

SPECIAL PROVISIONS

FOR

CITY OF SAN LUIS OBISPO

TRANSIT FACILITY ELECTRIC VEHICLE CHARGING INFRASTRUCTURE

Specification No. 1000535

November 2022



**PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION**

**919 Palm Street
San Luis Obispo, CA 93401
(805) 781-7200**

TRANSIT FACILITY ELECTRIC VEHICLE CHARGING INFRASTRUCTURE

Specification No. 1000535

Approval Date: November 15, 2022



11/30/2022



11/30/2022



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**NOTICE TO BIDDERS
BID SUBMISSION**

Sealed bids will be received by the City of San Luis Obispo at the Public Works Administration Office located at 919 Palm Street, San Luis Obispo, California 93401, until

11:00 a.m. on January 12, 2023

at which time they will be publicly opened and read aloud. Submit bid in a sealed envelope plainly marked:

**Transit Facility Electric Vehicle Charging Infrastructure, Specification No.
1000535**

Any bid received after the time and date specified will not be considered and will be returned to the bidder unopened. Bids received by Fax or Email will not be considered.

By submission of bid you agree to comply with all instruction and requirements in this notice and the contract documents.

All bids must be submitted on the Bid Item List form(s) provided and submitted with all other Bid Forms included in these Special Provisions.

Each bid must be accompanied by either a:

1. certified check
2. cashier's check
3. bidder's bond

made payable to the City of San Luis Obispo for an amount equal to ten percent of the bid amount as a guaranty. Guaranty will be forfeited to the City San Luis Obispo if the bidder, to whom the contract is awarded, fails to enter into the contract.

The City of San Luis Obispo reserves the right to accept or reject any or all bids or waive any informality in a bid.

All bids are to be compared based on the City Engineer's estimate of the quantities of work to be done, as shown on the Bid Item List.

Bids will only be accepted from bidders that are licensed in compliance with the provisions of Chapter 9, Division III of Business and Professions Code.

The award of the contract, if awarded, will be to the lowest responsive bid submitted by a responsible contractor whose bid complies with the requirements prescribed. If the contract is awarded, the contract will be awarded within 60 calendar days after the opening of the bids.

NOTICE TO BIDDERS

Failure to raise defects in the notice to bidders or bid forms prior to bid opening constitute a waiver of those defects.

BID DOCUMENTS

A copy of the plans and special provisions may be downloaded, free of charge, from the City's website at:

www.slocity.org/government/department-directory/public-works/public-works-bids-proposals

Standard Specifications and Engineering Standards referenced in the Special Provisions may be downloaded, free of charge, from the City's website at:

www.slocity.org/government/department-directory/public-works/documents-online/construction-documents

You are responsible to obtain all issued addenda prior to bid opening. Addenda will be available to download at the City's website listed above or at the office of the City Engineer.

Contact the project manager, <<INSERT NAME>> at <<INSERT PHONE NUMBER>> or the Public Works Department at (805) 781-7200 prior to bid opening to verify the number of addenda issued.

You are responsible to verify your contact information is correct on the plan holders list located on the City's website at:

www.slocity.org/government/department-directory/public-works/public-works-bids-proposals.

PROJECT INFORMATION

In general, the project consists of installing electric vehicle infrastructure at the Transit Facility.

The project estimated construction cost is \$2,000,000

Contract time is established as 60 working days.

The fixed liquidated damages amount is established at \$500 per day for failure to complete the work within the contract time.

NOTICE TO BIDDERS

In compliance with section 1773 of the Labor Code, the State of California Department of Industrial Relations has established prevailing hourly wage rates for each type of workman. Current wage rates may be obtained from the Division of Labor at:

<https://www.dir.ca.gov/oprl/DPreWageDetermination.htm>

This project is subject to compliance monitoring and enforcement by the Department of Industrial Relations.

QUALIFICATIONS

You must possess a valid Class A Contractor's License at the time of the bid opening.

You and any subcontractors required to pay prevailing wage must be registered with the Department of Industrial Relations pursuant to Section 1725.5 of the Labor Code.

You must have experience constructing projects similar to the work specified for this project. Provide three similar reference projects completed as either the prime or subcontractor. All referenced projects must have been completed within the last five years from this project's bid opening date.

One of the three reference projects must have been completed under contract with a city, county, state or federal government agency as the prime contractor.

Two of the referenced projects must be for construction of a concrete pad.

One of the referenced projects must be for installation of electric vehicle charging infrastructure.

Failure to provide reference projects as specified in this section and as required on the qualification form is cause to reject a bid as being non-responsive.

The City reserves the right to reject any bid based on non-responsiveness if a bidder fails to provide a bid that complies with all bidding instructions.

The City reserves the right to reject a responsive bid based on the non-responsibility of the bidder if the Director of Public Works or Designee finds, after providing notice and a hearing to the bidder, that the bidder lacks the

1. knowledge
2. experience,
3. or is otherwise not responsible

as defined in Section 3.24 of the San Luis Obispo Municipal Code to complete the project in the best interest of the City.

Rejected bidders may appeal this determination. Appeal must comply with the requirements in this Notice to Bidders.

NOTICE TO BIDDERS

It is the City of San Luis Obispo's intent to award the contract to the lowest responsive bid submitted by a responsible bidder. If in the bidder's opinion the contract has been or may be improperly awarded, the bidder may protest the contract award.

Protests must be filed no later than five working days after either:

1. bid opening date
2. notification of rejected bid.

Protest must be in writing and received by the project manager located at:

919 Palm Street
San Luis Obispo, CA 93401.

Valid protests must contain the following information:

1. the reasons for the protest
2. any supporting documentation
3. the ruling expected by the City to remedy the protest.

Any protest not containing all required information will be deemed invalid and rejected.

The City will consider additional documentation or other supporting information regarding the protest if submitted in compliance to the specified time limits. Anything submitted after the specified time limit will be rejected and not be considered.

The Director of Public Works or Designee may request additional information to be submitted within three days of the request, unless otherwise specified, and will notify the protester of ruling within ten days of determination.

If the protester is not satisfied with ruling, the protester may appeal the ruling to the City Council in compliance with Chapter 1.20 of the City of San Luis Obispo Municipal Code.

Pursuant to the Public Records Act (Government Code, § 6250, et seq.), the City will make public records available upon request.

AWARD

The lowest bidder will be determined using the TOTAL PROJECT BID.

As a condition to executing a contract with the City, two bonds each equal to one hundred percent of the total contract price are required in compliance with Section 3-1.05 of the Standard Specifications.

You may substitute securities for moneys withheld under the contract in compliance with the provisions of the Public Contract Code, Section 10263.

NOTICE TO BIDDERS

ACCOMMODATION

If any accommodations are needed to participate in the bid process, please contact Argelia Chang at (805) 781-7200 or by Telecommunications Device for the Deaf at (805) 781-7107. Requests should be made as early as possible in the bidding process to allow time for accommodation.

BID FORMS

All bid forms must be completed and submitted with your bid. Failure to submit these forms and required bid bond is cause to reject the bid as nonresponsive. Staple all bid forms together.

THE UNDERSIGNED, agrees that they have carefully examined:

1. the location of the proposed work
2. the plans and specifications
3. read the accompanying instructions to bidders

and propose to furnish all:

4. materials
5. labor

to complete all the required work satisfactorily in compliance with

6. plans
7. specifications
8. special provisions

for the prices set forth in the bid item list:

BID ITEM LIST FOR TRANSIT FACILITY ELECTRIC VEHICLE CHARGING INFRASTRUCTURE, SPECIFICATION NO. 1000535

Item No.	SS ₍₁₎	Item Description	Unit of Measure	Estimated Quantity	Item Price (in figures)	Total (in figures)
1	13	Water Pollution Control Plan	LS	1	---	
2	15	Remove Trees and Brush	LS	1	---	
3	39-3	Remove Asphalt Pavement	SF	35,700		
4	41-11	Remove Concrete Pavement	SF	23,650		
5	15	Remove Catch Basin	EA	3		
6	15	Remove Chain Link Fence	LF	16		
7	15	Demo Light Post Concrete Footing	LS	1		
8	72	3" Drain Rock	TON	8		
9	72	Class 8 RSP Fabric	SF	450		
10	26	Class II Aggregate Base	SF	59,350		
11	39	Hot Mix Asphalt Pavement	SF	35,700		
12	39	Asphalt Containment Berm	LF	960		
13	40	Concrete Pavement	SF	23,650		
14	80	Chain Link Fence	LF	45		
15	15	Utility Adjustment to Finished Grade – Valves and Cleanouts	EA	6		

BID FORMS

Item No.	SS ₍₁₎	Item Description	Unit of Measure	Estimated Quantity	Item Price (in figures)	Total (in figures)
16	15	Utility Adjustment to Finished Grade – Manholes	EA	4		
17	84	Striping – Thermoplastic	LS	1	---	
18	77	Pothole Existing Utilities	EA	10		
19	70	Containment Area Catch Basins	LS	1	---	
20	99	New 1600A switchboard material and installation	LS	1	---	
21	51	New concrete pad for 1600A switchboard	LS	1	---	
22	99	New Flat Top Manhole material and installation	LS	1	---	
23	86	Pull Boxes	EA	7		
24	51	Charger Concrete pad	EA	14		
25	99	Charger universal plates	EA	12		
26	86	Conduit, bends, and material	LS	1	---	
27	77	Trenching for conduits	LS	1	---	
28	12	Bollards	EA	52		
29	99	Circuit Breakers	LF	2		
30	86	Conductors	LS	1	---	
Bid Total					\$	
Total Project Bid					\$	
Company Name:						

(1) refers to section in the Standard Specifications, with modifications in the Special Provisions, that describe required work.

BID FORMS

LIST OF SUBCONTRACTORS

Pursuant to Section 4100 of the Public Contracts Code and section 2-1.33C of the standard specifications, the Bidder is required to furnish the following information for each Subcontractor performing more than 1/2 percent (0.5%) of the total base bid. Do not list alternative subcontractors for the same work. Subcontracting must not total more than fifty percent (50%) of the submitted bid except as allowed in section 5-1.13 of the standard specifications.

For Streets & Highways projects, subcontractors performing less than ten thousand dollars (\$10,000) worth of work need not be mentioned. **Subcontractors required to pay prevailing wage, must be registered with the Department of Industrial Relations pursuant to Labor Code section 1725.5 to be listed.**

NOTE: If there are no subcontractors, write "NONE" and submit with bid.

Name Under Which Subcontractor is Licensed	License Number	DIR Public Works Registration Number	Address and Phone Number of Office, Mill or Shop	Specific Description of Subcontract	% of Total Base Bid
_____	_____	_____	_____	_____	_____
_____			_____	_____	
_____			_____	_____	
_____	_____	_____	_____	_____	_____
_____			_____	_____	
_____			_____	_____	
_____	_____	_____	_____	_____	_____
_____			_____	_____	
_____			_____	_____	
_____	_____	_____	_____	_____	_____
_____			_____	_____	
_____			_____	_____	

Attach additional sheets as needed.

PUBLIC CONTRACT CODE SECTION 10285.1 STATEMENT

In compliance with Public Contract Code Section 10285.1 (Chapter 376, Stats. 1985), the bidder hereby declares under penalty of perjury under the laws of the State of California that the bidder, or any subcontractor to be engaged by the bidder, **has** _____, **has not** _____ been convicted within the preceding three years of any offenses referred to in that section, including any charge of fraud, bribery, collusion, conspiracy, or any other act in violation of any state or federal antitrust law in connection with the bidding upon, award of, or performance of, any public works contract, as defined in Public Contract Code Section 1101, with any public entity, as defined in Public Contract Code Section 1100, including the Regents of the University of California or the Trustees of the California State University. The term "bidder" is understood to include any partner, member, officer, director, responsible managing officer, or responsible managing employee thereof, as referred to in Section 10285.1.

NOTE: The bidder must place a check mark after "has" or "has not" in one of the blank spaces provided. The above Statement is part of the Bid. Signing this Bid on the signature portion constitute signature of this Statement. Bidders are cautioned that making a false certification may subject the certifier to criminal prosecution.

PUBLIC CONTRACT CODE SECTION 10162 QUESTIONNAIRE

In compliance with Public Contract Code Section 10162, the Bidder must complete, under penalty of perjury, the following questionnaire:

Has the bidder, any officer of the bidder, or any employee of the bidder who has a proprietary interest in the bidder, ever been disqualified, removed, or otherwise prevented from bidding on, or completing a federal, state, or local government project because of a violation of law or a safety regulation?

_____ Yes _____ No

If the answer is yes, attach a letter explaining the circumstances

PUBLIC CONTRACT CODE SECTION 10232 STATEMENT

In compliance with Public Contract Code Section 10232, you hereby state under penalty of perjury, that no more than one final unappealable finding of contempt of court by a federal court has been issued against you within the immediately preceding two-year period because of your failure to comply with an order of a federal court which orders you to comply with an order of the National Labor Relations Board.

LABOR CODE SECTION 1725.5 STATEMENTS

The bidder has delinquent liability to an employee or the state for any assessment of back wages or related damages, interest, fines, or penalties pursuant to any final judgment, order, or determination by a court or any federal, state, or local administrative agency, including a confirmed arbitration award. Any judgment, order, or determination that is

BID FORMS

under appeal is excluded, provided that the contractor has secured the payment of any amount eventually found due through a bond or other appropriate means.

_____ Yes

_____ No

The bidder is currently debarred under Section 1777.1 or under any other federal or state law providing for the debarment of contractors from public works.

_____ Yes

_____ No

NOTE: The above Statements and Questionnaire are part of the Bid. Signing this Bid on the signature portion constitute signature of this Statement and Questionnaire. Bidders are cautioned that making a false certification may subject the certifier to criminal prosecution.

BID FORMS

NON-COLLUSION DECLARATION

I, _____, declare that
I am _____ of _____,
the party making the foregoing bid that the bid is not made in the interest of, or on behalf
of, any undisclosed person, partnership, company, association, organization, or
corporation; that the bid is genuine and not collusive or sham; that the bidder has not
directly or indirectly induced or solicited any other bidder to put in a false or sham bid, and
has not directly or indirectly colluded, conspired, connived, or agreed with any bidder or
anyone else to put in a sham bid, or that anyone refrained from bidding; that the bidder has
not in any manner, directly or indirectly, sought by agreement, communication, or
conference with anyone to fix the bid price of the bidder or any other bidder, or to fix any
overhead, profit, or cost element of the bid price, or of that of any other bidder, or to secure
any advantage against the public body awarding the contract of anyone interested in the
proposed contract; that all statements contained in the bid are true; and, further, that the
bidder has not, directly or indirectly, submitted his or her bid price or any breakdown thereof,
or the contents thereof, or divulged information or data relative thereto, or paid, and will not
pay, any fee to any corporation, partnership, company association, organization, bid
depository, or to any member or agent thereof to effectuate a collusive or sham bid.

Executed on _____, 20____, in _____

I declare under penalty of perjury under the laws of the State of California that the foregoing
is true and correct.

(SEAL)

(Signature and Title of Declarant)

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

Notary Public

Company Name:_____

BID FORMS

BIDDER ACKNOWLEDGEMENTS

By signing below, the bidder acknowledges and confirms that this bid is based on the information contained in all contract documents, including the notice to bidders, plans, specifications, special provisions, and addendum number(s) _____. **(Note: You are responsible to verify the number of addenda prior to the bid opening.)**

The undersigned further agrees that in case of default in executing the required contract, with necessary bonds, within eight days, (not including Saturdays, Sundays, and legal holidays), after having received a mailed notice that the contract is ready for signature, the proceeds of the check or bond accompanying his bid will become the property of the City of San Luis Obispo.

Licensed in accordance with an act providing for the registration of contractors, License No. _____, Expiration Date _____.

The above statement is made under penalty of perjury, and any bid not containing this information "will be considered non-responsive and will be rejected" by the City.

Signature of Bidder _____

(Print Name and Title of Bidder)

**DIR- Public Works
Registration No:**

Business Name (DBA):

Owner/Legal Name:

Indicate One: ☐ Sole-proprietor ☐ Partnership ☐ Corporation

List Partners/Corporate Officers:

Business Address

Street Address

Mailing Address

City, State, Zip Code

Phone Number

Fax Number

Email Address

Date

BID FORMS

QUALIFICATIONS

Failure to furnish complete reference information **ON THIS FORM**, as specified in this project's Notice to Bidders and indicated below, is cause to reject the bid. Additional information may be attached but is not a substitute for this form.

Reference Number 1

Customer Name & Contact Individual	
Telephone & Email	
Project Name (Site Address):	
Is this similar to the project being bid or did this project include xxx activity? Yes ☐ No ☐	Describe the services provided and how this project is similar to that which is being bid: Date project completed:
Was this contract for a public agency? Yes ☐ No ☐	

Reference Number 2

Customer Name & Contact Individual	
Telephone & Email	
Project Name (Site Address):	
Is this similar to the project being bid or did this project include xxx activity? Yes ☐ No ☐	Describe the services provided and how this project is similar to that which is being bid: Date project completed:
Was this contract for a public agency? Yes ☐ No ☐	

Reference Number 3

Customer Name & Contact Individual	
Telephone & Email	
Project Name (Site Address):	
Is this similar to the project being bid or did this project include xxx activity? Yes ☐ No ☐	Describe the services provided and how this project is similar to that which is being bid: Date project completed:
Was this contract for a public agency? Yes ☐ No ☐	

BID FORMS

ATTACH BIDDER'S BOND TO ACCOMPANY BID

Know all men by these presents:

That we _____, AS PRINCIPAL, and

_____, AS SURETY, are held and firmly bound unto the City of San Luis Obispo in the sum of:

_____ Dollars (_____) to be paid to said City or its certain attorney, its successors and assigns; for which payment, well and truly to be made, we bind ourselves, our heirs, executors and administrators, successors or assigns, jointly and severally, firmly by these presents:

THE CONDITION OF THIS OBLIGATION IS SUCH, that if the certain bid of the above bounden _____

to construct _____
(insert name of street and limits to be improved or project)

dated _____ is accepted by the City of San Luis Obispo, and if the above

bounden _____, his heirs, executors, administrators, successors, and assigns shall duly enter into and execute a contract for such construction and shall execute and deliver the two bonds described within ten (10) days (not including Saturdays, Sundays, or legal holidays) after the above bounden,

_____, has received notice by and from the said City of San Luis Obispo that said contract is ready for execution, then this obligation shall become null and void; otherwise, it shall be and remain in full force and virtue.

IN WITNESS WHEREOF, we hereunto set our hands and seals this ____ day of _____, 20____.

Bidder Principal:

Signature _____ Date _____
Title: _____

Surety:

Bidder's signature is not required to be notarized. Surety's signature must be notarized.
Equivalent form may be substituted
(Rev. 6-30-14)

SPECIAL PROVISIONS

ORGANIZATION

Special provisions are under headings that correspond with the main section heading of the Standard Specifications. Each special provision begins with a revision clause that describes or introduces a revision to the Standard Specifications. Any paragraph added or deleted by a revision clause does not change the paragraph number of the Standard Specifications for any other reference to a paragraph of the Standard Specifications.

DIVISION I GENERAL PROVISIONS

1 GENERAL

Add to Section 1-1.01 GENERAL:

The work must be done in compliance with the City of San Luis Obispo, Department of Public Works:

1. Transit Facility Electric Vehicle Charging Infrastructure Special Provisions
2. City of San Luis Obispo Standard Specifications and Engineering Standards – 2020 edition
3. State of California, Department of Transportation Standard Specifications and Standard Plans – 2015 edition

In case of conflict between documents, governing ranking must comply with section 5-1.02 of the City of San Luis Obispo's Standard Specifications.

Failure to comply with the provisions of these sections is a material breach of contract:

1. Sections 5 through 8 of the Standard Specifications
2. Section 12 through 15 of the Standard Specifications
3. Section 77-1 of the Standard Specifications
4. Section 81 of the Standard Specifications
5. authorized working hours
6. OSHA compliance

2 BIDDING

Replace Section 2-1.33A BID DOCUMENT COMPLETION AND SUBMITTAL, General with:

Furnish bid using blank forms provided in the Special Provisions. Bid must include all forms and must be signed by the bidder.

