - 2. 20% reactive and 80% resistive simultaneous load carrying capability.
- B. Acceptance test shall be documented by means of certified, calibrated test equipment on strip charts or other permanent recording means. Test results shall be included in complete factory acceptance test manual certified by factory engineer.

- C. Testing shall be manufacturer's standard, and following tests shall be added if not included in standard testing:
 - 1. Engine performance testing:
 - a. Load operation.
 - b. Continuous running.
 - c. Overload operation.
 - 2. Governor characteristics test.
 - 3. Functional factory operation test of assembled unit and test equipment. Perform test at 100% load rating for four hours at unity power factor.
 - 4. Dynamic response to step voltage changes.
 - 5. Insulation resistance test.
 - 6. Winding resistance test.
 - 7. IEEE 115 tests.
 - 8. 10% overload for 1 hour.
- D. Generator set speed shall be adjustable to within $\pm 5\%$ of normal operating speed. Speed variation during load rejection shall not cause trip due to overspeed of unit.
- E. Provide certified test reports for complete generator set assembly and sub-assemblies.
- F. Manufacturer shall provide notice to Owner to permit witnessing of tests.
- G. Prior to shipment, correct defects and defective equipment revealed or noted during testing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Verify generator space and arrangement, and install system components within designated space. If space allocated does not meet installation requirements, notify Engineer immediately before proceeding.
- B. Provide structural pad as required for permanent installation.
- C. Install in accordance with manufacturer's recommendations.
- D. Connect to external fuel source.
- E. Provide external power, control, and grounding connections.

3.02 FIELD QUALITY CONTROL

- A. Load bank test:
 - 1. After installation is completed, perform break-in in accordance with manufacturer's recommendations.
 - 2. Provide load bank to test engine(s) at 100% of full kilowatt resistive load.
 - 3. After break-in period, run entire unit as follows:
 - a. 50% load for 1 hour.
 - b. 75% load for 1 hour.
 - c. 100% load for 3 hours.
 - 4. Provide log of test results indicating oil pressure, water temperature, voltage, amperes and frequency.
 - 5. Record values every 15 minutes for one hour, every 30 minutes for remainder of test.
 - 6. Record any abnormal readings or condition and outside air temperature at time of test.
 - 7. Demonstrate operation of alarm functions and engine safety shutdown circuits.

8. Engine shall perform satisfactorily without excessive smoke, overheating, vibration, blowby, and piping leaks. Demonstrate proper operation of all engine and switchgear components, including cooling, exhaust and fuel systems.
 9. Provide necessary load banks, meters, and personnel.
 10. Demonstrate automatic operation of transfer switches and engine generator set by introducing loss of power at each transfer switch.
 11. Provide photograph of oscilloscope trace of generator output 60-cycle sine wave. Demonstrate isochronous operation from 10% to 100% load. Demonstrate parallel speed droop operation from 10% to 100% load. Demonstrate both manual and automatic operation.
- B. Final test:
1. Simulate power failure of normal supply, verify start up time of diesel generator and transfer to emergency mode within preset time delays specified.
 2. Restore normal supply, verify transfer within preset time delays and operation of diesel generator under no load condition for a preset time period.
 3. Test operation of automatic transfer switch to insure proper automatic and manual operation and with automatic transfer switch manufacturer's requirements and/or recommendations. Verify signals sent for load shed are operating devices correctly.
 4. Test diesel generator main breaker and all other breakers associated with emergency power transfer to insure proper protection and operation of transfer systems.
 5. Following satisfactory completion of tests, replace fuel oil in storage tank consumed during testing.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Final connections, check-out, start-up, testing and instruction by shall be performed by factory-authorized and trained technician.
- B. Provide factory qualified erection engineer to personally supervise complete installation of diesel engine and generator including setting, alignment, assembly, connections, startup, testing, and instruction of Owner. Furnish manufacturer's written certification assuring that each item of equipment is complete, in good condition, free from damage, and properly installed, connected, and adjusted.
- C. Factory qualified engineer shall be present at job site during following activities:
1. Pre-installation coordination meeting with Contractor, Engineer, and Owner to coordinate installation and interconnection of packaged engine-generator system with other engine-generator equipment.
 2. Post-installation startup and testing assistance prior to system turnover and initial instruction period for operating personnel.
 3. Maintain competent, factory service organization that is available for service on 24-hour call basis.

3.04 TRAINING

- A. Provide services of fully trained manufacturer's technician to instruct Owner's staff in care and operation of generating set. Period of instruction shall not be less than required to provide adequate training and instruction to staff.
- B. Instruct Owner for a period of no less than 1 day in maintenance and operation of equipment.
- C. Instruction and training program shall include basic theory of engine operation, procedures of operating, preventative maintenance, troubleshooting and major component replacement.