3 CONTRACT AWARD AND EXECUTION

Replace 1st and 2nd paragraph in Section 3-1.18 CONTRACT EXECUTION with:

Upon notification of project award, return:

1. executed contract
2. insurance

SPECIAL PROVISIONS

3. contract bonds
within five business days after the bidder receives the contract.

Add Section 3-1.18B CONTRACT EXECUTION, Building Permit:

3-1.18B Building Permit

The contractor must obtain a no-fee building permit from the Community Development Department. All requirements of the building permit shall be applied to the project.

4 SCOPE OF WORK

Add to Section 4-1.03 WORK DESCRIPTION:

Comply with the provisions of Section(s) X [these section number should match the SS numbers listed in the Bid Item List]....for general, material, construction, and payment specifics.

5 CONTROL OF WORK

6 CONTROL OF MATERIALS

7 LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

Add to Section 7-1.03B PUBLIC CONVENIENCE, Traffic Control Plan

Provide traffic control plan and traffic control application at or before the preconstruction meeting. Traffic control plan must be drawn to scale. Traffic control application may be obtained on the City's website:

www.slocity.org/government/department-directory/public-works/documents-online/construction-documents

Upon approval of the traffic control plan, the City will issue a no-fee Encroachment Permit. Permittee is responsible to comply with all conditions of the traffic control plan. Complete work using due diligence to restore free flowing of traffic.

8 PROSECUTION AND PROGRESS

Replace the 1st paragraph in Section 8-1.02A SCHEDULE, General with:

Provide a Level 1 schedule for this work.

Add to Section 8-1.04B START OF JOB SITE ACTIVITIES, Standard Start:

Contract time will start on the first Monday after preconstruction meeting.

9 PAYMENT

Add to Section 9-1.01 GENERAL:

SPECIAL PROVISIONS

Work as specified in these specifications and as shown on the Plans for which no separate payment is provided for in the Bid Item List will be considered a subsidiary obligation of the Contractor and the cost thereof shall be included in the applicable Contract prices for the item to which the work applies.

The following additional Bid Item descriptions are included for those atypical bid items not fully covered in the Standard Specifications:

BID ITEM 2 – REMOVE TREES AND BRUSH - Measurement and payment for removal of approximately three (3) trees with larger than 6-inch diameter trunks, six (6) trees with smaller than 6-inch diameter trucks, and brush as directed by the City and indicated on the plans, will be made at the unit price bid per lump sum. Payment shall include the cost of, but not limited to, the excavation and removal of existing trees, brush and vegetation. This bid item shall include all the necessary labor, tools, materials, and equipment required to do all the work.

BID ITEMS 5 – REMOVE CATCH BASIN - Measurement and payment for removal and disposal of existing catch basins as indicated on the plans will be made at the unit price bid per each. Payment shall include the cost of, but not limited to, the demolition and removal of the existing catch basin and plugging the ends of the existing drainage piping to be abandoned in place with minor concrete not less than 6 inches thick. This bid item shall include all the necessary labor, tools, materials, and equipment required to do all the work.

BID ITEM 6 - REMOVE CHAINLINK FENCE - Measurement and payment for removal of existing chainlink fencing will be made at the unit price bid per linear foot. Payment shall include the cost of, but not limited to, the demolition and removal of existing fence, posts, barbed wire, concrete and accessories as indicated on the Plans in front of new switchboard location. This bid item shall include all the necessary labor, tools, materials, and equipment required to do all the work.

BID ITEM 7 – DEMO LIGHT POST CONCRETE FOOTING - Payment for this lump sum bid item shall be made on a percent complete basis, based on the lump sum amount for this item, and includes full compensation for the demolition, removal, and disposal of the existing light post concrete footing in accordance with the Contract Documents including but not limited to removal and disposal of concrete, wiring, conduit, equipment, appurtenances, and demolition of facilities. Salvage lamp and light post and return to the City. This bid item shall include all the necessary labor, tools, materials, and equipment required to do all the work.

BID ITEMS 19 – CONTAINMENT AREA CATCH BASINS - Payment for this lump sum bid item shall be made on a percent complete basis, based on the lump sum amount for this item, and includes full compensation for the installation of containment area drainage catch basins, piping, excavation, backfill, compaction, and connections to existing piping in accordance with the Contract Documents including but not limited to all the necessary labor, tools, materials, and equipment required to do all the work.

SPECIAL PROVISIONS

BID ITEM 20 – NEW 1600A SWITCHBOARD MATERIAL AND INSTALLATION - Payment for this lump sum bid item shall be made on a percent complete basis, based on the lump sum amount for this item, and includes full compensation for the installation of a new 1600A Switchboard material in accordance with the Contract Documents including but not limited to all the necessary labor, tools, materials, and equipment required to do all the work.

BID ITEM 21 – NEW CONCRETE PAD FOR 1600A SWITCHBOARD - Payment for this lump sum bid item shall be made on a percent complete basis, based on the lump sum amount for this item, and includes full compensation for the construction of a new concrete pad for the 1600A Switchboard in accordance with the Contract Documents including but not limited to all the necessary labor, tools, materials, and equipment required to do all the work.

BID ITEM 22 – NEW FLAT TOP MANHOLE MATERIAL AND INSTALLATION - Payment for this lump sum bid item shall be made on a percent complete basis, based on the lump sum amount for this item, and includes full compensation for the installation of the new flat top manhole material in accordance with the Contract Documents including but not limited to all the necessary labor, tools, materials, and equipment required to do all the work.

BID ITEMS 24 – CHARGER CONCRETE PAD – Measurement and payment for installation of a concrete pad for the EV Bus Charger as supplied by the City will be made at the unit price bid per each in accordance with the Contract Documents including but not limited to all the necessary labor, tools, materials, and equipment required to do all the work.

BID ITEMS 26 – CONDUIT, BENDS, AND MATERIALS - Payment for this lump sum bid item shall be made on a percent complete basis, based on the lump sum amount for this item, and includes full compensation for the installation of conduit, bends, and materials in accordance with the Contract Documents including but not limited to all the necessary labor, tools, materials, and equipment required to do all the work.

BID ITEMS 27 – TRENCHING FOR CONDUITS - Payment for electrical trench excavation, backfill and compaction shall be made on a percent complete basis, based on the lump sum amount for this item, and includes full compensation for electrical trenchwork. The lump sum cost shall constitute full compensation for furnishing all labor, materials, tools, and equipment necessary for electrical trenchwork in accordance with the Contract Documents including, but not limited to trench excavation, excavation (including rock) pipe bedding, trench zone, compaction, erosion control; removal and disposal of excavated soil not suitable for backfill, dewatering, protection of existing utilities and conduit. Such payment will be considered full compensation for all labor, materials, tools, and equipment for completion, implementation and compliance with the Plans and Specifications.

SPECIAL PROVISIONS

BID ITEM 29 – CIRCUIT BREAKERS - Payment for circuit breakers shall be made on a per linear foot and shall include full compensation for furnishing the labor, materials, tools, and equipment and doing all the work involved to install new circuit breakers in accordance with the Contract Documents including, but not limited to procurement, installation, routing, testing and connecting to required electrical devices per plans, specifications and NEC.

BID ITEMS 30 – CONDUCTORS - Payment for conductors shall be made on a percent complete, based on the lump sum amount for this item, and shall include full compensation for furnishing the labor, materials, tools, and equipment and doing all the work involved to install new conductors in accordance with the Contract Documents including, but not limited to procurement, installation, routing, testing and connecting to required electrical devices per plans, specifications and NEC.

DIVISION II GENERAL CONSTRUCTION

10 GENERAL

Add Section 10-1.02A, General Constraints on Sequence and Schedule of Work:

The Transit Facility Electrical Vehicle Charging Infrastructure site in the City of San Luis Obispo (City) is a critical facility for the ongoing operations of the City's transit operations program.

Conduct work in a manner that will not impair the operational capabilities of essential elements of the site.

Utilize description of critical events in work sequence in this Section as a guideline for scheduling and undertaking the Work.

Work sequence and constraints presented do not include all items affecting completion of the Work but are intended to describe critical events necessary to minimize disruption of the existing facilities and to ensure no interruption of service operations of City's safety response teams.

Add Section 10-1.02F, Shutdown and Construction Constraints:

Execute the Work while the existing facility is in operation.

Add Section 10-1.02G, Operations and Maintenance Access:

Provide safe, continuous access to bus maintenance facilities for City personnel.

13 WATER POLLUTION CONTROL

Add to Section 13-3.01A Summary:

The area of disturbance for this project is anticipated to be less than one-acre; therefore, provide a Water Pollution Control Plan (WPCP) and implementation in compliance with Section 13.

15 EXISTING FACILITIES

16 TEMPORARY FACILITIES

Add Section 16-3 TEMPORARY CONSTRUCTION FACILITIES as follows:

16-3.01A Summary

Contractor shall provide its own office and construction utilities including the cost of permits, usage, generation, installation, relocation, distribution, maintenance, safety, disposal, and removal.

Contractor shall not install or remove any temporary utility without prior written approval of the Engineer.

Temporary utilities placed underground shall be permanently marked as to prevent damage by others, and accurately located for removal. Damage to above ground and underground utilities by the Contractor shall be repaired or replaced by the Contractor at no cost to the District.

Obtain permits and inspections required by public utility companies, State of California, San Luis Obispo County and/or special districts for the installation and use of temporary utilities. Utility installations shall comply with all codes and regulations.

The Contractor is cautioned that there is limited space available on site for temporary storage yards, parking, storage buildings, and temporary office space. Limited staging area will be made available to the Contractor. The Contractor shall satisfy itself that the staging area is adequate for the Contractor's use. If the staging area is not adequate, the Contractor shall find additional staging area for itself offsite. The cost for additional staging area shall be included in the Contractor's bid and no additional payment will be made to the Contractor for additional staging area.

Contractor shall submit for approval the Contractor's proposed plan for temporary utilities, storage facilities/yards, temporary offices/trailers, and temporary construction water.

SPECIAL PROVISIONS

Provide power required for construction operations. Reimburse Owner for the cost of any permanent power used, including power used for testing and commissioning of equipment and systems.

16-3.01B Electrical Power – Construction Phase

The Contractor can make its own arrangements with the local utility company to provide adequate temporary electrical service at a location acceptable to the City and utility service provider. The Contractor shall then provide adequate jobsite distribution facilities conforming to applicable codes and safety regulations. The Contractor shall provide, at its own cost, all electric power required for construction, testing, general and security lighting, and all other purposes whether supplied through temporary or permanent facilities.

16-3.01C Dust Control

Perform dust control operations to prevent construction operations from producing dust in amounts harmful to persons or causing a nuisance to persons living nearby or occupying buildings in the vicinity of the work. Use water or dust preventative to control dust.

16-3.01D Fire Danger

Minimize fire danger in the vicinity of and adjacent to the construction site. Provide labor and equipment to protect the surrounding private property from fire resulting from construction operations.

16-3.01E Sanitary Conveniences

The Contractor shall provide suitable and adequate sanitary conveniences for the use of all persons at the site of the Work. Such conveniences shall include chemical toilets or water closets and shall be located at appropriate locations at the site of the Work. All sanitary conveniences shall conform to the regulations of the public authority having jurisdiction over such matters. At the completion of the Work, all such sanitary conveniences shall be removed and the site left in a sanitary condition.

16-3.01F Temporary Construction Fences and Gates

Contractor may, upon approval by Engineer, install temporary fences, gates, barricades, or other suitable means to protect property and prevent damage and injury.

16-3.01G Illumination

The Contractor shall provide temporary lighting in all work areas sufficient to maintain a lighting level during working hours not less than the lighting level required by OSHA standards.

SPECIAL PROVISIONS

Permanent building lighting may not be used during construction.

16-3.01H Progress/Work Area Cleaning

Maintain staging and work areas in a clean and orderly condition free from trash. "Trash" shall include all: food scraps, office garbage, construction rubbish/debris, waste/excess materials, shipping/packing materials, and windblown trash. Trash shall be collected and placed into containers daily at designated waste storage areas in locations approved by the Owner and removed periodically for offsite disposal at Contractor's expense.

16-3.01I Removal

Remove temporary equipment, facilities, and materials prior to request for final inspection.

Clean and repair damage caused by installation and use of temporary work.

Remove all temporary site improvements. All materials removed shall be disposed of off-site and the area shall be returned to the design as set forth in Contract Documents.

DIVISION VI STRUCTURES

45 GENERAL

Add to Section 45-1.01 GENERAL:

For concrete structures and steel reinforcement specifications, the Structural Plans shall take precedent over the State Standard Specifications. Refer to Sheets 7 through 9 of the Plan.

DIVISION VIII MISCELLANEOUS CONSTRUCTION

80 FENCES

Add to Section 80-3.01A, Summary:

Chain link fence shall be galvanized type CL-6, BW and comply with Caltrans Standard Plans including A85, A85A, and A85B.

DIVISION IX TRAFFIC CONTROL DEVICES

84 MARKINGS

Add to Section 84-2.03C Application of Stripes and Markings:

Preformed thermoplastic is only allowed with the approval of the Engineer.

DIVISION X ELECTRICAL WORK

86 ELECTRICAL

Add Section 86-1.01, GENERAL:

For construction specifications of electrical items, the Electrical Plans shall take precedent over the State Standard Specifications. Refer to Electrical Sheets of the Plan Set and to Technical Specifications included in Appendix B.

DIVISION XIII APPENDICES

Appendix A - Form of Agreement

Appendix B – Technical Specifications

APPENDIX

APPENDIX A - FORM OF AGREEMENT

THIS AGREEMENT, made on _____, by and between the City of San Luis Obispo, a municipal corporation and charter city, San Luis Obispo County, California (hereinafter called the Owner) and **COMPANY NAME** (hereinafter called the Contractor).

WITNESSETH:

That the Owner and the Contractor for the consideration stated herein agree as follows:

ARTICLE 1, SCOPE OF WORK: The Contractor shall perform everything required to be performed, shall provide and furnish all of the labor, materials, necessary tools, expendable equipment, and all utility and transportation services required to complete all the work of construction of

NAME OF PROJECT, SPEC NO.

in strict compliance with the plans and specifications therefor, including any and all Addenda, adopted by the Owner, in strict compliance with the Contract Documents hereinafter enumerated.

It is agreed that said labor, materials, tools, equipment, and services shall be furnished and said work performed and completed under the direction and supervision and subject to the approval of the Owner or its authorized representatives.

ARTICLE II, CONTRACT PRICE: The Owner shall pay the Contractor as full consideration for the faithful performance of this Contract, subject to any additions or deductions as provided in the Contract Documents, the contract prices as follows:

Item No.	Item	Unit of Measure	Estimated Quantity	Item Price (in figures)	Total (in figures)
1.					
2.					
3.					

BID TOTAL: \$.00

Payments are to be made to the Contractor in compliance with and subject to the provisions embodied in the documents made a part of this Contract.

Should any dispute arise respecting the true value of any work omitted, or of any extra work which the Contractor may be required to do, or respecting the size of any payment to the Contractor, during the performance of this Contract, said dispute shall be decided by the Owner and its decision shall be final, and conclusive.

ARTICLE III, COMPONENT PARTS OF THIS CONTRACT: The Contract consists of the following documents, all of which are as fully a part thereof as if herein set out in full, and if not attached, as if hereto attached:

1. Notice to Bidders and Information for Bidders
2. Standard Specifications and Engineering Standards
3. Special Provisions, any Addenda, Plans and Contract Change Orders
4. Caltrans Standard Specifications and Standard Plans 2015
5. Accepted Bid and Bid Bond
6. List of Subcontractors
7. Public Contract Code Sections 10285.1 Statement
8. Public Contract Code Section 10162 Questionnaire
9. Public Contract Code Section 10232 Statement
10. Labor Code Section 1725.5 Statements
11. Bidder Acknowledgements
12. Qualifications
13. Non-collusion Declaration
14. Agreement and Bonds
15. Insurance Requirements and Forms

ARTICLE IV INDEMNIFICATION: The Contractor shall indemnify, defend with legal counsel approved by City, and hold harmless City, its officers, officials, employees and volunteers from and against all liability, loss, damage, expense, cost (including without limitation reasonable legal counsel fees, expert fees and all other costs and fees of litigation) of every nature arising out of or in connection with the Contractor's negligence, recklessness or willful misconduct in the performance of work hereunder or its failure to comply with any of its obligations contained in this Agreement, except such loss or damage which is caused by the sole or active negligence or willful misconduct of the City. Should conflict of interest principles preclude a single legal counsel from representing both the City and the Contractor, or should the City otherwise find the Contractor's legal counsel unacceptable, then the Contractor shall reimburse the City its costs of defense, including without limitation reasonable legal counsel fees, expert fees and all other costs and fees of litigation. The Contractor shall promptly pay any final judgment rendered against the City (and its officers, officials, employees and volunteers) with respect to claims determined by a trier of fact to have been the result of the Contractor's negligent, reckless or wrongful performance. It is expressly understood and agreed that the foregoing provisions are intended to be as broad and inclusive as is permitted by the law of the State of California and will survive termination of this Agreement.

The Contractor obligations under this section apply regardless of whether such claim, charge, damage, demand, action, proceeding, loss, stop notice, cost, expense, judgment, civil fine or penalty, or liability was caused in part or contributed to by an Indemnitee. However, without affecting the rights of the City under any provision of this agreement, the Contractor shall not be required to indemnify and hold harmless the City for liability attributable to the active negligence of City, provided such active negligence is determined by agreement between the parties or by the findings of a court of competent jurisdiction. In

APPENDIX

instances where the City is shown to have been actively negligent and where the City's active negligence accounts for only a percentage of the liability involved, the obligation of the Contractor will be for that entire portion or percentage of liability not attributable to the active negligence of the City.

ARTICLE V. It is further expressly agreed by and between the parties hereto that should there be any conflict between the terms of this instrument and the bid of said Contractor, then this instrument shall control and nothing herein shall be considered as an acceptance of the said terms of said bid conflicting herewith.

IN WITNESS WHEREOF, the parties to these presents have hereunto set their hands this year and date first above written.

CITY OF SAN LUIS OBISPO
A Municipal Corporation

Derek Johnson, City Manager

APPROVED AS TO FORM

CONTRACTOR:

Name of Company

J. Christine Dietrick
City Attorney

By: _____
Name of CAO/President
Its: CAO/PRESIDENT

(2nd signature required if Corporation):

By: _____
Name of Corporate Officer

Its: _____

APPENDIX B – TECHNICAL SPECIFICATIONS

**SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL**

PART 1 – GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. General requirements applicable to all Electrical Work.
 - 2. General requirements for electrical submittals.
- B. Related sections:
 - 1. Section 26 05 03 - Utility Coordination.
 - 2. Section 26 05 33 - Conduits.
 - 3. Section 26 05 53 - Identification for Electrical Systems.
 - 4. Section 26 08 50 - Field Electrical Acceptance Tests.
- C. Interfaces to equipment, instruments, and other components:
 - 1. The Drawings, Specifications, and overall design are based on preliminary information furnished by various equipment manufacturers which identify a minimum scope of supply from the manufacturers. This information pertains to, but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.
 - 2. Provide all material and labor needed to install the actual equipment furnished, and include all costs to add any additional conduit, wiring, terminals, or other electrical hardware to the Work, which may be necessary to make a complete, functional installation based on the actual equipment furnished:
 - a. Make all changes necessary to meet the manufacturer's wiring requirements.
 - 3. Submit all such changes and additions to the Engineer for acceptance.
 - 4. Review the complete set of Drawings and Specifications in order to ensure that all items related to the electrical power and control systems are completely accounted for. Include any such items that appear on the Drawings or in the Specifications from another discipline in the scope of Work:
 - a. If a conflict between Drawings and Specifications is discovered, refer conflict to the Engineer as soon as possible for resolution.
 - 5. Loop drawings:
 - a. Provide all electrical information required in the preparation of loop drawings including, but not limited to:
 - 1) Conduit numbers and associated signal(s) contained within each conduit.
 - 2) Wire numbers.
 - 3) Equipment terminal numbers.
 - 4) Junction boxes and signal(s) contained within each junction box.
 - 5) Equipment power sources, and associated circuit numbers.
 - 6) As-built drawings detailing wiring.
- D. All electrical equipment and systems for the entire Project must comply with the requirements of the Electrical Specifications, whether referenced in the individual Equipment Specifications or not:
 - 1. The requirements of the Electrical Specifications apply to all Electrical Work specified in other sections.
 - 2. Inform all vendors supplying electrical equipment or systems of the requirements of the Electrical Specifications.
 - 3. Owner is not responsible for any additional costs due to the failure of Contractor to notify all subcontractors and suppliers of the Electrical Specifications requirements.
- E. Contract Documents:
 - 1. General:

- a. The Drawings and Specifications are complementary and are to be used together in order to fully describe the Work.
- 2. Specifications:
 - a. The General and Supplementary Conditions of the Contract Documents govern the Work.
 - b. These requirements are in addition to all General Requirements.
- 3. Contract Drawings:
 - a. The Electrical Drawings show desired locations, arrangements, and components of the Electrical Work in a diagrammatic manner.
 - b. Locations of equipment, control devices, instruments, boxes, panels, etc. are approximate only; exercise professional judgment in executing the Work to ensure the best possible installation:
 - 1) The equipment locations and dimensions indicated on the Drawings are approximate. Use the shop drawings to determine the proper layout, foundation, and pad requirements, etc. for final installation. Coordinate with all subcontractors to ensure that all electrical equipment is compatible with other equipment and space requirements. Make changes required to accommodate differences in equipment dimensions.
 - 2) The Contractor has the freedom to select any of the named manufacturers identified in the individual specification sections, if noted; however, the Engineer has designed the spatial equipment layout based upon a single manufacturer and has not confirmed that every named manufacturer's equipment fits in the allotted space. It is the Contractor's responsibility to ensure that the equipment being furnished fits within the defined space.
 - c. Installation details:
 - 1) The Contract Drawings include typical installation details the Contractor is to use to complete the Electrical Work. For cases where a typical detail does not apply, develop installation details that may be necessary for completing the Work, and submit these details for review by the Engineer.
 - 2) Not all typical installation details are referenced within the Drawing set. Apply and use typical details where appropriate.
 - d. Schematic diagrams:
 - 1) All controls are shown de-energized.
 - 2) Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.
 - 3) Add slave relays, where required, to provide all necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.
 - 4) Mount all devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted or indicated.
 - 5) Schematic diagrams are to be used in conjunction with the descriptive operating sequences in the Contract Documents. Combine all information and furnish a coordinated and fully functional control system.
- F. Alternates/Alternatives:
 - 1. In accordance with Owner's front end bid documents.
- G. Changes and change orders:
 - 1. In accordance with Owner's front end bid documents.

1.02 REFERENCES

- A. Code compliance:
 - 1. The publications are referred to in the text by the basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of the bid governs.

2. The standards listed are hereby incorporated into this Section.
 - a. American National Standards Institute (ANSI).
 - b. American Society of Civil Engineers (ASCE):
 - 1) ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
 - c. ASTM International (ASTM).
 - d. Illuminating Engineering Society (IES).
 - e. Institute of Electrical and Electronics Engineers (IEEE).
 - f. Insulated Cable Engineers Association (ICEA).
 - g. International Code Council (ICC).
 - 1) International Code Council Evaluation Service (ICC-ES).
 - (a) AC 156 – Acceptance Criteria for Seismic Certification by Shake Table Testing of Non-Structural Components (ICC-ES AC 156).
 - h. International Society of Automation (ISA).
 - i. National Electrical Manufacturers Association (NEMA):
 - 1) 250 - Enclosures for Electrical Equipment (1000 V Maximum).
 - j. National Fire Protection Association (NFPA):
 - 1) 70 - National Electrical Code (NEC).
 - k. National Institute of Standards and Technology (NIST).
 - l. Underwriters' Laboratories, Inc. (UL).
- B. Compliance with laws and regulations:
 1. In accordance with Owner's front end bid documents.

1.03 DEFINITIONS

- A. Definitions of terms and other electrical and instrumentation considerations as set forth by:
 1. IEEE.
 2. NETA.
 3. IES.
 4. ISA.
 5. NEC.
 6. NEMA.
 7. NFPA.
 8. NIST.
- B. Specific definitions:
 1. FAT: Factory acceptance test.
 2. ICSC: Instrumentation and controls subcontractor.
 3. LCP: Local control panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
 4. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
 5. PCIS: Process control and instrumentation system.
 6. RTU: Remote telemetry unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
 7. Space: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that does not physically contain a device but is capable of accepting a device with no modifications to the equipment, i.e., provide all standoffs, bus, and hardware, as part of the space.
 8. Spare: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that physically contains a device with no load connections to be made.
 9. VCP: Vendor control panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.

10. Unequipped space: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that does not physically contain a device, standoff, bus, hardware, or other equipment.

1.04 SYSTEM DESCRIPTION

A. General requirements:

1. The Work includes everything necessary for and incidental to executing and completing the Electrical Work indicated on the Drawings and specified in the Specifications and reasonably inferable there from:
 - a. The Electrical Drawings are schematic in nature; use the Structural, Architectural, Mechanical, and Civil Drawings for all dimensions and scaling purposes.
2. It is the intent of these Specifications that the entire electrical power, instrumentation, and control system be complete and operable. Provide all necessary material and labor for the complete system from source of power to final utilization equipment, including all connections, testing, calibration of equipment furnished by others as well as equipment furnished by the Contractor, whether or not specifically mentioned but which are necessary for successful operation.
3. Provide all Electrical Work, including conduit, field wiring, and connections by the electrical subcontractor under the provisions of the Electrical Specifications for all aspects of the Work.
4. Coordinate all aspects of the Work with the electrical subcontractor and other subcontractors before bidding in order to ensure that all costs associated with a complete installation are included. The Owner is not responsible for any change orders due to lack of coordination of the Work between the Contractor, the electrical subcontractor, the other subcontractors or suppliers.
5. Provide all trenching, forming, rebar, concrete, back filling, hard surface removal and replacement, for all items associated with the Electrical Work and installation:
 - a. As specified in the Contract Documents.
6. Defective work:
 - a. In accordance with Owner's front end bid documents.
7. Utility coordination: Coordinate with the electric utility as required.

1.05 SUBMITTALS

A. General:

1. Instruct all equipment suppliers of submittals and operation and maintenance manuals of the requirements in this Section.
2. Furnish the submittals required by each section in the Electrical Specifications.
3. Adhere to the wiring numbering scheme specified in Section 26 05 53 throughout the Project:
 - a. Uniquely number each wire.
 - b. Wire numbers must appear on all Equipment Drawings.
4. Use equipment and instrument tags, as indicated on the Drawings, for all submittals.

B. Seismic requirements:

1. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site seismic loads based on the seismic design criteria per the Manufacturer's instructions.
2. Exemptions: A "statement of seismic qualification" and a "special seismic certification" are not required for the following equipment:
 - a. Temporary or moveable equipment.
 - b. Equipment anchored to the structure and having a total weight of 20 pounds or less.
 - c. Distribution equipment anchored to the structure and having a total unit weight of 3 pounds per linear foot, or less.

C. Operation and maintenance manuals:

1. Furnish the Engineer with a complete set of written operation and maintenance manuals 8 weeks before Functional Acceptance Testing.
- D. Material and equipment schedules:
 1. Furnish a complete schedule and/or matrix of all materials, equipment, apparatus, and luminaries that are proposed for use:
 - a. Include sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.
- E. Schedule of values:
 1. In addition to completing all items referred to in the schedule of values, submit per unit material and labor costs used in developing the final bid for the electrical system, for the express purpose of pricing and cost justification for any proposed change orders. In addition to the items shown on the schedule of values, provide per unit material and labor costs for conduit and wire installation for specific types, sizes, and locations as indicated on the Drawings and Conduit Schedule. It is the responsibility of the electrical subcontractor to prove to the Engineer's satisfaction that said per unit costs were used in the development of the final Bid amount.
- F. Record Documents:
 1. In accordance with Owner's front end bid documents.
- G. Test reports:
 1. Additional requirements for field acceptance test reports are specified in Section 26 08 50.
- H. Calculations:
 1. Where required by specific Electrical Specifications:
 - a. Because these calculations are being provided by a registered professional engineer, they will be reviewed for form, format, and content but will not be reviewed for accuracy and calculation means.
- I. The following submittals should be assembled and delivered in separate binders:
 1. Valmont Radio Tower.
 2. Radio/Repeater Panel.
 3. Radio Tower Lighting Panel.
 4. Conduits, Pull Boxes, Hand holes, Cable and Wiring Devices.
 5. Electrical Miscellaneous Components – Ground Equipment, Circuit Breakers, Transformers, Fiber optic cables etc.,
- J. Each submittal shall be bound in a three-ring binder, which is sized such that when all material is inserted, the binder is not over 3/4 full. Binder construction shall allow easy removal of any page without complete manual disassembly. Spiral ring type binders are not acceptable.
 1. Each binder shall be appropriately labeled on the outside spine and front cover with the project name, contract number, equipment supplier's name, specification section(s), and major material contained therein.
 2. An index shall be provided at the inside of the front cover. This index shall itemize the contents of each tab and sub tab section. Also list the project name, contract number and equipment's supplier's name, address and phone number on the index page.
 3. Field equipment shop documents, panel equipment shop documents, drawings, and bill of materials shall be grouped under separate tabs. Shop documents shall be ordered in the same sequence as their corresponding Contract specification subsection. Failure to mark applicable products and to cross out non-applicable products shall cause rejection of the entire submittal.
 4. Data summary sheets shall be provided to sub tab all shop documents for each individual piece of equipment. Data summary sheets shall be on blue paper. The data summary sheets shall have the following information:
 - a. Product identification; name used herein and on the Contract Drawings.
 - b. the manufacturer's model number, part number or other designation. This shall include the specific numbers of all options.

- c. Tag number per the Drawings.

1.06 QUALITY ASSURANCE

- A. Furnish all equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with Owner's front end bid documents and per Manufacturer's instructions.

1.08 PROJECT OR SITE CONDITIONS

- A. Site conditions:
 - 1. Provide an electrical, instrumentation and control system, including all equipment, raceways, and any other components required for a complete installation that meets the environmental conditions for the Site as specified in the General Requirements and below.
 - 2. Altitude, temperature and humidity:
 - a. Provide all electrical components and equipment fully rated for continuous operation at this altitude, with no additional derating factors applied.
 - b. Provide additional temperature conditioning equipment to maintain all equipment in non-conditioned spaces subject to these ambient temperatures, with a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature, as determined by the equipment manufacturer's guidelines:
 - 1) Provide all power conduits wiring for these devices (e.g. heaters, fans, etc.) whether indicated on the Drawings or not.
- B. Provide enclosures for electrical, instrumentation and control equipment, regardless of supplier or subcontractor furnishing the equipment, that meet the requirements outlined in NEMA Standard 250 for the following types of enclosures:
 - 1. NEMA Type 1: Intended for indoor use, primarily to provide a degree of protection from accidental contact with energized parts or equipment.
 - 2. NEMA Type 3R: Intended for outdoor use, to provide a degree of protection against ingress of solid foreign objects (falling dirt), and from the ingress of water (rain, sleet, snow).
 - 3. NEMA Type 4: Intended for indoor or outdoor use, primarily to protect equipment from exposure to windblown dust and rain, splashing or hose directed water, ice formation and freezing.
 - 4. NEMA Type 4X: Made from corrosion resistant materials (fiberglass reinforced plastic, 316 stainless steel or equal) and are intended for indoor or outdoor use, primarily to protect equipment from exposure to windblown dust and rain, splashing or hose directed water, ice formation and freezing, and corrosion.
 - 5. NEMA Type 12: Intended for indoor use, primarily to provide a degree of protection from dust, falling dirt and dripping non-corrosive liquids.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING

- A. General:
 - 1. As specified in accordance with the Owner's front end bid documents.
 - 2. Testing requirements are specified in Section 26 08 50 and other sections.
- B. Pre-submittal conference:
 - 1. Before producing any submittals, schedule a pre-submittal conference for the purposes of reviewing the entire Project, equipment, control philosophy, schedules, and submittal requirements.

1.11 WARRANTY

- A. Warrant the Electrical Work as specified in in accordance with the Owner's front end bid documents.

1. Provide additional warranty as specified in the individual Electrical Specifications.

1.12 SYSTEM START-UP

- A. Replace or modify equipment, software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements:
 1. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the Engineer.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

- A. Before Substantial Completion, perform all maintenance activities required by any sections of the Specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.
- B. Furnish all spare parts as required by other sections of the Specifications.

1.15 OPERATION AND MAINTENANCE MANUALS

- A. Submit Operation and Maintenance Manuals. The manuals shall describe the equipment and meet all the requirements in the other technical sections and include the following:
 1. Operating instructions and start up procedures including receiving and installation requirements.
 2. Maintenance instructions listing preventive and corrective maintenance procedures. Corrective maintenance procedures shall identify the most probable failures and the appropriate repairs. Test measurement levels shall be referenced to specific test points on the installed equipment.
 3. Spare parts data shall be furnished for each item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply. A list and itemized price breakdown of spare parts recommended for stocking shall be furnished. The parts selected shall be those, in the manufacturer's judgment, will be involved in the majority of maintenance difficulties encountered.
 4. A table listing the tag number, manufacturer and manufacturer's model number shall be provided to summarize the Bill of Material.
 5. Control schematics, ladder diagrams and interconnection drawings.
 6. Catalog cuts and technical manuals for all components of the system.
 7. Originals of all guarantees and warranties issued for the various items of equipment, showing all dates of expiration.
 8. Originals of all factory and field test results.
 9. Final as-builts of all shop drawings, incorporating manufacturing and field changes. All drawings will be by 11x17 inch sheet size and also electronic format, AutoCAD on CD.
 10. For items referenced under AutoCAD Record Drawings included in this Specification, provide a CD with files as required in "AutoCAD Record Drawings."
 11. All catalog cut information, warranties, testing results and technical manuals shall be provided on CD in PDF format, in addition to hardcopy.
 12. Operation and maintenance manuals to be delivered and approved prior to final approval and project completion.

1.16 RECORD DRAWINGS

- A. During progress of job, keep up to date one set of electrical drawings stamped with "As Built". Dimension from the following readily obtained base lines:
 1. Exact location, type and function of concealed control equipment and devices.
 2. Exact elevation and locations and size of underground conduits.
 3. Show the dimensions, location and routing of electrical work which will become concealed.

- B. Maintain "As Built" drawings weekly in conjunction with the actual progress of installation. Accurate progress drawings shall be available on site for examination by the City's representative.
- C. At completion of the project, deliver "As Built" drawings to the City's representative.
- D. The Contractor shall guarantee the accuracy of the "As Built" record drawings, and the AutoCAD record drawings for a period of one year after the City has accepted the project. During this time, the Contractor shall bear all costs associated with correcting deficiencies and inaccuracies of these Drawings. During this time, the Contractor shall also bear all costs necessary to field investigate any deficiencies, or inaccuracies and field trace wires if required by Project Engineer.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Provide similar items of same manufacturer throughout the electrical and instrumentation portion of the Project.
- B. Allowable manufacturers are specified in individual Electrical Specifications.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

- A. Furnish all materials under this Contract that are new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products and that bear all approvals and labels as required by the Specifications.
- B. Provide materials complying with the applicable industrial standards.
- C. Stainless steel:
 - 1. Where stainless steel is indicated or used for any portion of the Electrical Work, provide a non-magnetic, corrosion-resistant alloy, ANSI Type 316, satin finish.
 - 2. Provide exposed screws of the same alloys.
 - 3. Provide finished material free of any burrs or sharp edges.
 - 4. Use only stainless steel hardware, when chemically compatible, in all areas that are or could be in contact with corrosive chemicals.
 - 5. Use stainless steel hardware, when chemically compatible, in all chemical areas or areas requiring NEMA Type 4X construction.
 - 6. Do not use stainless steel in any area containing chlorine, gas or solution, chlorine products or ferric chloride.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. Provide all equipment that is new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. It is the electrical subcontractor's responsibility to be fully familiar with the existing conditions and local requirements and regulations.

- B. Comply with pre-bid conference requirements as specified in accordance with the Owner's front end bid documents.
- C. Review the site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. Equipment locations shown on Electrical Drawings may change due to variations in equipment size or minor changes made by others during construction:
 - 1. Verify all dimensions indicated on the Drawings:
 - a. Actual field conditions govern all final installed locations, distances, and levels.
 - 2. Review all Contract Documents and approved equipment shop drawings and coordinate Work as necessary to adjust to all conditions that arise due to such changes.
 - 3. Make minor changes in location of equipment before rough in, as directed by the Owner or Engineer.
 - 4. Provide a complete electrical system:
 - a. Install all extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical system.
- B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.
- C. Cutting and patching:
 - 1. Perform all cutting, patching, channeling, core drilling, and fitting required for the Electrical Work, except as otherwise directed:
 - a. Secure the permission of the Engineer before performing any operation likely to affect the strength of a structural member such as drilling, cutting or piercing:
 - 1) Before cutting, channeling, or core drilling any surface, ensure that no penetration of any other systems will be made:
 - (a) Verify that area is clear and free of conduits, cables, piping, ductwork, post-tensioning cables, etc.
 - (b) Use tone-locate system or X-ray to ensure that area is clear of obstructions.
 - b. Review the complete Drawing set to ensure that there are no conflicts or coordination problems before cutting, channeling, or core drilling any surface.
 - 2. Perform all patching to the same quality and appearance as the original work. Employ the proper tradesmen to secure the desired results. Seal around all conduits, wires, and cables penetrating walls, ceilings, and floors in all locations with a fire stop material, typically:
 - a. 3M: CP 25WB+: Caulk.
 - b. 3M: Fire Barrier: Putty.
 - 3. Use the installation details indicated on the Drawings as a guide for acceptable sealing methods.
- D. Install all conduits and equipment in such a manner as to avoid all obstructions and to preserve headroom and keep openings and passageways clear:
 - 1. Install all conduits and equipment in accordance with working space requirements in accordance with the NEC.
 - a. This includes any panel, disconnect switch or other equipment that can be energized while open exposing live parts regardless of whether it is likely to require examination or has serviceable parts.
 - 2. Where the Drawings do not show dimensions for locating equipment, install equipment in the approximate locations indicated on the Drawings.
 - a. Adjust equipment locations as necessary to avoid any obstruction or interferences.
 - 3. Where an obstruction interferes with equipment operation or safe access, relocate the equipment.