DATA SHEETS ENGINE GENERATOR SET		Equipment Name:	
		Tag No.:	REV.
DESCRIPTION	UNITS	SPEC DATA	VENDOR DATA
Manufacturer	-		
Catalog/Serial No.	-		
Ratings (based on site conditions):			
Model No.	-	By Manufacturer	
Frame No.	-	By Manufacturer	
Prime Power	KVA/MVA	37.5 KVA	
Standby Power	KVA/MVA	43.75 KVA	
Power Factor	PU	By Manufacturer	
Terminal Voltage	V	120/240VAC	
Voltage Regulation	%	± 0.5%	
Frequency	Hz	60	
Rated Full Load Amperes	A	By Manufacturer	
Ground Configuration	-	solidly grounded	
Efficiency / % Load	%	Per NEMA MG 1	
Insulation Class	-	H	
Temperature Rise Above Ambient	-	F	
Voltage Regulator Model		By Manufacturer	
Qty of generators in parallel	Ea	None	
Site Requirements:			
Installed Location	-	Outdoors	
Maximum Ambient Temperature	°F	100	
Minimum Ambient Temperature	°F	-20	
Altitude	Ft	6000	
Seismic Zone		II	
Operating noise limit	dBA	75	
Package Features:			
Continuous	-		
Special Protection	Y/N	N	
Dimensions (H x W x D)	in	By Manufacturer	
Weight Without Fuel	lb	By Manufacturer	
Total Weight with Fuel	lb	By Manufacturer	
Fuel Tank Location	-	Sub-base	
Manufacturer Tech. Rep on site	Y/N	1 days at Start-up	
Enclosure:			
Material	Steel	Steel	
Finish		Manufacturer Std.	
Enclosure Type		Weather Protected	
Sound Attenuation Enclosure	Y/N	Y	
Engine:			
Model number	-	By Manufacturer	
Cylinder Bank Configuration	-	By Manufacturer	
Speed	rpm	1800	
Cycle	stroke	Four stroke	

DATA SHEETS ENGINE GENERATOR SET		Equipment Name:	
		Tag No.:	REV.
DESCRIPTION	UNITS	SPEC DATA	VENDOR DATA
No. of Cylinders		By Manufacturer	
Fuel Type		Diesel	
Fuel Tank capacity	Gal	By Manufacturer	
Hours of operation without refueling Tank	hrs	24	
Fuel Tank Warming Heater	Vac	120	
Fuel consumption w/ Fan	gallons/hr	By Manufacturer	
Lube Oil, Volume	quarts	By Manufacturer	
Lube Oil Heater:	Y/N	Y	
Rating (Maximum 16 amps)	KW	BY Manufacturer	
Operating Voltage	Vac	120	
Alternator Space Heater:	Y/N	Y	
Rating (Maximum 16 amps)	KW	BY Manufacturer	
Operating Voltage	Vac	120	
Water Jacket, Volume	quarts	By Manufacturer	
Jacket Water Heater	Y/N	Y	
Jacket Water Heater Voltage	Vac	120	
Engine Block Heater	Y/N	Y	
Block Heater Voltage	Vac	120	
Batteries and Charger:			
Charger Manufacturer	-	By Manufacturer	
Charger Model No.	-	By Manufacturer	
Charger Input Voltage	Vac	120	
Battery Manufacturer		By Manufacturer	
Catalog/Serial No.		By Manufacturer	
Maintenance Free	Y/N	Y	
Battery Voltage	Vdc	12	
Battery Warranty	years	10	
Battery Blanket Heater	Y/N	Y	
Blanket Heater Voltage	Vac	120	
Duty Cycle Loading	minutes	By Manufacturer	
Battery breaker/disconnect	Y/N	Y	
Engine Generator Controls:			
Digital/Analog		By Manufacturer	
Off/Manual/Auto Switch with Indication	Y/N	Y	
Phase selector switch	Y/N	Y	
Phase Voltage	Y/N	Y	
Current	Y/N	Y	
Emergency Stop Button	Y/N	Y	
Temperature Indication and Alarm	Y/N	Y	
Water Level Indication and Alarm	Y/N	Y	
Oil Level Indication and Alarm	Y/N	Y	
Oil Pressure Indication and Alarm	Y/N	Y	
Over Speed Indication and Alarm	Y/N	Y	

DATA SHEETS ENGINE GENERATOR SET		Equipment Name:	
		Tag No.:	REV.
DESCRIPTION	UNITS	SPEC DATA	VENDOR DATA
Over Crank Indication and Alarm	Y/N	Y	
RPM Indication	Y/N	Y	
Fuel Level	Y/N	Y	
Remote Control / Monitoring	Y/N	Y	
Remote Fuel Shutdown	Y/N	N	
Main Disconnect:			
Main Type:	-	Breaker	
Manufacturer and Model Number	-	By Manufacturer	
Model Number	-	By Manufacturer	
Rated Continuous Current	A	By Manufacturer	
Rated Symmetrical Interrupt	kA	65	
Thermal-Magnetic Element	Y/N	Y	
Fuse Type and Size	Type/A	Not used	
Special Requirements:			
	-		
Special Tools:			
	-	By Manufacturer	

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior lighting fixtures and accessories.
- B. Exterior lighting fixtures and accessories.
- C. Ballasts.

1.02 ACTION SUBMITTALS

- A. Product Data:
 - 1. Lamp ANSI designation, initial and mean lumen output, average rated hours of lamp life and lamp mortality curve, and color temperature and color rendering index.
 - 2. Ballast ANSI designation; electrical characteristics, including volts, lamp, and line operating and starting amperes, watts and watt losses, percent of allowable line voltage variation range and lamp crest factor; total current harmonic distortion; minimum lamp starting temperature; and normal and maximum ballast operating temperature.
- B. Shop Drawings: Dimensioned and detailed drawings in booklet form with separate sheet or sheets for each fixture, assembled in luminaire "type" alphabetical order and showing:
 - 1. Materials of construction.
 - 2. Arrangement of components and wiring.
 - 3. Gasket sealed for weather tightness.
 - 4. Means of mounting luminaire and adjusting aspect.
 - 5. Finish; photometric data with lamp or lamps specified.
 - 6. Electrical data including volts, amperes and watts; and for roadway type lighting fixtures.
 - 7. Distribution data according to IES roadway classification type.