4. Where the Drawings do not indicate the exact mounting and/or supporting method to be used, use materials and methods similar to the mounting details indicated on the Drawings.
- E. Earthwork and concrete:
 1. Install all trenching, shoring, concrete, backfilling, grading and resurfacing associated with the Electrical Work:
 - a. Requirements as specified in the Contract Documents.
- F. Terminations:
 1. Provide and terminate all conductors required to interconnect power, controls, instruments, panels, and all other equipment.
- G. Miscellaneous installation requirements:
 1. In case of interference between electrical equipment indicated on the Drawings and the other equipment, notify the Engineer.
 2. Location of manholes and pullboxes indicated on the Drawings are approximate. Coordinate exact location of manholes and pullboxes with Mechanical and Civil Work.
 3. Provide additional manholes or pullboxes to those shown where they are required to make a workable installation.
- H. Labeling:
 1. Provide all nameplates and labels as specified in Sections 26 05 53.
- I. Equipment tie-downs:
 1. Anchor all instruments, control panels, and equipment by methods that comply with seismic and wind bracing criteria, which apply to the Site.
 2. All control panels must be permanently mounted and tied down to structures in accordance with the Project seismic criteria.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

- A. For Owner and Engineer witnessed FAT:
 1. Contractor is responsible for the Owner's and Engineer's costs associated with FAT as specified in other sections.
- B. Owner training:
 1. In accordance with Owner's front end bid documents and in this Section.
- C. Source testing (FAT):
 1. Provide source testing and owner training on electrical equipment as defined below:
 - a. 26 32 14 - Single Diesel Fueled Engine Generator, Non- Witnessed, Owner Training requirements: 4 hrs per session for Maintenance, 4 hrs per session for Operation

3.08 FIELD QUALITY CONTROL

- A. Inspection:
 1. Allow for inspection of electrical system installation as specified in this section.
 2. Provide any assistance necessary to support inspection activities.
 3. Engineer inspections may include, but are not limited to, the following:
 - a. Inspect equipment and materials for physical damage.
 - b. Inspect installation for compliance with the Drawings and Specifications.
 - c. Inspect installation for obstructions and adequate clearances around equipment.
 - d. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.
 - e. Inspect equipment nameplate data to verify compliance with design requirements.
 - f. Inspect raceway installation for quality workmanship and adequate support.

- g. Inspect cable terminations.
- 4. Inspection activities conducted during construction do not satisfy inspection or testing requirements specified in Section 26 08 50.
- B. Field acceptance testing (Functional Testing):
 - 1. Notify the Engineer when the Electrical Work is ready for field acceptance testing.
 - 2. Perform the field acceptance tests as specified in Section 26 08 50.
 - 3. Record results of the required tests along with the date of test:
 - a. Use conduit identification numbers to indicate portion of circuit tested.
- C. Workmanship:
 - 1. Leave wiring in panels, manholes, boxes, and other locations neat, clean, and organized:
 - a. Neatly coil and label spare wiring lengths.
 - b. Shorten, re-terminate, and re-label excessive used as well as spare wire and cable lengths, as determined by the Engineer.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

- A. As specified in Section 01 77 00.
- B. Remove all foreign material and restore all damaged finishes to the satisfaction of the Engineer and Owner.
- C. Clean and vacuum all enclosures to remove all metal filings, surplus insulation and any visible dirt, dust or other matter before energization of the equipment or system start-up.
- D. As specified in other sections of the Contract Documents.

3.11 PROTECTION

- A. Protect all Work from damage or degradation until Substantial Completion.
- B. Maintain all surfaces to be painted in a clean and smooth condition.

3.12 SCHEDULES (NOT USED)

END OF SECTION 26 05 00

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**SECTION 26 05 03
UTILITY COORDINATION**

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Coordination with the utility companies to provide service.
 - 2. Contractor's responsibilities for connecting to utilities and providing utility service to the facilities.
 - 3. Descriptions of utility services required.
- B. Related sections:
 - 1. Section 26 05 00 - Common Work Results for Electrical.

1.02 REFERENCES

- A. As specified in Section 26 05 00.

1.03 DEFINITIONS

- A. As specified in Section 26 05 00.
- B. Utility contacts:
 - 1. Electric utility: For service equipment coordination
 - a. Name: Kevin Chang.
 - b. Utility: Pacific Gas & Electric.
 - c. Address: -
 - d. Phone number: 415-725-1209
 - e. E-mail: kevin.chang@pge.com
 - 2. Electric utility: For transformer upgrade
 - a. Name: Justin McDonald.
 - b. Utility: Pacific Gas & Electric.
 - c. Address: -
 - d. Phone number: 805-546-1271
 - e. E-mail: Justin.McDonald@pge.com

1.04 SYSTEM DESCRIPTION

- A. Electrical service:
 - 1. Provide all Work and materials and bear all costs for providing temporary construction power and the permanent electrical service, including but not limited to:
 - a. All Work and materials not provided by the electric utility.
 - b. All permits and fees required by the electric utility.
 - 2. Provide electrical ducts, raceways, conductors and connections indicated on the Drawings, and all other Work and materials required for a complete electrical service, including but not limited to the following:
 - a. Electrical primary and secondary conduits and conductors from the point of electric utility connection to the service entrance equipment.
 - b. Metering conduits from the instrument transformers to the meter.
 - c. All work shown on the utility plans.
- B. General:
 - 1. Coordinate and obtain inspections and final installation approval from the serving utilities and other authorities having jurisdiction.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Sections 01 33 00 and 26 05 00.
- B. Certification:

1. Submit certification that the intended installation has been coordinated with the utility companies.
2. Include a narrative description of the utility's requirements and points of connection, names and telephone numbers for contacts at the utilities.

1.06 QUALITY ASSURANCE

- A. As specified in Section 26 05 00.
- B. Materials and equipment used in performance of Electrical Work shall be listed or labeled by UL, or other equivalent recognized independent testing laboratory, for the class of service intended.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 26 05 00.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING

- A. General:
 1. Before start of Site Work, make arrangements for electrical service as required.
- B. Electrical systems:
 1. Before bidding, the electrical contractor shall coordinate with the City for most up to date utilities plans from PG&E to determine the Work and materials that will be required from the Contractor, and all fees and permits that will be required, so that all utility systems furnished by the Contractor will be included in the bid.
 2. Before commencing Work, coordinate electric service entrance requirements with local electric utility to assure that the installation will be complete as specified in these Contract Documents:
 - a. Ensure power transformer size, electrical characteristics, and location are consistent with the design and service voltage provided by the electric utility coordinated with other trades.
 - b. Arrange for utility revenue meter.
 - c. Coordinate installation of metering CTs and PTs furnished by the electric utility.
 - d. Pay any charges required by the electric utility for connection and turn-on.
- C. Before commencing Site Work, coordinate underground conduit installations with other Work to eliminate conflicts and avoid interferences with other underground systems.

1.11 WARRANTY

- A. As specified in Section 26 05 00.

1.12 SYSTEM START-UP

- A. As specified in Section 26 05 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS (NOT USED)

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

- A. Furnish materials in accordance with the applicable requirements of the utilities and as specified in these Specifications.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

- A. Furnish equipment in accordance with the applicable requirements of the utilities and as specified in these Specifications.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 26 05 00.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

- A. As specified in Section 26 05 00.

3.08 FIELD QUALITY CONTROL

- A. As specified in Section 26 05 00.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

- A. As specified in Section 26 05 00.

3.11 PROTECTION

- A. As specified in Section 26 05 00.

3.12 SCHEDULES (NOT USED)

END OF SECTION 26 05 03

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SECTION 26 05 18
600-VOLT OR LESS WIRES AND CABLES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. 600 volt class or less wire and cable.
- B. Related sections:
 - 1. Section 26 05 00 - Common Work Results for Electrical.
 - 2. Section 26 05 26 - Grounding and Bonding.
 - 3. Section 26 05 53 - Identification for Electrical Systems.

1.02 REFERENCES

- A. As specified in Section 26 05 00.
- B. ASTM International (ASTM):
 - 1. B3 - Standard Specification for Soft or Annealed Copper Wire.
 - 2. B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- C. CSA International (CSA).
- D. Insulated Cable Engineers Association (ICEA):
 - 1. NEMA WC 70/ICEA S-95-658-1999 - Standard for Nonshielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
 - 2. NEMA WC 57/ICEA S-73-532 - Standard for Control, Thermocouple Extension, and Instrumentation Cables.
- E. National Fire Protection Association (NFPA):
 - 1. 70 - National Electrical Code (NEC).
 - 2. 72 - National Fire Alarm and Signaling Code.
 - 3. 101 - Life Safety Code.
- F. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
 - 1. 568-C.2 - Balanced Twisted-Pair Telecommunication Cabling and Components Standard.
- G. Underwriter's Laboratories Inc., (UL):
 - 1. 44 - Thermoset-Insulated Wires and Cables.
 - 2. 1277 - Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
 - 3. 1424 - Standard for Cables for Power-Limited Fire-Alarm Circuits.
 - 4. 1569 - Standard for Metal-Clad Cables.
 - 5. 2196 - Standard for Tests for Fire Resistive Cables.
 - 6. 2225 - Standard for Cables and Cable-Fittings For Use in Hazardous (Classified) Locations.

1.03 DEFINITIONS

- A. As specified in Section 26 05 00.
- B. Definitions of terms and other electrical considerations as set forth in the:
 - 1. ASTM.
 - 2. ICEA.

1.04 SYSTEM DESCRIPTION

- A. Furnish and install the complete wire and cable system.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Sections 01 33 00 and 26 05 00.

- B. Product data:
 - 1. Manufacturer of wire and cable.
 - 2. Insulation:
 - a. Type.
 - b. Voltage class.
 - 3. American wire gauge (AWG) size.
 - 4. Conductor material.
 - 5. Pulling compounds.
- C. Shop drawings:
 - 1. Show splice locations.
 - a. For each proposed splice location provide written justification describing why the splice is necessary.
- D. Test reports:
 - 1. Submit test reports for meg-ohm tests.
- E. Calculations:
 - 1. Submit cable pulling calculations to the Engineer for review and comment for all cables that will be installed using mechanical pulling equipment. Show that the maximum cable tension and sidewall pressure will not exceed manufacturer recommended values:
 - a. Provide a table showing the manufacturer's recommended maximum cable tension and sidewall pressure for each cable type and size included in the calculations.
 - b. Submit the calculations to the Engineer a minimum of 2 weeks before conduit installation.

1.06 QUALITY ASSURANCE

- A. As specified in Section 26 05 00.
- B. All wires and cables shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 26 05 00.

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 26 05 00.

1.12 SYSTEM START-UP

- A. As specified in Section 26 05 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
 - 1. 600 volt class wire and cable:
 - a. General Cable.
 - b. Okonite Company.
 - c. Southwire Company.
 - 2. 600 volt VFD cable:
 - a. General Cable.
 - b. Southwire Company.
 - 3. Instrumentation class wire and cable:

- a. Alpha Wire Company.
- b. Belden CDT.
- c. General Cable BICC Brand.
- d. Okonite Company.
- e. Rockbestos Surprenant Cable Corporation.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

- A. Conductors:
 - 1. Copper in accordance with ASTM B3.

2.04 MANUFACTURED UNITS

- A. General:
 - 1. Provide new wires and cables manufactured within 1 year of the date of delivery to the Site.
 - 2. Permanently mark each wire and cable with the following at 24-inch intervals:
 - a. AWG size.
 - b. Voltage rating.
 - c. Insulation type.
 - d. UL symbol.
 - e. Month and year of manufacture.
 - f. Manufacturer's name.
 - 3. Identify and mark wire and cable as specified in Section 26 05 53:
 - a. Use integral color insulation for Number 2 AWG and smaller wire.
 - b. Wrap colored tape around cable larger than Number 2 AWG.
- B. 600 volt class wire and cable:
 - 1. Provide AWG or kcmil sizes as indicated on the Drawings or in the Conduit Schedules:
 - a. When not indicated on the Drawings, size wire as follows:
 - 1) In accordance with the NEC:
 - (a) Use 75 degree Celsius ampacity ratings.
 - (b) Ampacity rating after all derating factors, equal to or greater than rating of the overcurrent device.
 - 2) Provide Number 12 AWG minimum for power conductors.
 - 3) Provide Number 14 AWG minimum for control conductors.
 - 2. Provide Class B stranding in accordance with ASTM B8:
 - a. Provide Class C stranding where extra flexibility is required.
 - 3. Insulation:
 - a. XHHW/XHHW-2
 - b. 90 degrees Celsius rating.
- C. Instrumentation class cable:
 - 1. Type TC.
 - 2. Suitable for use in wet locations.
 - 3. Voltage rating: 600 volts.
 - 4. Temperature rating:
 - a. 90 degrees Celsius rating in dry locations.
 - b. 75 degrees Celsius rating in wet locations.
 - 5. Conductors:
 - a. Insulation:
 - 1) Flame-retardant PVC, 15 mils nominal thickness, with nylon jacket 4 mils nominal thickness.
 - b. Number 16 AWG stranded and tinned.
 - c. Color code:

- 1) Pair: Black and white.
- 2) Triad: Black, white and red.
- 3) Multiple pairs or triads:
 - (a) Color-coded and numbered.
6. Drain wire:
 - a. 18 AWG.
 - b. Stranded, tinned.
7. Jacket:
 - a. Flame retardant, moisture and sunlight resistant PVC.
 - b. Ripcord laid longitudinally under jacket to facilitate removal.
8. Shielding:
 - a. Individual pair/triad:
 - 1) Minimum 1.35-mil double-faced aluminum foil/polyester tape overlapped to provide 100 percent coverage.
 - b. Multiple pair or triad shielding:
 - 1) Group shield: Minimum 1.35-mil double-faced aluminum foil/polyester tape overlapped to provide 100 percent coverage.
 - 2) Completely isolate group shields from each other.
 - 3) Cable shield: 2.35 mils double-faced aluminum and synthetic polymer backed tape overlapped to provide 100 percent coverage.
 - c. All shielding to be in contact with the drain wire.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

- A. Wire ties:
 1. One of the following or equal:
 - a. T&B "Ty-Rap" cable ties.
 - b. Panduit cable ties.
- B. Wire markers:
 1. As specified in Section 26 05 53.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. Assembly and testing of cable shall comply with the applicable requirements of ICEA S-95-658-1999.
- B. Test Type THHN/THWN-2 in accordance with the requirements of UL 44.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 26 05 00.
- B. Color-coding:
 1. Color-coding shall be consistent throughout the facility.
 2. The following color code shall be followed for all 240/120 volt and 208/120 volt systems:
 - a. Phase A - Black.
 - b. Phase B - Red.
 - c. Phase C - Blue.

- d. Single phase system - Black for one hot leg, red for the other.
- e. Neutral - White.
- f. High phase or wild leg - Orange.
- g. Equipment ground - Green.
- 3. The following color code shall be followed for all 480/277 volt systems:
 - a. Phase A - Brown.
 - b. Phase B - Orange.
 - c. Phase C - Yellow.
 - d. Neutral - Gray.
 - e. Equipment ground - Green.
- 4. The following color code shall be followed for all 120 VAC control wiring:
 - a. Power - Red.
 - b. Neutral - White.
- 5. The following color code shall be followed for all general purpose DC control circuits:
 - a. Grounded conductors - White with blue stripe.
 - b. Ungrounded conductors - Blue.
- 6. Switch legs shall be violet. Three-way switch runners shall be pink.
- 7. Wires in intrinsically safe circuits shall be light blue.
- 8. Wire colors shall be implemented in the following methods:
 - a. Wires manufactured of the desired color.
 - b. Continuously spiral wrap the first 6 inches of the wire from the termination point with colored tape:
 - 1) Colored tape shall be wrapped to overlap 1/2 of the width of the tape.
- C. Install conductors only after the conduit installation is complete, and all enclosures have been vacuumed clean, and the affected conduits have been swabbed clean and dry:
 - 1. Install wires only in approved raceways.
 - 2. Do not install wire:
 - a. In incomplete conduit runs.
 - b. Until after the concrete work and plastering is completed.
- D. Properly coat wires and cables with pulling compound before pulling into conduits:
 - 1. For all Number 4 AWG and larger, use an approved wire-pulling lubricant while cable is being installed in conduit:
 - a. Ideal Products.
 - b. Polywater Products.
 - c. 3M Products.
 - d. Greenlee Products.
 - e. Or equal as recommended by cable manufacturer.
 - f. Do not use oil, grease, or similar substances.
- E. Cable pulling:
 - 1. Prevent mechanical damage to conductors during installation.
 - 2. For cables Number 1 AWG and smaller, install cables by hand.
 - 3. For cables larger than Number 1 AWG, power pulling winches may be used if they have cable tension monitoring equipment.
 - 4. Provide documentation that maximum cable pulling tension was no more than 75 percent of the maximum recommended level as published by the cable manufacturer. If exceeded, the Engineer may, at his discretion, require replacement of the cable.
 - 5. Ensure cable pulling crews have all calculations and cable pulling limitations while pulling cable.
 - 6. Add a junction box or pullbox where required to prevent cable pulling tension or sidewall pressure from exceeding 75 percent of manufacturer's recommendation for the specified cable size:
 - a. Leave sufficient slack to make proper connections.

- F. Use smooth-rolling sheaves and rollers when pulling cable into cable tray to keep pulling tension and bending radius within manufacturer's recommendations.
- G. Install and terminate all wire in accordance with manufacturer's recommendations.
- H. Neatly arrange and lace conductors in all switchboards, panelboards, pull boxes, and terminal cabinets by means of wire ties:
 - 1. Do not lace wires in gutter or panel channel.
 - 2. Install all wire ties with a flush cutting wire tie installation tool:
 - a. Use a tool with an adjustable tension setting.
 - 3. Do not leave sharp edges on wire ties.
- I. Terminate stranded conductors on equipment box lugs such that all conductor strands are confined within the lug:
 - 1. Use ring type lugs if box lugs are not available on the equipment.
- J. Lighting circuits:
 - 1. Each circuit shall have a dedicated neutral.
- K. Apply wire markers to all wires at each end after being installed in the conduit and before meg-ohm testing and termination.
- L. Instrumentation class cable:
 - 1. Install instrumentation class cables in separate raceway systems from power cables:
 - a. Install instrument cable in metallic conduit within non-dedicated manholes or pull boxes.
 - b. Install cable without splices between instruments or between field devices and instrument enclosures or panels.
 - 2. Do not make intermediate terminations, except in designated terminal boxes as indicated on the Drawings.
 - 3. Shield grounding requirements as specified in Section 26 05 26.
- M. Signal cable:
 - 1. Separate and isolate electrical signal cables from sources of electrical noise and power cables by minimum 12 inches.
- N. Wiring allowances:
 - 1. Equipment locations may vary slightly from the drawings. Include an allowance for necessary conductors and terminations for motorized equipment, electrical outlets, fixtures, communication outlets, instruments, and devices within 10 linear feet of locations indicated on the Drawings.
 - 2. Locations for pull boxes, manholes, and duct banks may vary slightly from the drawings. Include an allowance for necessary conductors and related materials to provide conductors to all pull boxes, manholes and duct banks within 20 linear feet of locations indicated on the Drawings.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 TESTING

- A. As specified in Section 26 08 50.

3.08 FIELD QUALITY CONTROL

- A. As specified in Section 26 05 00.
- B. Grounding:
 - 1. As specified in Section 26 05 26.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26 05 00.

3.12 SCHEDULES (NOT USED)

END OF SECTION 26 05 18

SECTION 26 05 21
LOW VOLTAGE WIRE CONNECTIONS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Wire connecting devices.
 - 2. Terminations.
 - 3. Splices.
- B. Related sections:
 - 1. Section 26 05 00 - Common Work Results for Electrical.
 - 2. Section 26 05 18 - 600-Volt or Less Wires and Cables.
 - 3. Section 26 08 50 – Field Electrical Acceptance Tests.

1.02 REFERENCES

- A. As specified in Section 26 05 00.
- B. ASTM International (ASTM):
 - 1. D3005 – Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.
- C. CSA International (CSA):
 - 1. C22.2 - No.197-M1983 (R2208) - PVC Insulating Tape.
- D. Underwriters Laboratories, Inc. (UL):
 - 1. 510 - Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.

1.03 DEFINITIONS

- A. As specified in Section 26 05 00.

1.04 SYSTEM DESCRIPTION

- A. Provide a complete system of wiring connectors, terminators, fittings, etc. for a complete wiring system suitable for the cables and conductors used.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Sections 01 33 00 and 26 05 00.
- B. Product data:
 - 1. Catalog cut sheets.
 - 2. Installation instructions.

1.06 QUALITY ASSURANCE

- A. As specified in Section 26 05 00.
- B. All materials shall be UL listed.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 26 05 00.

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 26 05 00.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 26 05 00.