1.03 QUALITY ASSURANCE

- A. Manufacturer qualifications:
 - 1. Manufacturer of major components within assembly.
 - 2. ISO 9000 certified.
 - 3. Manufacturer shall have produced similar electrical equipment for a minimum period of 5 years.
 - 4. When requested by Engineer, provide acceptable list of similar equipment installations complying with requirements of this specification.
- B. American National Standards Institute (ANSI)
 - 1. ANSI C82.1 - Ballasts for Fluorescent Lamps.
 - 2. ANSI C82.2 - Fluorescent Lamp Ballasts - Methods of Measurement.
 - 3. ANSI C2 - National Electrical Safety Code.
 - 4. ANSI C81.10-76 - Electric Lamp Bases and Holders - Screw-Shell Types (Revised and Consolidated into ANSI C81.61-90).
 - 5. ANSI C82.1 - Specifications for Fluorescent Lamp Ballasts.
- C. Federal Communications Commission (FCC) Part 15 - Rules and Regulations: Radio Frequency Devices
- D. National Electrical Manufacturers Association (NEMA)
 - 1. 270 - Procedure for Fluorescent Lamp/Ballast/Fixture Performance Comparison.
 - 2. OD 3 - Physical and Electrical Interchangeability of Photo Control Devices and Mating Receptacles.
- E. Military Standards (MIL-STD):

1. 461A - Electromagnetic Interference Characteristics Requirements for Equipment.
2. 462 - Electromagnetic Interference Characteristics, Measurement.
3. 463 - Definition and System of Units Electromagnetic Interference Technology.

F. National Fire Protection Association (NFPA):

1. 70 - National Electrical Code (NEC)

G. Underwriters Laboratories (UL):

1. UL 57 - Electric Fixture.
2. UL 496 - Edison-Base Lamp holders.
3. UL 676 - Underwater Lighting Fixtures.
4. UL 542 - Lamp holders, Starters, and Starter Holders for Fluorescent Lamps.
5. UL 773 - Plug-in, Locking Type Photo controls, for Use with Area Lighting.
6. UL 773A - Non-industrial Photoelectric Switches for Lighting Control.
7. UL 884 - Lighting fixtures used in hazardous locations.
8. UL 935 - Fluorescent Lamp Ballasts.
9. UL 1570 - Fluorescent Lighting Fixtures.

H. Code of Federal Regulations (CFR):

1. CFR 21 Part 1040 - Performance Standards for Light-Emitting Products.
2. CFR 40 Part 761 - Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions.

I. Federal Specifications (FS) W-F-412E - Fixtures, Lighting, Incandescent Lamp Industrial.

J. Illuminating Engineering Society of North America (IES), LHBK - Lighting Handbook, References and Application Volumes.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. During delivery and storage, handle equipment to prevent damage, denting, or scoring.
- B. Store equipment and components in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 LIGHTING FIXTURES

- A. Types: As designated in "Lighting Fixture Schedule" on Drawings.
- B. Lighting fixtures shall be furnished completely assembled with wiring and mounting devices, ready for installation in their intended location.
- C. Design fixtures with supports independent of ceiling supports.
- D. Equip with required lamps.
- E. Fixtures used as air handling registers shall meet requirements for intended use.
- F. Fluorescent lamp sockets:
 1. Lamp holder contacts: Biting-edge type of phosphorous-bronze with silver flash contact surface type.
 2. Contacts for recessed, double-contact lamp holders and for slim line lamp holders: Silver-plated.
 3. Lamp holders for bi-pin lamps, except for "U" type lamps: Telescoping-compression type, or single-slot entry type requiring 1/4 turn of lamp after insertion.

- G. Lenses, diffusers, covers, and globes: 100% virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.
1. Plastic: High-resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
 2. Lens thickness: 0.125" (3 mm) minimum, unless greater thickness is indicated.

2.02 LAMPS

- A. Comply with standard of ANSI C78 series that is applicable to each type of lamp. Provide luminaires with indicated lamps of designated type, characteristics, and wattage. Where a lamp is not indicated for a luminaire, provide medium wattage lamp recommended by manufacturer for luminaire.

2.03 LIGHTING BALLASTS

- A. Fluorescent lamp ballasts shall be suitable for lamps as listed in "Lighting Fixture Schedule" and as follows:
- B. Fluorescent, solid-state, electronic ballast "Solid-State Ballast":
1. Type: *Rapid start* *instant start* mode.
 2. Thermal protection: UL Class P with internal automatic-resetting.
 3. Conform to ETL-CBM label requirements.
 4. Power factor: Not less than 90%.
 5. Maintain constant light output of 4' rapid-start fluorescent lamps over operating ranges of 90 volts to 145 volts (120-volt ballasts) and 200 volts to 320 volts (277-volt ballasts).
 6. Input current third harmonic content: Not to exceed 13%.
 7. Total current THD: Less than 20%.
 8. Provide sequenced start progression which first heats cathode filaments and then ignites lamp.
 9. Withstand line transients: As defined in IEEE Publication 587, Category A.
 10. Frequency of operation: 20 kHz or greater, and operate without visible flicker.
 11. Meet requirements of Federal Communications Commission Rules and Regulations, Part 18.
 12. Parallel lamp circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.
 13. Ballast:
 - a. Light regulation of ± 10 lumen output with $\pm 10\%$ input voltage regulation. Ballast shall have 10% flicker (maximum) using any compatible lamp.
 - b. UL-listed Class P with a sound rating of "A."
 - c. Enclosure size shall conform to standards of electromagnetic ballasts.
 - d. Ballast shall have circuit diagrams and lamp connections displayed on ballast packages.
 - e. Ballast shall operate lamps in a parallel circuit configuration that permits operation of remaining lamps if one or more lamps fail or are removed.
 14. T-8 lamp ballast:
 - a. Ballast shall be capable of starting and maintaining operation at a minimum of 50°F (10°C) for F32T8 lamps, unless otherwise indicated. *When indicated, ballast shall be capable of starting and maintaining operation at a minimum of 0°F (-17°C) for F32T8 lamps.*
 - b. Total harmonic distortion (THD): *20%* *_____%* (maximum). Input wattage:
 - 1) *32 watts (maximum) when operating one F32T8 lamp.*
 - 2) *62 watts (maximum) when operating two F32T8 lamps*
 - 3) *92 watts (maximum) when operating three F32T8 lamps*
 - 4) *114 watts (maximum) when operating four F32T8 lamps*
 15. F17T8 lamp ballast:
 - a. Capable of starting maintaining operation at a minimum of 50°F (10°C) for F17T8 lamps, unless otherwise indicated.
 - b. Total harmonic distortion (THD): 25% (maximum).
 - c. Input wattage: 34 watts (maximum) when operating two F17T8 lamps.
 16. T-5 long twin tube lamp ballast:
 - a. Minimum starting temperature: 50°F (10°C).
 - b. Total harmonic distortion (THD): Not greater than *25% when operating one lamp,* *15% when operating 2 lamps

- c. Input wattage:
 - 1) 45 watts (maximum) when operating one F40 T-5 lamp.
 - 2) 74 watts (maximum) when operating two F40 T-5 lamps.
 - 3) 105 watts (maximum) when operating three F40 T-5 lamps.
- C. Fluorescent electromagnetic ballasts:
 1. UL 935. Ballasts shall be high power factor type (0.9 minimum), *unless indicated otherwise* and designed to operate on voltage system to which they are connected.
 2. Ballasts shall be Class P and shall have sound rating "A" *unless otherwise noted*.
 3. Design and construct fixtures and ballasts to limit ballast case temperature to 90°C when installed in an ambient temperature of 40°C
 4. Electromagnetic ballasts for T-8 and T-12 lamps shall be energy saving.
 5. Provide 3 lamp fixtures with 2 ballasts per fixture.
 6. Electromagnetic energy-saving ballasts:
 - a. NEMA C82.1. Provide energy-saving fluorescent ballasts of CBM certified full light output type
 7. Provide electromagnetic ballasts for compact fluorescent lamps.
- D. Low-temperature fluorescent ballasts: Minimum starting temperature of -20°F for 800 and 1,500 mA lamps as indicated.
- E. Maximum sound ratings (equivalent to General Electric ratings):
 1. Rapid-start: Sound Level A.
 2. Instant-start (Slim line): Sound Level C.
 3. High-output (800 mA): Sound Level C.
 4. Super-high-output (1,500 mA): Sound Level D.
- F. Standards: ANSI C82.1 and UL 935.
- G. Luminaire wiring:
 1. Conductors: Stranded copper.
 2. Insulation: 600-volt class, type in accordance with manufacturer's standards for ambient and environmental conditions.
 3. Other requirements in accordance with NEC Article 410F.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine each piece of equipment to ensure there are no defects and that equipment conforms to these specifications.

3.02 PREPARATION

- A. Interior and exterior of equipment shall be cleaned prior to placing into service. Debris shall be removed and appropriately discarded.

3.03 INSTALLATION

- A. Install equipment in strict accordance with manufacturer's recommendations.
- B. Determine locations and arrangement of equipment from Drawings. Locations shown on Drawings are approximate unless dimensioned. Choose precise location to clear obstructions and to provide sufficient space for operation and maintenance.
- C. Coordinate timing of installation and location of equipment with other trades.
- D. Make permanent lighting system, or selected portions thereof, operable as soon as possible.