1.12 SYSTEM START-UP

- A. As specified in Section 26 05 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers for each type of technology are specified with the equipment in this Section.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

- A. Control connections:

1. Use insulated ring type wire terminators for connections to all screw terminals:
 - a. With chamfered/funneled terminal barrel entry.
 - b. Deep internal serrations.
 - c. Long barrel design to reduce electrical resistance and increased insulator-barrel surface area to ensure that the insulator remains in contact with the barrel.
 - d. Electroplated-tin copper conductor.
 - e. Manufacturer: The following or equal:
 - 1) Thomas and Betts, Stakon.
2. For process equipment connections work from manufacturer's drawings.

- B. Joints, taps, and connections:

1. 600-volt conductors:
 - a. Use solderless connectors.
 - b. Use only plated copper alloy connectors or lugs:
 - 1) Aluminum connectors or lugs are not acceptable for copper conductors.
 - c. For wire Number 10 AWG and smaller use compression splice caps, with insulating caps:
 - 1) Manufacturer: The following or equal:
 - (a) Buchanan 2006S or 2011S, with 2007 or 2014 insulating caps.
 - d. For wire Number 8 AWG and larger, use heavy duty copper compression connectors:
 - 1) Manufacturer: One of the following or equal:
 - (a) Burndy.
 - (b) Thomas and Betts.
 - e. Heat shrink tubing:
 - 1) Suitable for indoors, outdoors, overhead, direct burial or submerged applications.
 - 2) Minimum shrink ratio: 4 to 1.
 - 3) Continuous operating temperature: -55 degrees Celsius to 110 degrees Celsius.
 - 4) Internally applied adhesive sealant.
 - 5) Cross-linked polyolefin:
 - (a) Manufacturers, one of the following or equal:
 - (1) 3M ITCSN.
 - (2) Thomas & Betts Shrink-Kon.

- C. Insulating tape:

1. General purpose insulating tape:
 - a. Minimum 7 mil vinyl tape.
 - b. Suitable for application in an ambient of -18 degrees Celsius (0 degrees Fahrenheit).
 - c. Operating range up to 105 degrees Celsius (220 degrees Fahrenheit).
 - d. Flame retardant, hot- and cold- weather resistant, UV resistant.
 - e. For use as a primary insulation for wire cable splices up to 600 VAC.

- f. Meeting and complying with:
 - 1) ASTM D3005 Type I
 - 2) UL 510.
 - 3) CSA C22.2.
 - g. Manufacturer: The following or equal:
 - 1) 3M - Scotch Number Super 33+.
- 2. General-purpose color-coding tape:
 - a. Minimum 7 mil vinyl tape.
 - b. Suitable for application on PVC and polyethylene jacketed cables.
 - c. For use indoors and outdoors in weather protected enclosures.
 - d. Available with the following colors:
 - 1) Red.
 - 2) Yellow.
 - 3) Blue.
 - 4) Brown.
 - 5) Gray.
 - 6) White.
 - 7) Green.
 - 8) Orange.
 - 9) Violet.
 - e. For use as phase identification, marking, insulating, and harnessing.
 - f. Meeting and complying with:
 - 1) UL 510.
 - 2) CSA C22.2.
 - g. Manufacturer the following or equal:
 - 1) 3M - Scotch Number 35.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 26 05 00.
- B. Load connections:
 - 1. Connect loads to the circuits as indicated. Color-code all branch circuits as specified in Section 26 05 18.
- C. Zero to 600-volt systems:
 - 1. Make all connections with the proper tool and die as specified by the device manufacturer.
 - 2. Use only tooling and dies manufactured by the device manufacturer.
 - 3. Insulate all connections and splices with Scotch 33+ tape and Scotchfill, or pre-molded plastic covers, or heat shrink tubing and caps.
 - 4. Number all power and control wires before termination.
- D. Motor connections (600 volts and below):
 - 1. Terminate wires with compression type ring lugs at motors.

2. Connection at both the motor leads and the machine wires shall have ring type compression lugs.
3. Cover bolted connectors with a heat shrinkable, cross-linked polyolefin material formed as a single opening boot:
 - a. In damp and wet locations, use a complete kit containing mastic that shall seal out moisture and contamination.
 - b. Shrink cap with low heat as recommended by manufacturer.
4. Wire markers shall be readable after boot installation.
5. Manufacturer: The following or equal:
 - a. Raychem MCK.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

- A. As specified in Section 01 75 17.

3.08 FIELD QUALITY CONTROL

- A. As specified in Section 26 05 00.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

- A. As specified in Section 26 05 00.

3.12 SCHEDULES (NOT USED)

END OF SECTION 26 05 21

**SECTION 26 05 26
GROUNDING AND BONDING**

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Grounding materials and requirements.
- B. Related sections:
 - 1. Section 26 05 00 - Common Work Results for Electrical.
 - 2. Section 26 08 50 - Field Electrical Acceptance Tests.

1.02 REFERENCES

- A. As specified in Section 26 05 00.
- B. ASTM International (ASTM):
 - 1. B3 - Standard Specification for Soft or Annealed Copper Wire.
 - 2. B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- C. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
- D. Underwriters Laboratories, Inc. (UL):
 - 1. 467 - Ground and Bonding Equipment.

1.03 DEFINITIONS

- A. As specified in Section 26 05 00.

1.04 SYSTEM DESCRIPTION

- A. Ground equipment and raceway systems so that the completed installation conforms to all applicable code requirements.
- B. Provide a complete electrical grounding system as indicated on the Drawings and as specified including but not limited to:
 - 1. Grounding electrodes.
 - 2. Bonding jumpers.
 - 3. Ground connections.
- C. Provide bonding jumpers and wire, grounding bushings, clamps and appurtenances required for complete grounding system to bond equipment and raceways to equipment grounding conductors.
- D. The ground system resistance (electrode to ground) of the completed installation, as determined by tests specified in Section 26 08 50, shall be:
 - 1. 5 ohms or less for industrial systems.
 - 2. 1 ohm or less for electrical buildings.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Sections 26 05 00.
- B. Product data:
 - 1. Catalog cut sheets.

1.06 QUALITY ASSURANCE

- A. As specified in Section 26 05 00.
- B. All grounding components and materials shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26 05 00.

1.08 PROJECT/SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26 05 00.

1.12 SYSTEM START-UP

A. As specified in Section 26 05 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Compression connectors: One of the following or equal:

1. FCI Burndy.
2. Thomas & Betts.

B. Ground rods: One of the following or equal:

1. Erico.
2. Harger.
3. Nehring

C. Ground cable: One of the following or equal:

1. Nehring.
2. Harger.
3. Southwire.

D. Precast ground well boxes: One of the following or equal:

1. Brooks Products.
2. Christy Concrete Products.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Ground rod:

1. Minimum: 3/4-inch diameter, 10 feet long.
2. Uniform 10 mil covering of electrolytic copper metallicity bonded to a rigid steel core:
 - a. The copper-to-steel bond shall be corrosion resistant.
3. In accordance with UL 467.
4. Sectional type joined by threaded copper alloy couplings.
5. Fit the top of the rod with a threaded coupling and steel-driving stud.

B. Ground cable:

1. Requirements:
 - a. Soft drawn (annealed).
 - b. Concentric lay, coarse stranded in accordance with ASTM B8.
 - c. Bare copper in accordance with ASTM B3.
2. Size is as indicated on the Drawings, but not less than required by the NEC.

C. Compression connectors:

1. Manufactured of high copper alloy specifically for the particular grounding application.
2. Suitable for direct burial in earth and concrete.
3. Identifying compression die number inscription to be impressed on compression fitting.

D. Equipment grounding conductors:

1. Conductors shall be the same type and insulation as the load circuit conductors:
 - a. Use 600-volt insulation for the equipment grounding conductors for medium voltage systems.
2. Minimum size in accordance with the NEC.
- E. Grounding electrode conductors:
 1. Minimum size in accordance with the NEC.
- F. Main bonding jumpers and bonding jumpers:
 1. Minimum size in accordance with the NEC.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

- A. Precast ground well boxes:
 1. Minimum 10 inch interior diameter.
 2. Traffic-rated cast iron cover.
 3. Permanent "GROUND" marking on cover.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 26 05 00.
- B. Provide a separate, green insulated, grounding conductor in each raceway independent of raceway material.
 1. Provide a separate grounding conductor in each individual raceway for parallel feeders.
- C. Provide a separate grounding conductor for each motor and connect at motor terminal box. Do not use bolts securing motor box to frame or cover for grounding connectors:
 1. When grounding motors driven by variable frequency drives (VFD) comply with the requirements of the VFD manufacturer.
- D. Provide a grounding type bushing with lug for connection of grounding conductor for conduits that originate from each motor control center section, switchboard, or panelboard:
 1. Individually bond these raceways to the ground bus in the equipment.
- E. Provide grounding type bushings with lugs for connection of grounding conductor at both ends of metallic conduit runs. Bond ground bushings to the grounding system.
- F. Provide a green insulated wire-grounding jumper from the ground screw to a box grounding screw and, for grounding type devices, to equipment grounding conductor.
- G. Interconnect the secondary switchgear, switchboard, or panelboard neutral bus to the ground bus in the secondary switchgear, switchboard, or panelboard compartment, only at service entrance point or after a transformer.
- H. Duct bank ground system:
 1. Provide a bare copper grounding conductor the entire length of each duct bank, embedded in the concrete of the duct bank as indicated on the Drawings and specified in the Specifications.

2. Bond duct bank ground conductors together where duct banks join, merge, intersect, or split.
- I. Grounding at service (600 V or Less):
1. Connect the neutral to ground only at one point within the enclosure of the first disconnecting means on the load side of the service transformer.
- J. Ground connections:
1. All connections to the ground grid system, the duct bank grounding system, equipment, ground rods, etc., shall be made using compression type grounding connectors as indicated on the Drawings, UL listed, and labeled for the application.
 2. Make ground connections in accordance with the manufacturer's instructions.
 3. Do not conceal or cover any ground connections until the Engineer or authorized representative has established and provided written confirmation that every grounding connection is as indicated on the Drawings and specified in the Specifications.
- K. Grounding electrode system:
1. Ground ring:
 - a. Provide all trenching and materials necessary to install the ground ring as indicated on the Drawings.
 - b. Ground ring conductor shall be in direct contact with the earth, or where embedded, concrete, of the size as indicated on the Drawings.
 - c. Minimum burial depth 36 inches or as indicated on the Drawings.
 - d. Re-compact disturbed soils to original density in 6-inch lifts.
 2. Ground rods:
 - a. Locations as indicated on the Drawings.
 - b. Length of rods forming an individual ground array shall be equal in length.
 - c. Drive ground rods and install grounding conductors before construction of concrete slabs and duct banks.
 - d. Pre-crimp all ground rods, as recommended by the manufacturer, before crimping connector to ground rod.
 3. Metal underground water pipe:
 - a. Bond metal underground domestic water pipe to grounding electrode system.
 4. Metal frame of building or structure:
 - a. Bond metal frame of building or structure to grounding electrode system.
 5. Extend grounding conductors through concrete to accessible points for grounding equipment and electrical enclosures.
 6. Where grounding conductors are not concrete-encased or direct buried, install in Schedule 40 PVC conduit for protection.
 7. Install grounding system at each structure where switchgear, motor control centers, switchboards, panelboards, panels, or other electrical equipment are installed.
- L. Shield grounding:
1. Shielded instrumentation cable shall have its shield grounded at one end only unless shop drawings indicate otherwise:
 - a. The grounding point shall be at the control panel or at the power source end of the signal carried by the cable.
 2. Terminate the shield drain wire on a dedicated terminal block.
 3. Use manufacturer's terminal block jumpers to interconnect ground terminals.
 4. Connection to the panel main ground bus shall be via a green No. 12 conductor to the main ground bus for the panel.
- M. Antenna ground:
1. Install individual ground rod or ground system for communication system antenna:
 - a. Install a dedicated grounding electrode conductor from the antenna ground to the grounding electrode system.
 - b. Do not connect any other grounds to the antenna grounding electrode conductor.

2. Install ground rod or ground system in accordance with the radio manufacturer's requirements.
- N. Where indicated on the Drawings, install ground rods in precast ground wells.
- O. Ground all gates, fences, and handrails, even if not shown on Drawings. Grounding conductor from ground grid to gates, fences and handrails shall be #2 AWG minimum.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 TESTING

- A. As specified in Section 26 08 50.

3.08 FIELD QUALITY CONTROL

- A. As specified in Section 26 05 00.
- B. Measure grounding electrode system resistance to ground in accordance with IEEE 81.

3.09 ADJUSTING

- A. Under the direction of the Engineer, add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurement meets the specified resistance requirements:
 1. Use of salts, water, or compounds to attain the specified ground resistance is not acceptable.

3.10 CLEANING (NOT USED)

3.11 PROTECTION

- A. As specified in Section 26 05 00.

3.12 SCHEDULES (NOT USED)

END OF SECTION 26 05 26

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**SECTION 26 05 29
HANGERS AND SUPPORTS**

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Mounting and supporting electrical equipment and components.
- B. Related sections:
 - 1. Section 26 05 00 - Common Work Results for Electrical.

1.02 REFERENCES

- A. As specified in Section 26 05 00.
- B. ASTM International (ASTM):
 - 1. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 2. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 3. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

1.03 DEFINITIONS

- A. As specified in Section 26 05 00.

1.04 SYSTEM DESCRIPTION

- A. Design requirements:
 - 1. Conform to the requirements of the Building Code.
 - 2. Demonstrate the following using generally accepted engineering methods:
 - a. That the anchors to the structure are adequate to resist the loads generated in accordance with the Building Code and equipment requirements.
 - b. That the required load capacity of the anchors can be fully developed in the structural materials to which they are attached.
 - 3. Design loading and anchoring requirements:
 - a. As indicated in the Building Code unless otherwise specified.
 - b. Seismic loading requirements:
 - 1) Freestanding, suspended, or wall-hung equipment shall be anchored in place by methods that will satisfy the requirements for the seismic design specified in Section 26 05 00.
 - c. Wind loading requirements:
 - 1) All exterior equipment shall be anchored in place by methods that will satisfy the requirements for wind design specified in Section 26 05 00.
 - d. Minimum safety factor against overturning: 1.5.
 - e. The foundation and structures to which hangers and supports are attached shall be capable of withstanding all anchor loads.
- B. Performance requirements:
 - 1. Hangers and supports individually and as a system shall resist all weights and code-required forces without deflections and deformations that would damage the supporting elements, the equipment supported, or the surrounding construction.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 26 05 00.
- B. Product data:
 - 1. Supports:
 - a. Materials.
 - b. Geometry.

- c. Manufacturer.
- 2. Hardware:
 - a. Materials.
 - b. Manufacturer.
- C. Shop drawings:
 - 1. Complete dimensioned and scalable shop drawings of all supporting structures, trapezes, wall supports, etc.
 - 2. Complete anchoring details for equipment, lighting and raceway, supporting structures, trapezes, wall supports for all equipment in excess of 200 pounds, and all freestanding supports:
 - a. Stamped by a professional engineer licensed in the state where the Project is being constructed.
 - b. Said submittals, by virtue of the fact that they bear the stamp of a registered engineer, will be reviewed for general consistency with the requirements specified in the Contract Documents, but not for context, accuracy, or method of calculation.
 - 3. Include data on attachment hardware and construction methods that will satisfy the design loading and anchoring criteria.
- D. Installation instructions:
 - 1. Furnish anchorage instructions and requirements based on the seismic and wind conditions of the Site:
 - a. Stamped by a professional engineer licensed in the state where the Project is being constructed.

1.06 QUALITY ASSURANCE

- A. As specified in Section 26 05 00.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 26 05 00.

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 26 05 00.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 26 05 00.

1.12 SYSTEM STARTUP

- A. As specified in Section 26 05 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
 - 1. Thomas & Betts.
 - 2. Power-Strut.
 - 3. Unistrut.
 - 4. Cooper B-Line.
 - 5. Robroy.
 - 6. Aickinstrut.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

- A. Use materials appropriate for the area as specified in Section 26 05 00.
- B. Hot dip galvanized steel:
 - 1. Supports:
 - a. In accordance with ASTM A123 or A153.
 - b. Minimum zinc coating thickness of 2.5 mils.
 - 2. Hardware:
 - a. Electro-galvanized.
 - b. In accordance with ASTM A153.
- C. Stainless steel:
 - 1. Supports:
 - a. In accordance with ASTM A240.
 - b. ANSI Type 316 material.
 - 2. Hardware:
 - a. ANSI Type 316 material.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

- A. Anchor bolts:
 - 1. Indoor, Dry Locations: Anchor bolts shall be ASTM A307 galvanized steel.
 - 2. Outdoor, Wet or Corrosive Areas: Anchor bolts shall be Type 316 ASTM A276 stainless steel.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

- A. Paint and finish all supporting structures per Owner's requirements.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 26 05 00.
- B. Mount all raceways, cabinets, boxes, fixtures, instruments, and devices on Contractor-fabricated racks unless otherwise indicated on the Drawings.
 - 1. Provide the necessary sway bracing to keep trapeze type structures from swaying under seismic events or wind loading.
- C. Brace and anchor freestanding equipment supports using methods that provide structural support based on the seismic loads and wind loads:
 - 1. Lateral deflection at top of supports not to exceed support height divided by 240 unless otherwise approved by the Engineer.
- D. Provide fabricated steel support pedestals for wall mounted panels that weigh more than 200 pounds:
 - 1. Fabricate pedestals out of welded angle, tube sections, or preformed channel.
 - 2. If the supported equipment is a panel or cabinet, match the supported equipment in physical appearance and dimensions.
 - 3. Provide auxiliary floor supports for transformers hung from stud walls and weighing more than 200 pounds.

4. Mount all equipment, cabinets, boxes, instruments, and devices in damp or wet locations on minimum of 7/8-inch preformed mounting channel.
 - a. Mount channel vertically along the length of the device so that water or moisture may run freely behind the device.
- E. Corrosion protection:
 1. Isolate dissimilar metals, except where required for electrical continuity.
 - a. Use neoprene washers, 9-mil polyethylene tape, or gaskets for isolation.
- F. Raceway:
 1. Furnish all racks and trapeze structures needed to support the raceway from the structure.
 - a. Group raceway and position on racks to minimize crossovers.
 - b. Provide the necessary bracing to keep trapeze type structures from swaying under loads from cable installation, seismic forces, or wind forces.
- G. Anchoring methods:
 1. Solid concrete: Anchor bolts, anchor rods, or post-installed anchors as specified herein.
 2. Metal surfaces: Machine screws or bolts.
 3. Hollow masonry units: Post-installed anchors as specified on drawings.
- H. Recoat or seal all drilled holes, cut or scratched surfaces or with products recommended by the manufacturer.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. As specified in Section 26 05 00.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 PROTECTION

- A. As specified in Section 26 05 00.

3.11 SCHEDULES (NOT USED)

END OF SECTION 26 05 29

SECTION 26 05 33 CONDUITS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Metallic conduits.
 - 2. Nonmetallic conduits.
 - 3. Conduit bodies.
 - 4. Conduit fittings and accessories.
 - 5. Conduit installation.
- B. Related sections:
 - 1. Section 26 05 00 - Common Work Results for Electrical.
 - 2. Section 26 05 29 - Hangers and Supports.
 - 3. Section 26 05 53 - Identification for Electrical Systems.