- E. Perform construction in accordance with NEC.
- F. Repair factory finishes where they become damaged during construction.
- G. Install equipment level and plumb.
- H. Coordinate with Division 1 for temporary lighting during construction.
- I. Grounding:
 - 1. Ground noncurrent carrying parts of equipment including metal poles, luminaires, mounting arms, brackets, and metallic enclosures.
 - 2. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.
- J. Lighting fixtures:
 - 1. Support lighting fixtures from building framing or floor slabs, independent of conduit system and suspended ceilings.
 - 2. To minimize equipment breakage, delay installation of lighting fixtures in locations near heavy piping and equipment until such equipment is in place.
 - 3. When permanent lighting system becomes operable, re-lamp lighting fixtures, as directed by Owner.
 - 4. Replace defective or damaged lighting fixtures and lamps at conclusion of job.
- K. Wall-mounted equipment:
 - 1. Concrete or masonry walls: Use expansion anchors and bolts; install collars around mounting bolts, or use other means to provide air space between wall and equipment enclosure.
 - 2. Structural steel mounting: Bolt to steel or brackets attached to steel; provide air space between steel and equipment enclosure.
- L. Floor-mounted equipment: Secure to concrete floor or foundation with expansion anchors.
- M. Lighting controls:
 - 1. Mount photocells facing north or upward and adjust to render insensitive to artificial lighting units.
 - 2. Install occupancy sensors and ambient light sensor in accordance with manufacturer's installation procedures. Final adjustments of sensors shall be coordinated with Owner for proper settings.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Clearing and grubbing.
- B. Stripping.
- C. Disposal.

1.02 SITE CONDITIONS

- A. The project area is an active military training area and has been historically within the impact zone for a range of ordnance. Unexploded ordnance (UXO) may exist on the site. There is no known UXO in the project area, but it may exist.
- B. Prior to commencing any clearing operations, Contractor shall visually inspect area to be cleared. Any items or objects that may be UXO should not be moved, buried or otherwise disturbed. Mark location of suspected UXO, and keep Contractor's personnel clear of the area.
- C. Contact range control immediately. Range control personnel with examine suspected UXO and remove or otherwise eliminate the hazard, if it is determined that the object is UXO.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 CLEARING AND GRUBBING

- A. Clearing: Remove and dispose of fences, trees, logs, brush, rubbish, and other objectionable material.
- B. Grubbing: remove and dispose of stumps and roots 3" (75 mm) and larger in diameter.
- C. Roadway widening and training site areas (except training classroom site): Entirely remove trees, stumps, brush, roots, and other vegetation.
- D. Backfill depressions caused by grubbing, and compact to conform to density of surrounding earth.

3.02 STRIPPING

- A. Strip areas to receive fill or to be occupied by new roadway or CONEX pads.
- B. Completely strip topsoil, rubbish, vegetation, and other foreign materials.
- C. Minimum depth: 6"
- D. Stockpile clean topsoil free from subsoil, stones, and other foreign materials, for finish grading of training sites.
- E. Dispose of excess stripped material on site as directed by Owner's representative.

3.03 DISPOSAL

- A. Dispose removed materials to locations designated by Owner.
- B. Dispose of removed vegetative materials by burning. Unburned materials shall be removed to disposal area.
- C. Grade final cover to allow for positive surface drainage.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Embankments materials.
- B. Stripping.
- C. Earth and borrow excavation.
- D. Embankment construction.
- E. Finish grading and protection.

PART 2 PRODUCTS

2.01 EMBANKMENT MATERIAL

- A. Obtain embankment material from excavated areas or from an approved borrow area.
- B. Embankment materials shall be free from debris, roots, organic, or other unstable or unsuitable materials.
- C. Use best earth materials (most granular in nature) as select fill for construction of top 12" of embankments for roads.

PART 3 EXECUTION

3.01 STRIPPING

- A. Prior to grading and/or borrow excavation, strip topsoil, vegetation and other objectionable material from construction areas. Average depth assumed to be 6" to 8". Stockpile clean topsoil at job site for finish grading. Dispose of vegetation and other objectionable material.

3.02 EARTH EXCAVATION

- A. Grading shall consist of excavation, removal and satisfactory disposal of excess excavated materials taken from within Project area, construction of embankments, subgrades, ditches, and incidental work; and removal and satisfactory disposal of unstable and unsuitable materials and their replacement with satisfactory materials where needed.
- B. In cuts for roads, proof-roll subgrade with fully loaded tandem-axle dump truck to detect localized zones of unstable material.
- C. Remove unstable material encountered and replace with suitable material.
- D. Dispose of unstable material within embankments not to be used under structures or roads.

3.03 BORROW EXCAVATION

- A. Borrow excavation shall consist of excavating, transporting, and placing of earth materials obtained from locations furnished by Contractor or from borrow pits furnished by Owner necessary for construction of embankments, subgrades and other parts of Work.
- B. Contractor shall furnish and pay for borrow sites, or other sources of borrow, and obtain from property owners necessary agreements for removal of excavated material. Borrow material shall have a

Standard Dry Density of not less than 95 lb/cu ft (1525 kg/m³) when tested in accordance with AASHTO T99 and shall not possess an organic content greater than 10% when tested in accordance with AASHTO T194.