1.02 REFERENCES

- A. As specified in Section 26 05 00.
- B. American National Standards Institute (ANSI):
 - 1. C80.1 - Electrical Rigid Steel Conduit.
 - 2. C80.3 - Steel Electrical Metallic Tubing.
 - 3. C80.5 - Electrical Rigid Aluminum Conduit.
 - 4. C80.6 - Electrical Intermediate Metal Conduit.
- C. National Electrical Manufacturer's Association (NEMA):
 - 1. RN-1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Steel Conduit.
 - 2. TC2 - Electrical Polyvinyl Chloride (PVC) Conduit.
 - 3. TC3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
 - 4. TC7 - Smooth-Wall Coilable Electrical Polyethylene Conduit.
 - 5. TC13 - Electrical Nonmetallic Tubing.
 - 6. TC14 - Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
- D. Underwriters Laboratories (UL):
 - 1. 1 - Standard for Flexible Metal Conduit.
 - 2. 6 - Standard for Electrical Rigid Metal Conduit - Steel.
 - 3. 6A - Standard for Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel.
 - 4. 360 - Standard for Liquidtight Flexible Steel Conduit.
 - 5. 651 - Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
 - 6. 651B - Standard for Continuous Length HDPE Conduit.
 - 7. 797 - Standard for Electrical Metallic Tubing - Steel.
 - 8. 1242 - Standard for Electrical Intermediate Metal Conduit - Steel.
 - 9. 1653 - Standard for Electrical Nonmetallic Tubing.
 - 10. 1660 - Standard for Liquidtight Flexible Nonmetallic Conduit.
 - 11. 1684 - Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

1.03 DEFINITIONS

- A. As specified in Section 26 05 00.
- B. Specific definitions and abbreviations:
 - 1. Conduit bodies: A separate portion of a conduit system that provides access through a removable cover to the interior of the system at a junction of 2 or more conduit sections. Includes, but not limited to, Shapes C, E, LB, T, X, etc.

2. Conduit fitting: An accessory that primarily serves a mechanical purpose. Includes, but not limited to, bushings, locknuts, hubs, couplings, reducers, etc.
3. GRC: Galvanized rigid steel conduit.
4. PCS: Polyvinyl chloride (PVC) coated rigid steel conduit.
5. PVC: Polyvinyl chloride rigid nonmetallic conduit.
6. SLT: Sealtight-liquidtight flexible conduit.
7. NPT: National pipe thread.

1.04 SYSTEM DESCRIPTION

- A. Provide conduits, conduit bodies, fittings, junction boxes, and all necessary components, whether or not indicated on the Drawings, as required, to install a complete electrical raceway system.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 26 05 00.
- B. Product data:
 1. Furnish complete manufacturer's catalog sheets for every type and size of conduit, fitting, conduit body, and accessories to be used on the Project.
 2. Furnish complete manufacturer's recommended special tools to be used for installation if required.
 3. Certified test results for PVC-coated metallic conduit showing the adhesive bond is stronger than the tensile strength of the PVC.
- C. Certifications:
 1. Furnish PVC-coated conduit manufacturer's certification for each installer.
- D. Record Documents:
 1. Incorporate all changes in conduit routing on electrical plan drawings.
 2. Dimension underground and concealed conduits from building lines.

1.06 QUALITY ASSURANCE

- A. As specified in Section 26 05 00.
- B. All conduits, conduit bodies, and fittings shall be UL listed and labeled.
- C. Every installer of PVC-coated metallic conduit shall be certified by the manufacturer for installation of the conduit.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 26 05 00.
- B. Do not expose nonmetallic to direct sunlight.
- C. Do not store conduit in direct contact with the ground.

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 26 05 00.

1.09 SEQUENCING

- A. Before installing any conduit or locating any device box:
 1. Examine the complete set of Drawings and Specifications, and all applicable shop drawings.
 2. Verify all dimensions and space requirements and make any minor adjustments to the conduit system as required to avoid conflicts with the building structure, other equipment, or the work of other trades.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 26 05 00.

1.12 SYSTEM START-UP

- A. As specified in Section 26 05 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Galvanized rigid steel conduit:
 - 1. One of the following or equal:
 - a. Western Tube and Conduit.
 - b. Allied Tube and Conduit.
 - c. Wheatland Tube Co.
- B. PVC-coated rigid steel conduit:
 - 1. One of the following or equal:
 - a. Robroy Industries.
 - b. Ocal, Inc.
 - c. Calbond.
- C. Sealtight-liquidtight flexible conduit:
 - 1. One of the following or equal:
 - a. Southwire.
 - b. AFC Cable Systems.
 - c. Electri-Flex Company.
 - d. Anaconda.
- D. Conduit bodies:
 - 1. One of the following or equal:
 - a. Crouse-Hinds.
 - b. Appleton.
 - c. O-Z/Gedney.
 - d. Ocal, Inc..
 - e. Robroy Industries.
 - f. Calbond.
 - g. Carlon.
- E. Joint compound:
 - 1. Thomas and Betts.
- F. Galvanized rigid steel conduit expansion fittings:
 - 1. One of the following or equal:
 - a. Crouse-Hinds.
 - b. Appleton.
 - c. O-Z/Gedney.
- G. Conduit hangers and supports:
 - 1. As specified in Section 26 05 29.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

- A. GRC:
 - 1. All threads: NPT standard conduit threads with a 3/4-inch taper per foot:

- a. Running conduit threads are not acceptable.
- 2. Hot-dip galvanized inside and out:
 - a. Ensures complete coverage and heats the zinc and steel to a temperature that ensures the zinc alloys with the steel over the entire surface.
 - b. Electro-galvanizing is not acceptable.
- 3. Manufactured in accordance with:
 - a. UL-6.
 - b. ANSI C80.1.
- B. PCS:
 - 1. The steel conduit, before PVC coating, shall be new, unused, hot-dip galvanized material, conforming to the requirements for Type GRC.
 - 2. Coated conduit NEMA Standard RN-1:
 - a. The galvanized coating may not be disturbed or reduced in thickness during the cleaning and preparatory process.
 - 3. Factory-bonded PVC jacket:
 - a. The exterior galvanized surfaces shall be coated with primer before PVC coating to ensure a bond between the zinc substrate and the PVC coating.
 - b. Nominal thickness of the exterior PVC coating shall be 0.040 inch except where part configuration or application of the piece dictates otherwise.
 - c. PVC coating on conduits and associated fittings shall have no sags, blisters, lumps, or other surface defects and shall be free of holes and holidays.
 - d. The PVC adhesive bond on conduits and fittings shall be greater than the tensile strength of the PVC plastic coating:
 - 1) Confirm bond with certified test results.
 - 4. A urethane coating shall be uniformly and consistently applied to the interior of all conduits and fittings:
 - a. Nominal thickness of 0.002 inch.
 - b. Conduits having areas with thin or no coating are not acceptable.
 - c. All threads shall be coated with urethane.
 - 5. The PVC exterior and urethane interior coatings applied to the conduits shall afford sufficient flexibility to permit field bending without cracking or flaking at temperature above 30 degrees Fahrenheit (-1 degree Celsius).
 - 6. PCS conduit bodies and fittings:
 - a. Malleable iron.
 - b. The conduit body, before PVC coating, shall be new, unused material and shall conform to appropriate UL standards.
 - c. The PVC coating on the outside of conduit bodies shall be 0.040-inch thick and have a series of longitudinal ribs to protect the coating from tool damage during installation.
 - d. 0.002-inch interior urethane coating.
 - e. Utilize the PVC coating as an integral part of the gasket design.
 - f. Stainless steel cover screw heads shall be encapsulated with plastic to ensure corrosion protection.
 - g. A PVC sleeve extending 1 conduit diameter or 2 inches, whichever is less, shall be formed at each female conduit opening.
 - 1) The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used.
 - 2) The sleeve shall provide a vapor- and moisture-tight seal at every connection.
- C. SLT:
 - 1. Temperature rated for use in the ambient temperature at the installed location but not less than the following:
 - a. General purpose:
 - 1) Temperature range: -20 degrees Celsius to +80 degrees Celsius.
 - b. Oil-resistant:

- 1) Temperature range: -20 degrees Celsius to +60 degrees Celsius.
 2. Sunlight-resistant, weatherproof, and watertight.
 3. Manufactured from single strip steel, hot-dip galvanized on all 4 sides before conduit fabrication.
 4. Strip steel spiral wound resulting in an interior that is smooth and clean for easy wire pulling.
 5. Overall PVC jacket.
 6. With integral copper ground wire, built in the core, in conduit trade sizes 1/2 inch through 1-1/4 inch.
- D. PVC:
1. Extruded from virgin PVC compound:
 - a. Schedule 40 unless otherwise specified.
 - b. Schedule 80 extra-heavy wall where specified.
 2. Rated for 90 degrees Celsius conductors or cable.
 3. Rated for use in direct sunlight.
- E. Conduit bodies:
1. Material consistent with conduit type:
 - a. Malleable iron bodies and covers when used with Type GRC.
 - b. PVC-coated malleable iron bodies and covers when used with Type PCS.
 2. Conduit bodies to conform to Form 8, Mark 9, or Mogul design:
 - a. Mogul design conforming to NEC requirements for bending space for large conductors for conduit trade sizes of 1 inch and larger with conductors #4 AWG and larger, or where required for wire-bending space.
 3. Gasketed covers attached to bodies with stainless steel screws secured to threaded holes in conduit body.

2.07 ACCESSORIES

- A. Connectors and fittings:
1. Manufactured with compatible materials to the corresponding conduit.
- B. Insulated throat metallic bushings:
1. Construction:
 - a. Malleable iron or zinc-plated steel when used with steel conduit.
 - b. Positive metallic conduit end stop.
 - c. Integrally molded non-combustible phenolic-insulated surfaces rated at 150 degrees Celsius.
 - d. Use fully insulated bushings on nonmetallic conduit system made of high-impact 150 degrees Celsius rated non-combustible thermosetting phenolic.
- C. Insulated grounding bushings:
1. Construction:
 - a. Malleable iron or steel, zinc-plated, with a positive metallic end stop.
 - b. Integrally molded non-combustible phenolic-insulated surfaces rated at 150 degrees Celsius.
 - c. Tin-plated copper grounding saddle for use with copper or aluminum conductors.
- D. Electrical unions (Erickson Couplings):
1. Construction:
 - a. Malleable iron for use with steel conduit.
 - b. Concrete tight, 3-piece construction.
 - c. Rated for Class I Division 1 Group D in hazardous areas.
- E. SLT fittings:
1. Construction:
 - a. Malleable iron.
 - b. Furnished with locknut and sealing ring.

- c. Liquidtight, rain-tight, oil-tight.
- d. Insulated throat.
- e. Furnish as straight, 45-degree elbows, and 90-degree elbows.
- f. Designed to prevent sleeving:
 - 1) Verify complete bonding of the raceway jacket to the plastic gasket seal.
- g. Equipped with grounding device to provide ground continuity irrespective of raceway core construction. Grounding device, if inserted into raceway and directly in contact with conductors, shall have rolled-over edges for sizes under 5 inches.
- h. Where terminated into a threadless opening using a threaded hub fitting, a suitable moisture-resistant/oil-resistant synthetic rubber gasket shall be provided between the outside of the box or enclosure and the fitting shoulder. Gasket shall be adequately protected by and permanently bonded to a metallic retainer.
- 2. Corrosion-resistant and outdoor SLT fittings:
 - a. Construction:
 - 1) PVC-coated liquidtight fittings with a bonded 0.040-inch thick PVC coating on the metal connector to form a seal around the SLT conduit.
 - 2) Insulated throat and an integral sealing ring.
- F. Hubs for threaded attachment of steel conduit to sheet metal enclosures:
 - 1. Construction:
 - a. Insulated throat.
 - b. PVC-coated when used in corrosive areas.
 - c. Bonding locknut.
 - d. Recessed neoprene O-ring to ensure watertight and dust-tight connector.
 - e. One half (1/2)-inch through 1-1/4-inch steel zinc electroplated.
 - f. One and one half (1-1/2)-inch through 6-inch malleable iron zinc plated.
 - 2. Usage:
 - a. All conduits in damp, wet, outdoor, and corrosive areas shall use threaded hubs for connections to sheet metal enclosures.
- G. PVC fittings:
 - 1. Materials:
 - a. All devices shall be made of PVC, using the same materials as used for Type PVC conduit.
 - b. All metal hardware shall be stainless steel.
- H. Expansion/deflection couplings:
 - 1. Use to compensate for movement in any directions between 2 conduit ends where they connect.
 - 2. Shall allow movement of 3/4 inch from the normal in all directions.
 - 3. Shall allow angular movement for a deflection of 30 degrees from normal in any direction.
 - 4. Constructed to maintain electrical continuity of the conduit system.
 - 5. Materials:
 - 6. End couplings: Bronze or galvanized ductile iron.
 - a. Sleeve: Neoprene.
 - b. Bands: Stainless steel.
 - c. Bonding jumper: Tinned copper braid.
- I. Expansion couplings:
 - 1. Shall allow for expansion and contraction of conduit:
 - a. Permitting 8-inch movement, 4 inches in either direction.
 - 2. Constructed to maintain electrical continuity of the conduit system.
 - 3. Materials:
 - a. Head: Malleable or ductile iron.
 - b. Sleeve: Steel.
 - c. Insulating bushing: Phenolic.

- d. Finish: Hot-dip galvanized.
- J. Conduit markers:
 - 1. As specified in Section 26 05 53.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. As specified in Section 26 05 00.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 26 05 00.
- B. General:
 - 1. Conduit routing:
 - a. The electrical drawings are diagrammatic in nature:
 - 1) Install conduit runs as specified with schematic representation indicated on the Drawings and as specified.
 - 2) Modify conduit runs to suit field conditions, as accepted by the Engineer:
 - (a) Make changes in conduit locations that are consistent with the design intent but are dimensionally different, or routing to bypass obstructions.
 - (b) Make changes in conduit routing due to the relocation of equipment.
 - 3) The electrical drawings do not indicate all required junction boxes and pull boxes:
 - (a) Provide junction boxes and pull boxes to facilitate wire pulling as required:
 - (1) To meet cable manufacturer's pulling tension requirements.
 - (2) To limit total conduit bends between pull locations.
 - (b) Install junction boxes and pull boxes at locations acceptable to the Engineer.
 - b. The Contractor is responsible for any deviations in general location, conduit size, routing, or changes to the conduit schedule without the express written approval or direction by the Engineer:
 - 1) The Engineer is the sole source in determining whether the change is constituted as a deviation:
 - 2) Perform any changes resulting in additional conduits, or extra work from such deviations.
 - 3) Incorporate any deviations on the Record Documents.
 - 2. Use only tools recommended by the conduit manufacturer for assembling the conduit system.
 - 3. Provide adequate clearances from high-temperature surfaces for all conduit runs.
 - 4. Do not install 1-inch or larger conduits in or through structural members unless approved by the Engineer.
 - 5. Run conduits exposed to view parallel with or at right angles to structural members, walls, or lines of the building:
 - a. Install straight and true conduit runs with uniform and symmetrical elbows, offsets, and bends.
 - b. Make changes in direction with long radius bends or with conduit bodies.
 - 6. Install conduits with total conduit bends between pull locations less than or equal to 270 degrees.

7. Route all exposed conduits to preserve headroom, access space and work space, and to prevent tripping hazards and clearance problems:
 - a. Install conduit runs so that runs do not interfere with proper and safe operation of equipment and do not block or interfere with ingress or egress, including equipment-removal hatches.
 - b. Route conduits to avoid drains or other gravity lines. Where conflicts occur, relocate the conduit as required.
8. When installing conduits through existing slabs or walls, make provisions for locating any possible conflicting items where the conduit is to penetrate. Use tone signal or X-ray methods to make certain that no penetrations will be made into the existing conduits, piping, cables, post-tensioning cables, etc.
9. Plug conduits brought into pull boxes, manholes, handholes, and other openings until used to prevent entrance of moisture.
10. For 2-inch and larger conduit runs, snake conduits with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of the conduit:
 - a. Remove and replace conduits through which mandrel will not pass.
11. Provide all sleeves and openings required for the passage of electrical raceways or cables even when these openings or sleeves are not specifically indicated on the Drawings.
12. Install complete conduit systems before conductors are installed.
13. Provide metallic conduits terminating in transformer, switchgear, motor control center, or other equipment conduit windows with grounding bushings and ground with a minimum No. 6 AWG ground wire.
14. Underground conduits:
 - a. Install underground conduits, including conduit runs below slabs-on-grade in concrete-reinforced duct bank construction per plan.
 - b. Make underground conduit size transitions at handholes and manholes.
 - c. Install spare conduits in underground duct banks towards top center of runs to allow for ease of installation of future cables as conduits enter underground manholes and handholes.
 - d. Seal around conduit penetrations of below grade walls with a mechanical seal.
- C. Lighting and receptacle conduits:
 1. Provide conduit runs for lighting and receptacle circuits, whether or not indicated on the Drawings:
 2. Install conduits in accordance with the requirements of this Section unless otherwise indicated.
 3. Minimum conduit size:
 - a. 3/4-inch for exposed conduits.
 - b. 1-inch for underground or in-slab conduits.
 4. Provide conduit materials for the installed location as specified in Section 26 05 00.
- D. Conduit usage:
 1. Exposed conduits:
 - a. Rigid conduit:
 - 1) Install the rigid conduit type for each location as specified in Section 26 05 00.
 - 2) Minimum size: 3/4-inch.
 - b. Flexible conduit:
 - 1) Use flexible conduit for final connections between rigid conduit and motors, vibrating equipment, instruments, control equipment, or where required for equipment servicing:
 - (a) Use Type SLT with rigid metallic conduit.
 - 2) Minimum size: 3/4-inch:
 - (a) 1/2 when required for connection to instruments.
 - 3) Maximum length:

(a) Fixed equipment:

Conduit Trade Size	Flexible Conduit Length (inch)
3/4	18
1	18
1-1/4	18
1-1/2	18
2	36
2-1/2	36
3	36
3-1/2	38
4	40

(b) Removable instruments or hinged equipment:

- (1) As required to allow complete removal or full movement without disconnecting or stressing the conduit.
 2. Concrete-encased and embedded conduits:
 - a. Type PVC Schedule 40 and PVC-coated rigid metallic conduit as specified below:
 - 1) Use Type PCS in underground and embedded installation as follows:
 - (a) Stub-up and risers to grade floor or equipment from nonmetallic conduits.
 - (b) Entering and exiting underground or embedded conduit runs a minimum 12 inches above and below grade of finished floor.
 - (c) For any and all bends where the total deflection is greater than 45 degrees.
 - b. Minimum size:
 - 1) 2-inch in duct banks unless otherwise indicated on the Drawings.
 - 2) 1-inch for in-slab conduits unless otherwise indicated on the Drawings.
 3. Direct-buried and sand-bedded duct bank conduits:
 - a. Type PVC Schedule 40.
 - b. Minimum size: 1-inch.
 4. PVC-coated rigid metallic conduit:
 - a. Use specifically manufactured or machined threading dies to manufacturer's specifications to accommodate the PVC jacket.
 5. GRC:
 - a. Conduit shall be cut square and reamed before threading.
 6. PVC:
 - a. Conduit terminations shall be via threaded adapters into threaded hubs on the junction boxes or conduit bodies.
 - b. Conduit terminations into boxes without threaded hubs shall utilize a threaded adapter and a flat neoprene washer on the outside of the box.
 - 1) Use a locknut on the inside of the box to tighten the adapter to the box.
 - c. Route conduit to afford it the maximum physical protection.
 - 1) If necessary, cover conduit to afford additional protection when it cannot be shielded by the structure or machinery frames.
 - (a) Use Schedule 80 where exposed runs may be subject to physical damage.
- E. Conduit joints and bends:
1. General:

- a. Where conduit is underground, under slabs on grade, exposed to the weather, or in NEMA Type 4 or NEMA Type 4X locations, make joints liquidtight.
 - b. Keep bends and offsets in conduit runs to an absolute minimum.
 - c. All bends shall be symmetrical.
 - d. The following conduit systems shall use large-radius sweep elbows:
 - 1) Underground conduits.
 - 2) Conduits containing shielded cables.
 - e. Provide large-radius factory-made bends for 1-1/4-inch trade size or larger.
 - f. Make field bends with a radius of not less than the requirements found in the NEC:
 - 1) The minimum bending radius of the cable must be less than the radius of the conduit bend.
 - 2) Make all field bends with power bending equipment or manual benders specifically intended for the purpose:
 - (a) Make bends so that the conduit is not damaged and the internal diameter is not effectively reduced.
 - (b) For the serving utilities, make bends to meet their requirements.
 - g. Replace all deformed, flattened, or kinked conduit.
 - 2. Threaded conduit:
 - a. Cut threads on rigid metallic conduit with a standard conduit-cutting die that provides a 3/4-inch per foot taper and to a length such that all bare metal exposed by the threading operation is completely covered by the couplings or fittings used. In addition, cut the lengths of the thread such that all joints become secure and wrench-tight just preceding the point where the conduit ends would butt together in couplings or where conduit ends would butt into the ends or shoulders of other fittings.
 - b. Thoroughly ream conduit after threads have been cut to remove burrs.
 - c. Use bushings or conduit fittings at conduit terminations.
 - d. On exposed conduits, repair scratches and other defects with galvanizing repair stick, Enterprise Galvanizing "Galvabar," or CRC "Zinc It."
 - e. Coat conduit threads with an approved electrically conductive sealant and corrosion inhibitor that is not harmful to the conductor insulation:
 - 1) Apply to the male threads and tighten joints securely.
 - 2) Clean excess sealant from exposed threads after assembly.
 - f. Securely tighten all threaded connections.
 - g. Any exposed threaded surfaces must be cleaned and coated with a galvanizing solution so that all exposed surfaces have a galvanized protective coating.
 - 3. PVC:
 - a. Use approved solvent-weld cement specifically manufactured for the purpose. Spray-type cement is not allowed.
 - b. Apply heat for bends so that conduit does not distort or discolor. Use a spring mandrel as required to ensure full inside diameter at all bends:
 - 1) Utilize a heater specifically for PVC conduit as recommended by the conduit manufacturer.
- F. Conduit sealing and drainage:
- 1. Conduit drainage and sealing:
 - a. Provide sealing and drainage in vertical drops of long (in excess of 20 feet), exterior, above-grade conduit runs at the points at which the conduit enters buildings, switchgear, control panels, lighting panelboards, and other similar enclosures.
 - b. Provide seal fittings with drains in vertical drops directly above grade for exterior and above-grade conduit runs that are extended below grade.
 - c. Provide conduit seals with drains in areas of high humidity and rapidly changing temperatures:
 - 1) Where portions of an interior raceway pass through walls, ceilings, or floors that separate adjacent areas having widely different temperatures.