3.04 EMBANKMENT CONSTRUCTION

- A. Maintain embankments in satisfactory condition until final acceptance.
- B. Preparation of surfaces to receive fill:
 - 1. After stripping of organic material or foreign matter, proof-roll areas to receive fill.
 - 2. If unsuitable or unstable material is encountered under embankment area, remove material and replace with suitable material prior to placing embankment material.
- C. Moisture control:
 - 1. Moisture content of embankment materials prior to, and during compaction shall be uniform throughout each layer of material.
 - 2. Place earth materials at or within 2% of optimum moisture content as determined by ASTM D698; wet granular materials thoroughly during or immediately prior to compaction.
 - 3. Add supplementary water to materials on embankment by sprinkling and mixing uniformly throughout layer as required.
 - 4. Spread temporarily excavated materials too wet for placing until moisture content is acceptable.
- D. Placing:
 - 1. Place embankment materials in manner permitting drainage, and in continuous, approximately horizontal layers, not exceeding 8" loose thickness.
 - 2. Avoid abrupt changes in embankment levels.
 - 3. If surface of previously placed materials is too dry or smooth to provide satisfactory bonding surface with new material, moisten and/or scarify in manner and to depths required to avoid shear plane.
 - 4. If compacted surface of any layer of fill is too wet for proper compaction of next succeeding layer to be placed:
 - a. Allow materials to dry or work with suitable equipment.
 - b. Compact to provide satisfactory bonding surface for next succeeding layer of fill to be placed.
 - 5. When each layer of material has been conditioned to moisture content specified, compact as follows:
 - a. Compact following embankments to minimum of 95% of maximum dry density as determined by ASTM D698:
 - 1) Embankments for roads and parking areas.
 - b. Compact other embankments to minimum of 90% of maximum dry density as determined by ASTM D698.
- E. Grade areas disturbed by construction operations to smooth, uniformly sloping surfaces.

3.05 FINISH GRADING

- A. Finish fill, excavated areas, and other disturbed areas to uniform grade and section normally obtainable with blade grader.
- B. Allowable template tolerances: + 0.10' (30 mm).
- C. Finish grade to neat appearance and to provide positive drainage.

3.06 FIELD QUALITY CONTROL

- A. Moisture-density laboratory tests: Minimum of one test on each type of soil to be used in embankment construction; conform to ASTM D698. Perform tests prior to placement of embankment materials.

- B. In-place density tests for embankments: Perform tests on road embankments during course of work on subgrade for each successive 8" layer at approximate 100' intervals conforming to ASTM D1556 or ASTM D2922.

3.07 PROTECTION

- A. Water shall be used as controlling agent to prevent operations from polluting air with dust.
- B. Regulations as set forth by OSHA and appropriate state agencies, shall govern.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preparation of subgrade to receive topsoil.
- B. Placing topsoil.
- C. Finish grading.

PART 2 PRODUCTS

2.01 TOPSOIL

- A. Topsoil supply:
 - 1. Use topsoil stockpiled on Site.
- B. Existing topsoil: Natural, fertile soil capable of sustaining vigorous plant growth, not in frozen or muddy condition. Free from subsoil, slag, clay, stones, lumps, live plants, foreign matter, and any material that may be harmful to plant growth.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

- A. Preparation shall not start until outside construction Work has been completed.
- B. Protect existing underground improvements from damage.
- C. Scarify subgrade to a depth of at least 4" by disking, harrowing, or other method. Surface shall be left rough to provide a good bond with topsoil.
- D. Remove roots, clods, stones, and any other debris larger than 2" in any dimension from surface.

3.02 PLACING TOPSOIL

- A. Place topsoil on training site graded areas with the exception of CONEX pads.
- B. Spread evenly, shape, and firm topsoil to a minimum depth of 4". Do not spread topsoil when topsoil or subgrade is frozen, or when excessively wet or dry.

3.03 FINISH GRADING

- A. Grade to uniformly sloping surfaces and to elevations shown on Drawings.
- B. Slope finish grade to provide positive surface drainage away from buildings and other structures.
- C. Finish grade shall be free of all holes, rills, or gullies caused by erosion or construction operations.
- D. Finished ground level shall be firm to prevent sinkage pockets when watered.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aggregate surfacing including subgrade preparation, hauling, spreading, compacting, and material tests.

1.02 QUALITY ASSURANCE

- A. Provide testing of materials and field compaction.
- B. Refer to Section 01 45 29 – Testing Laboratory Services

PART 2 PRODUCTS

2.01 MATERIALS

- A. Aggregate shall be gravel, crushed gravel, crushed stone, or crushed slag, meeting following gradation:

Sieve Size	Percent Passing Sieve
1"	100
1/2"	65-95
No. 4	40-60
No. 16	15-45
No. 200	5-13

- B. Percent of wear shall not exceed 40 in accordance with AASHTO T96, Grading A or B. Aggregate shall have a liquid limit not exceeding 25 and plasticity index not exceeding 4. Percent of loss shall not exceed 20 in accordance with AASHTO T104, 5-cycle, sodium sulfate solution.
- C. Aggregate may conform to UDOT 1" untreated base course gradation standards at Contractors discretion.

PART 3 EXECUTION

3.01 CONSTRUCTION

- A. Prior to placing aggregate, prepare subgrade in accordance with Section 31 22 00 - Grading.
- B. Deposit aggregate in its final position with spreader. Compact surface of aggregate with a pneumatic-tired roller. Surface shall be rolled at least four times and compacted to minimum of 95% of maximum dry density as determined by ASTM D698. If moisture content of aggregate is insufficient to permit specified compaction during rolling operations, add sufficient water to obtain specified compaction.
- C. Provide laboratory test results indicating conformance to article "Materials."
- D. Provide moisture density laboratory test conforming to ASTM D698.
- E. In-place density tests: Perform at least 1 test per 1000 LF roadway conforming to ASTM D1556 on aggregate surfacing during course of work.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe culverts and flared end sections

1.02 INFORMATIONAL SUBMITTALS

- A. Include data on materials and dimensions of flumes and diaphragms.
- B. Submit certificates of compliance for materials as specified.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Reinforced concrete pipe (RCP): AASHTO M170. Diameter and class shown on Drawings.
- B. Standard end sections (aprons), when called for on Drawings, shall be of same material as pipe to which they are attached.

PART 3 EXECUTION

3.01 PIPE INSTALLATION

- A. Execute Work in the dry; provide pumping or drainage necessary to completely remove water from work area.
- B. Bedding: Provide firm, compacted foundation of uniform density throughout length of pipe; shape to provide full bearing contact for lower quadrant of pipe. Foundation shall be free from clods, frozen lumps, rocks, roots, or other foreign material.
- C. Keep pipe clean of dirt and foreign material. Protect pipe from damage at all times.
- D. Seal joints in RCP culverts with preformed flexible gasket or mastic joint sealer. When mastic joint sealer is used, completely fill joint with material after pipes have been brought together. Push or pull each section of pipe as tight as reasonably possible to section in place to ensure tight joints.
- E. Fill handling holes in RCP culverts with a precast plug, seal, and cover with mastic or mortar.
- F. Backfilling:
 - 1. Use material excavated from site. Use best granular material available for placement under pipe haunches and for backfill on sides of pipe up to top of pipe.
 - 2. Backfill material shall be free of clods, rocks, organic matter, and other deleterious material.
 - 3. Placing and compacting:
 - a. Place and compact soil under haunches and on sides of pipe with special care.
 - b. Place backfill material simultaneously on both sides of pipe in layers not exceeding 6" in depth.
 - c. Compact backfill material, under haunches and on sides of pipe up to top of pipe, to 95% as determined by ASTM D698.
- G. Carry hand-compacted backfill sufficient height above top of pipe to eliminate possibility of damage to pipe by equipment.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Grounding system requirements providing protection of equipment and personnel.

1.02 WORK BY OTHERS

- A. Receiving, unloading, and storage.
- B. Final placement and assembly.

1.03 INFORMATIONAL SUBMITTALS

- A. Submit with Bid:
 - 1. Description of ground system components to be used.
 - 2. Product data sheets for components.
- B. Product Data:
 - 1. Final product data sheets for each type of component.
 - 2. Accessories list.
 - 3. Ratings and nameplate information.
 - 4. Special installation tools list.
- C. Quality assurance data:
 - 1. Certified shop test reports.
 - 2. Certified field installation data and reports.
 - 3. Manufacturer's installation information.
 - 4. Copies of component warranties.

1.04 MAINTENANCE MATERIALS

- A. Provide complete set of special tools as necessary for installation for each piece of equipment. Tools and their intended use shall be identified in assembly instructions.

1.05 QUALITY ASSURANCE

- A. Manufacturer qualifications:
 - 1. Grounding assembly manufacturer shall be manufacturer of major components of ground system.
 - 2. Manufacturer shall be ISO certified.
 - 3. When requested by Engineer, provide acceptable list of similar equipment installations complying with this Specification.
- B. Regulatory requirements:
 - 1. Design, manufacture, and test ground system and accessories in accordance with applicable requirements of NFPA 70, IEEE STD 80, IEEE STD 81, IEEE STD 142 IEEE STD 837, and applicable state and local codes and regulations.
 - 2. Standards of foreign organizations shall not be used without written approval from Engineer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare detailed packing lists and shipping notification for all items shipped.
- B. During delivery and storage, handle equipment to prevent damage.

- C. Store equipment in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. FCI-Burndy.
- B. Erico.
- C. Galvan Industries
- D. Southern Grounding Products
- E. Harger Lightning & Grounding
- F. Thompson Lightning Protection, Inc.

2.02 SYSTEM DESCRIPTION

- A. Grounding system includes, but is not limited to, rods, cable, connectors and miscellaneous hardware and materials.
- B. Owner will provide outline, arrangement, and detail drawings for grounding system.

2.03 MATERIALS

- A. Grounding materials shall be new and undamaged.
- B. Ground rods: Copper-clad steel not less than 3/4" (19 mm) in diameter and 10' (3 m) in length. Ground rods shall be UL listed with not less than 10 mils of Copper cladding and stamped near top of rod to show manufacturer, diameter, and length with one end pointed to facilitate driving. Ground rod size shall be as shown on Drawings. If ground rod is longer than 10' (3 m), use sectional, threaded ground rods.
- C. Bare ground cable: Soft drawn copper in accordance with ASTM B3, Class A or B stranding, not less than No. 4/0 AWG (120 mm²) in accordance with ASTM B8. Ground conductor size shall be as shown on Drawings.
- D. Insulated ground conductors shall have green colored insulation.
- E. Ground conductors shall be bare or have green colored insulation or marked with green colored tape or adhesive labels at each end and at every point where conductor is accessible.
- F. Connections shall be made using an exothermic welded process or compression system.
 - 1. Exothermic molds and weld metal shall be selected for connection and be made in strict accordance with manufacturer's instructions.
 - 2. Where compression type connections are used, provide tools and proper dies as recommended by manufacturer.
 - 3. Where flush ground plates are to be embedded in concrete, ground cable shall be exothermally welded to plate and plate firmly secured to concrete forms.
- G. Above-grade connections shall be provided as shown on Drawings.
- H. Above-grade clamps and other hardware used with grounding system shall be bronze or copper alloy.