- G. Conduit supports:
1. General:
 - a. Provide appropriate hangers, supports, fasteners, and seismic restraints to suit applications:
 - 1) As specified in Section 26 05 29.
 - 2) Provide support materials consistent with the type of conduit being installed as specified in Section 26 05 00.
 - b. Support conduit at the intervals required by the NEC.
 - c. Perforated strap and plumbers tape are not acceptable for conduit supports.
 2. Conduit on concrete or masonry:
 - a. Use 1-hole malleable iron straps with metallic or plastic expansion anchors and screws or support from preset inserts.
 - b. Use preset inserts in concrete when possible.
 - c. Use pipe spacers (clamp backs) in wet locations.
 - d. On plaster or stucco, use 1-hole malleable iron straps with toggle bolts.
 3. Conduit on metal decking:
 - a. Use 1-hole malleable iron straps with 1-inch long cadmium-plated Type A panhead sheet-metal screws. Fully or partially hammer-driven screws are not acceptable.
 4. Suspended conduit:
 - a. Use malleable-iron factory-made split-hinged pipe rings with threaded suspension rods sized for the weight to be carried (minimum 3/8-inch diameter), Kindorf, or equal.
 - b. For grouped conduits, construct racks with threaded rods and tiered angle iron or preformed channel cross members. Clamp each conduit individually to a cross member. Where rods are more than 2-feet long, provide rigid sway bracing.
 5. Supports at structural steel members:
 - a. Use beam clamps.
 - b. Drilling or welding may be used only as specified or with approval of the Engineer.
 6. PVC-coated rigid metal systems:
 - a. Provide right-angle beam clamps and "U" bolts specially formed and sized to snugly fit the outside diameter of the coated conduit. Provide "U" bolts with PVC-encapsulated nuts that cover the exposed portions of the threads.
 - b. Securely fasten exposed conduits with Type 316 stainless steel clamps or straps.
- H. Expansion or expansion/deflection fittings:
1. General:
 - a. Align expansion coupling with the conduit run to prevent binding.
 - b. Follow manufacturer's instructions to set the piston opening.
 - c. Install expansion fittings across concrete expansion joints and at other locations where necessary to compensate for thermal or mechanical expansion and contraction.
 - d. Furnish fittings of the same material as the conduit system.
- I. Empty conduits:
1. Provide a polyethylene rope rated at 250 pounds tensile strength in each empty conduit more than 10 feet in length.
 2. Seal ends of all conduits with approved, manufactured conduit seals, caps, or plugs immediately after installation:
 - a. Keep ends sealed until immediately before pulling conductors.
- J. Miscellaneous:
1. Provide electrical unions at all points of union between ends of rigid conduit systems that cannot otherwise be coupled:
 - a. Running threads and threadless couplings are not allowed.
 2. Replace any conduits installed that the Engineer determines do not meet the requirements of this Specification.

3.04 ERECTION, INSTALLATION, APPLICATIONS, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 26 05 00.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 PROTECTION

A. As specified in Section 26 05 00.

3.11 SCHEDULES (NOT USED)

END OF SECTION 26 05 33

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SECTION 26 05 34 BOXES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Device boxes.
 - 2. Raceway system boxes.
- B. Related sections:
 - 1. Section 26 05 00 - Common Work Results for Electrical.

1.02 REFERENCES

- A. As specified in Section 26 05 00.
- B. ASTM International (ASTM):
 - 1. A47 - Standard Specification for Ferritic Malleable Iron Castings.
 - 2. D149 - Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
 - 3. D495 - Standard Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation.
 - 4. D570 - Standard Test Method for Water Absorption of Plastics.
 - 5. D648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
 - 6. D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - 7. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
- C. Joint Industry Conference (JIC).
- D. Underwriters Laboratories, Inc. (UL):
 - 1. 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.03 DEFINITIONS

- A. As specified in Section 26 05 00.
- B. Specific definitions:
 - 1. Raceway system boxes: Boxes that are used for wire and cable pullboxes, conduit junction boxes, or terminal boxes.

1.04 SYSTEM DESCRIPTION

- A. Provide outlet boxes for devices such as switches, receptacles, telephone and computer jacks, security systems, junction, and pullboxes for use in the raceway systems, etc.
- B. Provide boxes as indicated on the Drawings or as needed to complete the raceway installation.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 26 05 00.
- B. Product data:
 - 1. Manufacturer.
 - 2. Materials.
 - 3. Dimensions:
 - a. Height.
 - b. Width.
 - c. Depth.
 - d. Weight.

- e. NEMA rating.
- 4. Conduit entry locations.
- 5. Catalog cut sheets.
- 6. Installation instructions.
- C. Shop drawings:
 - 1. Include identification and sizes of pull boxes.

1.06 QUALITY ASSURANCE

- A. As specified in Section 26 05 00.
- B. Regulatory requirements:
 - 1. Outlet boxes shall comply with all applicable standards of:
 - a. JIC.
 - b. NEC.
 - c. NEMA.
 - d. UL.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 26 05 00.

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 26 05 00.

1.09 SEQUENCING

- A. As specified in Section 26 05 00.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 26 05 00.

1.12 SYSTEM START-UP

- A. As specified in Section 26 05 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
 - 1. Plastic coated boxes:
 - a. Rob Roy.
 - b. OCAL.
 - 2. Cast device boxes:
 - a. Appleton.
 - b. Crouse - Hinds.
 - c. OZ/Gedney.
 - 3. Formed steel enclosures:
 - a. Hoffman.
 - b. Thomas and Betts.
 - c. Stahlin.
 - d. Rittal.
 - 4. Stainless steel enclosures:
 - a. Hoffman.
 - b. Stahlin.
 - c. Rittal.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

- A. Cast device boxes:
 - 1. Construction:
 - a. With internal green ground screw.
 - b. Furnished with a suitable gasketed cover.
 - c. With integral cast mounting lugs when surface mounted.
 - d. Conduit sizes range from 3/4 inch to 1 inch.
 - e. Tapered threaded hubs with integral bushing.
 - 2. Malleable iron boxes:
 - a. Conforming to ASTM A47 Grade 32510.
- B. Plastic coated cast device boxes:
 - 1. Construction:
 - a. With internal green ground screw.
 - b. Furnished with a suitable gasketed cover.
 - c. With integral cast mounting lugs when surface mounted.
 - d. Conduit sizes range from 3/4 inch to 1 inch.
 - e. Double coated with a nominal 0.002-inch (2 mil) urethane on both the interior and exterior before application of PVC coating.
 - f. With a minimum 0.040-inch (40 mil) PVC coating bonded to exterior.
 - g. With pressure sealing sleeve to protect the connection with conduit.
- C. Formed steel enclosures:
 - 1. Steel:
 - a. NEMA Type 12.
 - b. Fabricated from 14-gauge steel, minimum.
 - c. All seams continuously welded ground smooth.
 - d. Door:
 - 1) Rolled lip around 3 sides.
 - 2) Attached to enclosure by means of a continuous stainless steel hinge and pin.
 - e. Neoprene door gasket to provide a watertight, dusttight, oiltight seal:
 - 1) Attached with an adhesive.
 - 2) Retained by a retaining strip.
 - f. Fabricate all external removable hardware for clamping the door to the enclosure body from zinc-plated heavy gauge steel:
 - 1) With a hasp and staple for padlocking.
 - g. Provide large enclosures with door and body stiffeners for extra rigidity.
 - h. No holes or knockouts.
 - i. Finish:
 - 1) ANSI-61 gray electrostatically applied polyester powder inside and out over cleaned and primed surfaces.
 - 2) White electrostatically applied polyester powder mounting plate.
 - j. Heavy gauge steel external mounting brackets when surface mounted.
 - 2. Stainless steel:
 - a. NEMA Type 4X:
 - 1) Boxes in locations subject to flooding or temporary submersion:
 - (a) NEMA Type 6.
 - b. Fabricated from 14-gauge Type 316 stainless steel.
 - c. All seams continuously welded.
 - d. Door:
 - 1) Rolled lip around 3 sides.

- 2) Attached to enclosure by means of a continuous stainless steel hinge and pin.
- e. Neoprene door gasket to provide a watertight seal:
 - 1) Attached with an adhesive.
 - 2) Retained by a retaining strip.
- f. Fabricate all external removable hardware for clamping the door to the enclosure body from heavy gauge stainless steel:
 - 1) With a hasp and staple for padlocking.
- g. Provide large enclosures with door and body stiffeners for extra rigidity.
- h. No holes or knockouts.
- i. Finish:
 - 1) Brushed.
- j. Stainless steel external mounting brackets when surface mounted.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

- A. Fasteners:
 - 1. Electroplated or stainless steel in boxes with wiring devices.
 - 2. Screws, nuts, bolts, and other threaded fasteners:
 - a. Stainless steel.
- B. Provide breather and drain fittings where appropriate.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 26 05 00.
- B. General:
 - 1. Provide materials and construction suitable for environmental conditions at the location of the box as specified in Section 26 05 00.
 - 2. Provide outlet box materials to match the conduit system:
 - a. GRC - Cast ferrous boxes.
 - b. PCS - PVC coated cast ferrous boxes.
 - 3. Solid type gang boxes:
 - a. For more than 2 devices.
 - b. For barriered outlets.
 - 4. Support all wall mounted NEMA Type 4 or NEMA Type 4X boxes to maintain a minimum of 7/8-inch free air space between the back of the enclosure and the wall:
 - a. Use machined spacers to maintain air space; built-up washers are not acceptable.
 - b. Use stainless steel or nylon materials for spacers.
 - 5. Use cast malleable iron boxes when box must support other devices.
 - 6. Boxes serving luminaires or devices:
 - a. Use as pull boxes wherever possible.
 - 7. Size boxes in accordance with NEC requirements and to provide sufficient room for the future components and cables indicated on the Drawings.

8. For fire-rated construction, provide materials and installation for use in accordance with the listing requirements of the classified construction.
- C. Outlet boxes:
 1. Locate outlet boxes as indicated on the Drawings:
 - a. Adjust locations so as not to conflict with structural requirements or other trades.
 2. Use deep threaded-hub malleable iron boxes:
 - a. To act as a pull box for conductors in a conduit system.
 - b. Accommodate wiring devices.
 3. Use deep threaded-hub plastic coated malleable iron boxes in corrosive and NEMA Type 4X area and when the conduit system is PVC coated steel.
 4. Outlet boxes may be used as junction boxes wherever possible.
- D. Pull boxes and junction boxes:
 1. Size pull boxes in accordance with NEC requirements and to provide sufficient room for any future conduits and cables as indicated on the Drawings.
 2. Install pull boxes such that access to them is not restricted.
- E. For boxes not indicated:
 1. Provide types and mountings as required to suit the equipment and that will be consistent with the conduit system and environmental conditions as indicated in Section 26 05 00.
 2. Outlet, switch, and junction boxes where surface mounted in exposed locations:
 - a. Cast ferrous boxes with mounting lugs, zinc, or cadmium plating finish.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 REINSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. As specified in Section 26 05 00.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING

- A. As specified in Section 26 05 00.

3.10 PROTECTION

- A. As specified in Section 26 05 00.

3.11 SCHEDULES (NOT USED)

END OF SECTION 26 05 34

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SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Identification of electrical equipment, devices, and components.
 - 2. Material, manufacturing, and installation requirements for identification devices.
- B. Related sections:
 - 1. Section 01 75 17 - Commissioning.
 - 2. Section 26 05 00 - Common Work Results for Electrical.
 - 3. Section 26 05 33 - Conduits.

1.02 REFERENCES

- A. As specified in Section 26 05 00.
- B. Occupational Safety and Health Administration (OSHA).

1.03 DEFINITIONS

- A. As specified in Section 26 05 00.

1.04 SYSTEM DESCRIPTION

- A. Nameplates:
 - 1. Provide a nameplate for each piece of electrical equipment and devices, control panel and control panel components.
 - 2. Provide all nameplates of identical style, color, and material throughout the facility.
 - 3. Device nameplates information:
 - a. Designations as indicated on the Drawings and identified on the Process and Instrumentation Drawings.
- B. Wire numbers:
 - 1. Coordinate the wire numbering system with all vendors of equipment so that every field wire has a unique number associated with it for the entire system:
 - a. Wire numbers shall correspond to the wire numbers on the control drawings or the panel and circuit numbers for receptacles and lighting.
 - b. Wire numbers shall correspond to the terminal block number to which they are attached in the control panel.
 - c. Internal panel wires on a common terminal shall have the same wire number.
 - d. Multi-conductor cables shall be assigned a cable number that shall be attached to the cable at intermediate pull boxes and stub-up locations beneath freestanding equipment. All multi-conductor and instrumentation cables shall be identified at pull points as described above:
 - 1) Label armored multi-conductor cable using the conduit number as indicated on the Drawings, following the requirements for conduit markers in Section 26 05 33.
 - 2. Provide the following wiring numbering schemes throughout the project for field wires between process control module, (PCM), vendor control panels, (VCP), motor control centers, (MCC), field starters, field instruments, etc.

Where:

ORIGIN LOC. = Designation for originating panel or device

ORIGIN	TERM.	= Terminal designation at originating panel or
device	DEST. LOC.	= Designation for destination panel or device

DEST. TERM. = Terminal designation at destination panel or device or PLC

I/O address at destination panel:

3. Identify equipment and field instruments as the origin.
4. PCMs are always identified as the destination.
5. Location is the panel designation for VCP, LCP, or PCM. For connections to MCCs, location is the specific starter tag and loop number. Location is the tag and loop number for motor starters, field instruments and equipment. Any hyphen in the panel designation or tag and loop number shall be omitted.
6. Terminal designation is the actual number on the terminal block where the conductor terminates at field devices and vendor control panels. For multi-conductor cables, all terminal numbers shall be shown, separated by commas.
7. Terminal designations at motor leads shall be the motor manufacturer's standard terminal designation (e.g. T1, T2, T3, etc.).
8. Terminal designations at PCMs where the field conductor connects to field terminal blocks for a PLC input or output shall be the PLC address (Note: the following PLC I/O numbering scheme is typical for Allen-Bradley, the numbering scheme should be modified to match that of the actual PLC manufacturer used for the project):

a. Discrete

Point:

W:X:Y/Z

Analog

Point:

W:X:Y.Z

Where

e:

W = I for input, O for output, X = PLC number (1, 2, 3...)

Y = Slot number (01, 02, 03...)

Z = Terminal number (00, 01, 02...) for a discrete point or a word number for an analog point (1, 2, 3...)

9. Terminal designations at PCMs where the conductor does not connect to a PLC I/O point shall be the terminal number with a "C" prefix (e.g. C0010). For common power after a fuse or neutrals after a switch, the subsequent points shall have a capital letter suffix starting with "A" (e.g. C0010A).

C. **Case 1:** Vendor control panel (VCP) to process control module

(PCM): Field wire number/label: A-B/C-D

A = Vendor control panel number without hyphen (VCP#)

B = Terminal number within VCP (manufacturer's or vendor's standard terminal number)

C = Process control module number without hyphen (PCM#)

D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)

Examples: VCP#-10/PCM#-I:1:01/01

VCP#-10/PCM#-

O:1:10/07

VCP#-

10/PCM#-

C0100

D. **Case 2:** Field instrument to process control module

(PCM): Field wire number/label: E-F/C-D

C = Process control module number without hyphen (PCM#)

D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)

E = Field mounted instrument tag and loop numbers without hyphen (EDV#)

F = Manufacturer's standard terminal number within instrument. Use both terminal numbers for analog points separated by a comma

Examples: TIT#-2,3/PCM#-I:1:01.1

TSH#-1/PCM#-I:2:01/00

- E. **Case 3:** Motor control center (MCC) to process control module

(PCM): Field wire number/label: G-B/C-D

B = Terminal number within Motor Control Center (manufacturer's or vendor's standard terminal number)

C = Process control module without hyphen (PCM#)

D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)

G = Actual starter designation in the motor control center without hyphen (MMS#)

Examples: MMS#-10/PCM#-I:1:01/01

MMS#-10/PCM#-

O:1:10/07

MMS#-

10/PCM#-C0100

- F. **Case 4:** Motor control center (MCC) to vendor control panel

(VCP): Field wire number/label: G-B/A-B

A = Vendor control panel number without hyphen (VCP#)

B = Terminal number within motor control center or vendor control panel (manufacturer's or vendors standard terminal number)

G = Actual starter designation in the motor control center without hyphen (MMS#)

Example: MMS#-X2/VCP#-10

- G. **Case 5:** Motor leads to a motor control center

(MCC): Field wire number/label:

H-I/G-B

B = Terminal number within motor control center (manufacturer's standard terminal number)

G = Actual starter designation in the motor control center without hyphen (MMS#)

H = Equipment tag and loop number without hyphen (PMP#)

I = Motor manufacturer's standard motor lead identification (e.g. T1, T2, T3, etc.)

Example: PMP#-T3/MMS#-T3

- H. **Case 6:** Remote or separately mounted starter or variable frequency drive (VFD) to process control module (PCM):

Field wire number/label: J-B/C-D

B = Terminal number within starter or variable frequency drive (manufacturer's standard terminal number)

C = Process control module number without hyphen (VCP#)

D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)

J = Starter or variable frequency drive tag and loop number without hyphen (MMS#)

Examples: MMS#-10/PCM#-I:1:01/01

MMS#-10/PCM#-

O:2:10/07

MMS#-

10/PCM#-C0010

- I. Identify all spare conductors as required for other field wires with an "S" prefix:

Example: S MMS#-10/PCM#-C011

1.05 SUBMITTALS

City of San Luis Obispo Transit
Facility EV Charging
Infrastructure

26 05 53 - 3

IDENTIFICATION FOR
ELECTRICAL SYSTEMS

- A. Furnish submittals as specified in Section 26 05 00.
- B. Product data:
 - 1. Nameplates:
 - a. Color.
 - b. Size:
 - 1) Outside dimensions.
 - 2) Lettering.
 - c. Material.
 - d. Mounting means.
 - 2. Nameplate schedule:
 - a. Show exact wording for each nameplate.
 - b. Include nameplate and letter sizes.
 - 3. Wire numbers:
 - a. Manufacturer's catalog data for wire labels and label printer.
- C. Record documents:
 - 1. Update the conduit schedule to reflect the exact quantity of wire numbers including spares and destination points for all wires.