- I. Above ground bolts, washers, and nuts shall be silicon bronze alloy or approved type of cadmium-plated steel.
- J. Connections to ground rods and ground cables to be buried in earth or concrete shall be suitable for direct burial and shall be identified for such use.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify Site conditions are acceptable for installation.
- B. Verify grounding system components are in good condition and undamaged.

3.02 INSTALLATION

- A. Install at locations shown on Drawings and in accordance with manufacturer's recommendations.
- B. Coordinate interface installation with existing grounding systems.
- C. Connect electrical equipment to ground grid with ground conductor. Electrical equipment shall be designated as metallic structures including equipment mounted thereon, instrument transformers, surge arrestors, overhead shield wires, transformers, breakers, voltage regulators, enclosures, switchgear, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, operate continuously at ground potential, and provide low impedance path for possible ground fault currents.
- D. Install separate, green-insulated equipment grounding conductor in conduit with related phase and neutral conductor.
- E. Multiconductor power cables shall have dedicated grounding conductor integrated within cable construction.
- F. Ground medium-voltage cable shields at each end using cable termination shield grounding kits supplied with medium voltage terminations. Install in strict accordance with manufacturer's instructions.
- G. Ground motors with ground conductor originating at ground lug in equipment where motor power is supplied and connected to motor frame inside motor terminal conduit box. Where motor has separately mounted starter or disconnect switch, ground conductor shall be bonded to starter and disconnect device enclosures and motor frame.
- H. Above-grade connections to permanent and removable equipment shall be exothermic-weld, bolted, or compression-connection type.
- I. Connections to exposed structural steel within buildings or plants shall be exothermic-welded type, unless noted otherwise. Connections to structural steel within substations shall be bolted type. Connections to galvanized steel shall be by bolting.
- J. Above-grade conductors:
 - 1. Install exposed conductors inconspicuously in vertical or horizontal positions on supporting structures.
 - 2. When located on irregular supporting surfaces or equipment, conductors shall run parallel to or normal to dominant surfaces.
 - 3. Conductors routed over concrete, steel, or equipment surfaces shall be kept in close contact with surfaces by using fasteners located at intervals not to exceed 3' (1 m).

- K. Conduits extending into equipment shall be grounded through grounding bushings in enclosure where terminated. Grounding bushings shall be wired together and connected internally to enclosure ground lug or ground bus with bare copper conductors.
- L. Conduits connected to metal enclosures shall be grounded to enclosure by either grounding bushing or double locknuts, with one conduit locknut on each side of enclosure, to provide continuous ground path back to source voltage. Provide grounding bushing for knockout holes in metal enclosures that are oversized, elongated, or deformed.
- M. Bare conductor, used for the building or facility lightning protection system, shall be connected to the below grade grounding system.
- N. Install ground conductor below grade around building perimeters, foundations, and equipment skids as indicated on Drawings. Repair or replace damaged ground system conductors.
- O. Exothermic welds shall encompass 100% of cable end being welded and shall resist moderate hammer blows.
- P. Connect building and pipe support columns to grid with No. 4/0 AWG (120 mm²) cable. Equipment skid frames, switchgear and motor control center ground bars, dry-type transformer cases, and other required solid grounds shall be connected to site grid by "stingers" extended from grid. Where indicated on Drawings, stingers shall be same diameter as ground cable. Provide 5' (1.5 m) of coiled cable above grade for equipment connection.
- Q. Care shall be taken when exposing and connecting to existing grounding systems to maintain continuity and backfill correctly.
- R. Excavate for grid conductor to depths of 18" (50 mm) minimum or as indicated on Drawings. Use special care for excavation near existing foundations and utilities. Excavate by hand in such areas. After installation of grid conductor, backfill with material from excavation, excluding large stones and organic material. Backfill around conductor completely, thoroughly tamping to provide good contact between earth and ground conductor.
- S. Install ground rods in firm soil outside of excavated areas. Drive top of rod to depth of 18" below grade as a minimum to match conductor depth, unless otherwise shown on Drawings. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
- T. Maximum resistance-to-ground of single driven ground rod shall not exceed 25 ohms. Maximum resistance-to-ground of ground grid system shall not exceed 2 ohms. If measured resistance exceeds above values, add rods and bond together to achieve desired resistance. Measurements shall be made and data recorded in presence of Owner's Representative.
- U. Install ground conductor near top and on each side of concrete encased duct bank. Connect duct bank ground conductor to plant grounding system. Install duct bank ground conductors through manhole walls to provide grounding for metallic noncurrent-carrying cable supports, metallic sheaths of cable, and enclosures. Metallic conduits within duct bank shall be provided with grounding bushings within manholes. Connect grounding bushings to grid conductor with minimum No. 8 AWG (10 mm²) conductor.

3.03 FIELD QUALITY CONTROL

- A. Ground grid resistance measurements and data recording shall be made by using fall-of-potential method in accordance with IEEE 81.
- B. Tests shall be made with approved ground resistance tester in accordance with instrument manufacturer's instructions.
 - 1. Make measurements made in presence of Owner's Representative and record data.

2. Volt-ohmmeter not acceptable.
3. Tests shall be performed by personnel knowledgeable in ground system testing.

3.04 MAINTENANCE

- A. Grounding system shall not require maintenance after final installation, testing, and acceptance.

END OF SECTION