1.06 QUALITY ASSURANCE (NOT USED)

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 26 05 00.

1.08 PROJECT SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 26 05 00.

1.12 SYSTEM START-UP

- A. As specified in Section 26 05 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Nameplates and signs:
 - 1. One of the following or equal:
 - a. Brady.
 - b. Seton.
- B. Conductor and cable markers:
 - 1. Heat-shrinkable tubing:
 - a. One of the following or equal:
 - 1) Raychem.
 - 2) Brady.
 - 3) Thomas & Betts.
 - 4) Kroy.
- C. Conduit and raceway markers:
 - 1. One of the following or equal:
 - a. Almetek: Mini Tags.
 - b. Lapp Group: Maxi System.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

- A. Nameplates:
 - 1. Fabricated from white-center and red face or black-center, white face laminated plastic engraving stock:
 - a. 3/32-inch thick material.
 - b. Two-ply.
 - c. With chamfered edges.
 - d. Block style engraved characters of adequate size to be read easily from a distance of 6 feet:
 - 1) No characters smaller than 1/8-inch in height.
- B. Signs:
 - 1. Automatic equipment and high voltage signs:
 - a. Suitable for exterior use.
 - b. In accordance with OSHA regulations.
- C. Conductor and cable markers:
 - 1. Machine printed black characters on white tubing.
 - 2. Ten point type or larger.
- D. Conduit and raceway markers:
 - 1. Non-metallic:
 - a. UV resistant holder and letters
 - b. Black letters on yellow background.
 - c. Minimum letter height: 1/2-inch.
 - d. Adhesive labels are not acceptable.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. Nameplates:
 - 1. Provide all nameplates for control panel operator devices (e.g. pushbuttons, selector switches, pilot lights, etc.):
 - a. Same material and same color and appearance as the device nameplates, in order to achieve an aesthetically consistent and coordinated system.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 26 05 00.
- B. Nameplates:
 - 1. Attach nameplates to equipment with rivets, bolts or sheet metal screws, approved waterproof epoxy-based cement or install in metal holders welded to the equipment.
 - 2. On NEMA Type 4, NEMA Type 4X, enclosures, use epoxy-based cement to attach nameplates.
 - 3. Nameplates shall be aligned and level or plumb to within 1/64 inch over the entire length:

- a. Misaligned or crooked nameplates shall be remounted, or provide new enclosures at the discretion of the Engineer.
- C. Conductor and cable markers:
 - 1. Apply all conductor and cable markers before termination.
 - 2. Heat-shrinkable tubing:
 - a. Tubing shall be shrunk using a heat gun that produces low temperature heated air.
 - b. Tubing shall be tight on the wire after it has been heated.
 - c. Characters shall face the open panel and shall read from left to right or top to bottom.
 - d. Marker shall start within 1/32 inch of the end of the stripped insulation point.
- D. Conduit markers:
 - 1. Furnish and install conduit markers for every conduit in the electrical system that is identified in the conduit schedule or part of the process system.
 - 2. Mark conduits at the following locations:
 - a. Each end of conduits that are greater than 10 feet in length.
 - b. Where the conduit penetrates a wall or structure.
 - c. Where the conduit emerges from the ground, slab, etc.
 - d. The middle of conduits that are 10 feet or less in length.
 - 3. Mark conduits after the conduits have been fully painted.
 - 4. Position conduit markers so that they are easily read from the floor.
 - 5. Attach non-metallic conduit markers with nylon cable ties:
 - a. Provide ultraviolet resistant cable ties for conduit markers exposed to direct sunlight.
 - 6. Mark conduits before construction review by Engineer for punch list purposes.
 - 7. Label intrinsically safe conduits in accordance with the requirements of the NEC.
- E. Signs and labeling:
 - 1. Furnish and install warning signs on equipment that has more than one source of power.
 - a. Warning signs to identify every panel and circuit number of the disconnecting means of all external power sources.
 - 2. Place warning signs on equipment that has 120 VAC control voltage source used for interlocking.
 - a. Identify panel and circuit number or conductor tag for control voltage source disconnecting means.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

- A. As specified in Section 01 75 17.

3.08 FIELD QUALITY CONTROL

- A. Replace any nameplates, signs, conductor markers, cable markers or raceway labels that in the sole opinion of the Engineer do not meet the Engineer's aesthetic requirements.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION 26 05 53

SECTION 26 08 50
FIELD ELECTRICAL ACCEPTANCE TESTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Responsibilities for testing the electrical installation.
 - 2. Adjusting and calibration.
 - 3. Acceptance tests.
- B. Related sections:
 - 1. Section 26 05 00 - Common Work Results for Electrical.
 - 2. Section 26 05 26 - Grounding and Bonding.
- C. Copyright information:
 - 1. Some portions of this Section are copyrighted by the InterNational Electrical Testing Association, Inc (NETA). See NETA publication ATS for details.

1.02 REFERENCES

- A. As specified in Section 26 05 00.
- B. American National Standards Institute (ANSI).
- C. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. 43 - IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
 - 2. 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
 - 3. 95 - IEEE Recommended Practice for Insulation Testing of AC Electric Machinery (2300 V and Above) With High Direct Voltage.
 - 4. 421.3 - IEEE Standard for High-Potential Test Requirement for Excitation Systems for Synchronous Machines.
 - 5. 450 - IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
 - 6. 1106 - IEEE Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications.
 - 7. 1188 - IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications.
 - 8. C57.13 - IEEE Standard Requirements for Instrument Transformers.
 - 9. C57.13.1 – IEEE Guide for Field Testing of Relaying Current Transformers.
 - 10. C57.13.3 - IEEE Guide for Grounding of Instrument Transformer Secondary Circuits and Cases.
 - 11. C57.104 - IEEE Guide for the Interpretation of Gases Generated in Oil- Immersed Transformers.
- D. Insulated Cable Engineer's Association (ICEA).
- E. InterNational Electrical Testing Association (NETA).
 - 1. ATS-2009 Standard for Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- F. International Electrotechnical Commission (IEC).
- G. Manufacturer's testing recommendations and instruction manuals.
- H. National Fire Protection Association (NFPA):
 - 1. 70 – National Electrical Code (NEC).
 - 2. 110 - Standard for Emergency and Standby Power Systems.
- I. National Institute of Standards and Technology (NIST).

- J. Specification sections for the electrical equipment being tested.
- K. Shop drawings.

1.03 DEFINITIONS

- A. As specified in Section 26 05 00.
- B. Specific definitions:
 - 1. Testing laboratory: The organization performing acceptance tests.

1.04 SYSTEM DESCRIPTION

- A. Testing of all electrical equipment installed under this Contract in accordance with the manufacturer's requirements and as specified in this Section. All the NETA standard electrical acceptance testing shall be performed by third party testing agency. Contractor shall be responsible for hiring the third party testing agency.
- B. Conduct all tests in the presence of the Engineer or the Engineer's representative:
 - 1. Engineer will witness all visual, mechanical and electrical tests, and inspections.
- C. The testing and inspections shall verify that the equipment is operational within the tolerances required and expected by the manufacturer, and these Specifications.
- D. Responsibilities:
 - 1. Contractor responsibilities:
 - a. Ensure that all resources are made available for testing, and that all testing requirements are met.
 - 2. Electrical subcontractor responsibilities:
 - a. Perform routine tests during installation.
 - b. Demonstrate operation of electrical equipment.
 - c. Commission the electrical installation.
 - d. Provide the necessary services during testing, and provide these services to the testing laboratory, Contractor, and other subcontractors, including but not limited to:
 - 1) Providing electrical power as required.
 - 2) Operating of electrical equipment in conjunction with testing of other equipment.
 - 3) Activating and shutting down electrical circuits.
 - 4) Making and recording electrical measurements.
 - 5) Replacing blown fuses.
 - 6) Installing temporary jumpers.
 - 3. Testing laboratory responsibilities:
 - a. Perform all acceptance tests specified in this Section.
 - b. Provide all required equipment, materials, labor, and technical support during acceptance tests.
- E. Upon completion of testing or calibration, attach a label to all serviced devices:
 - 1. The label shall indicate the date serviced and the company that performed the service.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 26 05 00.
- B. Manufacturers' testing procedures:
 - 1. Submit manufacturers' recommended testing procedures and acceptable test results for review by the Engineer.
- C. Test report:
 - 1. Test reports shall be based on NETA's latest Acceptance Testing Specifications having a sign-off, pass/fail data filed for each line item covered by NETA's Acceptance Testing Specifications latest edition.
 - 2. Include the following:
 - a. Summary of Project.
 - b. Description of equipment tested.

- c. Description of tests performed.
 - d. Test results.
 - e. Conclusions and recommendations.
 - f. Completed test forms.
 - g. List of test equipment used and calibration dates.
- D. Testing laboratory qualifications:
 - 1. Submit a complete resume and statement of qualifications from the proposed testing laboratory detailing their experiences in performing the tests specified:
 - 2. Testing organization shall be corporately and financially independent of the supplier, producer and installer of the equipment, who has been regularly engaged in the testing of equipment for a period of at least 10 years. All testing shall be conducted under the direct supervision of an electrical engineer, registered in the State of California. This registered electrical engineer will prepare and sign test reports with values, recommendations, and comments.
 - 3. Testing equipment required to conduct the specified tests shall be furnished by the testing organization. Testing equipment shall be in good working condition and comply with the requirements of this Specification and applicable industry standards.
 - 4. Testing shall be done in accordance with the manufacturer's instructions, these Specifications, and applicable NETA Acceptance Testing Specifications, NEMA, ANSI, NFPA, and ASTM Standards. Forms shall include space for ENGINEER sign off at time of test. Testing organization shall meet Federal OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, 1910 and 1936. Membership in the InterNational Electrical Testing Association constitutes proof of meeting such criteria.
 - 5. The testing organization shall cooperate with any manufacturer's representative that may be retained by the CONTRACTOR. Testing organization shall be Cutler Hammer; Electro test; Power Systems; General Electric; or equal NETA approved testing company.
- E. Division of responsibilities:
 - 1. Submit a list identifying who is responsible for performing each portion of the testing.

1.06 QUALITY ASSURANCE

- A. As specified in Section 26 05 00.
- B. Testing laboratory qualifications:
 - 1. The testing laboratory shall be an independent testing company.
 - 2. Selection of the testing laboratory and testing personnel is subject to approval by the Engineer based on testing experience and certifications of the individuals and testing capabilities of the organization.

1.07 DELIVERY, STORAGE, AND PROTECTION (NOT USED)

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 26 05 00.

1.09 SEQUENCING

- A. At least 30 days before commencement of the acceptance tests, submit the manufacturer's complete field testing procedures to the Engineer and to the testing laboratory, complete with expected test results and tolerances for all equipment to be tested.
- B. Perform testing in the following sequence:
 - 1. Perform routine tests as the equipment is installed including:
 - a. Insulation-resistance tests.
 - b. Continuity tests.
 - c. Rotational tests.
 - 2. Adjusting and preliminary calibration.
 - 3. Acceptance tests.
 - 4. Demonstration.

5. Commissioning and plant start-up.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 26 05 00 and 01 78 36.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED) PART 2

1.15 PRODUCTS (NOT USED)

PART 2 EXECUTION

2.01 EXAMINATION (NOT USED)

2.02 PREPARATION

- A. Test instrument calibration:
 1. Utilize a testing laboratory with a calibration program which maintains all applicable test instrumentation within rated accuracy.
 2. The accuracy shall be traceable to the NIST in an unbroken chain.
 3. Calibrate instruments in accordance with the following frequency schedule:
 - a. Field instruments: 6 months maximum.
 - b. Laboratory instruments: 12 months maximum.
 - c. Leased specialty equipment where the accuracy is guaranteed by the lessor (such as Doble): 12 months maximum.
 4. Dated calibration labels shall be visible on all test equipment.
 5. Maintain an up-to-date instrument calibration record for each test instrument:
 - a. The records shall show the date and results of each calibration or test.
 6. Maintain an up-to-date instrument calibration instruction and procedure for each test instrument.
- B. Do not begin testing until the following conditions have been met:
 1. All instruments required are available and in proper operating condition.
 2. All required dispensable materials such as solvents, rags, and brushes are available.
 3. All equipment handling devices such as cranes, vehicles, chain falls and other lifting equipment are available or scheduled.
 4. All instruction books, calibration curves, or other printed material to cover the electrical devices are available.
 5. Data sheets to record all test results are available.
- C. Engine generator tests:
 1. The following individuals must be present and remain at the site during the entire field testing of the engine generator:
 - a. Manufacturer's field engineer for the voltage regulator.
 - b. Manufacturer's field engineer for the governor and governor controller.
 - c. Manufacturer's field engineer for the switchgear.
 - d. Load bank operator.
 - e. Electrical contractor.
 - f. Electric utility's field engineer.

2.03 INSTALLATION (NOT USED)

2.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

2.05 REPAIR/RESTORATION (NOT USED)

2.06 RE-INSTALLATION (NOT USED)

2.07 FIELD QUALITY CONTROL

- A. Dry type transformers:
 - 1. Visual and mechanical inspection:
 - a. Compare equipment nameplate data with the Contract Documents.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, and grounding.
 - d. Verify that resilient mounts are free and that any shipping brackets have been removed.
 - e. Inspect equipment for cleanliness.
 - f. Inspect bolted electrical connections for high resistance using one of the following methods:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
 - (a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
 - g. Verify that as-left tap connections are as specified.
 - 2. Electrical tests:
 - a. Perform resistance measurements through bolted connections with a low- resistance ohmmeter.
 - b. Perform insulation-resistance tests winding-to-winding and each winding- to-ground:
 - 1) Apply voltage in accordance with manufacturer's published data.
 - (a) Refer to NETA ATS tables in the absence of manufacturer's published data.
 - c. Calculate dielectric absorption ration or polarization index.
 - d. Perform turns ratio tests at all tap positions.
 - e. Verify correct secondary voltage, phase-to-phase and phase-to-neutral after energization and before loading.
 - 3. Test values:
 - a. Compare bolted connection resistance values to values of similar connections:
 - 1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - b. Bolt-torque levels shall be in accordance with manufacturer's published data:
 - 1) Refer to NETA ATS tables in the absence of manufacturer's published data.
 - c. Tap connections are left as found unless otherwise specified.
 - d. Minimum insulation-resistance values of transformer insulation shall be in accordance with manufacturer's published data:
 - 1) Refer to NETA ATS tables in the absence of manufacturer's published data.
 - 2) Investigate insulation values less than the allowable minimum.
 - e. The dielectric absorption ratio or polarization index shall not be less than 1.0.
 - f. Turns-ratio results should not deviate more than 1/2 percent from either the adjacent coils or calculated ratio.
 - g. Phase-to-phase and phase-to-neutral secondary voltages shall be in agreement with nameplate data.
- B. Low voltage cables, 600 volt maximum:
 - 1. Visual and mechanical inspection:
 - a. Compare cable data with the Drawings and Specifications.
 - b. Inspect exposed sections of cable for physical damage and correct connection as indicated on the Drawings.
 - c. Inspect bolted electrical connections for high resistance by 1 of the following methods:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:

- (a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
 - d. Inspect compression applied connectors for correct cable match and indentation.
 - e. Inspect for correct identification and arrangement.
 - f. Inspect cable jacket insulation and condition.
 - 2. Electrical tests:
 - a. Perform resistance measurements through bolted connections with a low- resistance ohmmeter.
 - b. Perform insulation resistance test on each conductor with respect to ground and adjacent conductors:
 - 1) Applied potential shall be 500 volts dc for 300 volt rated cable and 1,000 volts dc for 600 volt rated cable.
 - 2) Test duration shall be 1 minute.
 - c. Perform continuity tests to insure correct cable connection.
 - d. Verify uniform resistance of parallel conductors.
 - 3. Test values:
 - a. Compare bolted connection resistance values to values of similar connections:
 - 1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - b. Insulation-resistance values shall be in accordance with manufacturer's published data:
 - 1) Refer to NETA ATS tables in the absence of manufacturer's published data.
 - 2) Investigate values of insulation-resistance less than the allowable minimum.
 - 3) Investigate values of insulation-resistance where there is a great deviation between of values between conductors.
 - c. Cable shall exhibit continuity.
 - d. Investigate deviations in resistance between parallel conductors.
- C. Low voltage molded case and insulated case circuit breakers:
- 1. Visual and mechanical inspection:
 - a. Compare equipment nameplate data with the Contract Documents.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage and alignment.
 - d. Verify that all maintenance devices are available for servicing and operating the breaker.
 - e. Verify the unit is clean.
 - f. Verify the arc chutes are intact.
 - g. Inspect moving and stationary contacts for condition and alignment.
 - h. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
 - i. Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism in accordance with manufacturers published data.
 - j. Operate circuit breaker to ensure smooth operation.
 - k. Inspect bolted electrical connections for high resistance by one of the following methods:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
 - (a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
 - l. Inspect operating mechanism, contacts, and arc chutes in unsealed units.
 - m. Verify cell fit and element alignment.
 - n. Verify racking mechanism operation.

- o. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 - p. Perform adjustments for final protective device settings in accordance with the coordination study.
 - q. Record as-found and as-left operation counter readings.
2. Electrical tests:
- a. Perform resistance measurements through bolted connections with a low- resistance ohmmeter.
 - b. Perform insulation-resistance tests for 1 minute on each pole, phase-to- phase and phase-to-ground with the circuit breaker closed and across each open pole:
 - 1) Apply voltage in accordance with manufacturer's published data.
 - 2) Refer to NETA ATS tables in the absence of manufacturer's published data.
 - c. Perform a contact/pole-resistance test.
 - d. Determine long-time pickup and delay by primary current injection.
 - e. Determine short-time pickup and delay by primary current injection.
 - f. Determine ground-fault pickup and delay by primary current injection.
 - g. Determine instantaneous pickup value by primary current injection.
 - h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data.
 - i. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function and trip unit battery condition:
 - 1) Reset all trip logs and indicators.
 - j. Verify operation of charging mechanism.
3. Test values:
- a. Compare bolted connection resistance values to values of similar connections:
 - 1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - b. Bolt-torque levels shall be in accordance with manufacturer's published data:
 - 1) Refer to NETA ATS tables in the absence of manufacturer's published data.
 - c. Insulation-resistance values shall be in accordance with manufacturer's published data:
 - 1) Refer to NETA ATS tables in the absence of manufacturer's published data.
 - 2) Investigate values of insulation-resistance less than the allowable minimum.
 - d. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
 - 1) If manufacturer's data is not available, investigate any values which deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.
 - e. Insulation-resistance values of control wiring shall not be less than 2 megohms.
 - 1) Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band including adjustment factors: If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS tables.
 - f. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
 - g. Ground fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
 - h. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances:
 - i. Refer to NETA ATS tables in the absence of manufacturer's published data.
 - j. Pickup values and trip characteristics shall be within manufacturer's published tolerances.

- k. Minimum pickup voltage of the shunt trip and close coils shall conform to the manufacturer's published data:
 - l. Refer to NETA ATS tables in the absence of manufacturer's published data.
 - m. Breaker open, close, trip, trip-free, anti-pump, and auxiliary features shall function as designed.
 - n. The charging mechanism shall operate in accordance with manufacturer's published data.
- D. Grounding systems:
 - 1. Visual and mechanical inspection:
 - a. Inspect ground system for compliance with that indicated on the Drawings, specified in Specifications, and in the NEC.
 - b. Inspect physical and mechanical condition.
 - c. Inspect bolted electrical connections for high resistance using one of the following methods:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
 - (a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
 - d. Inspect anchorage.
 - 2. Electrical tests:
 - a. Perform resistance measurements through bolted connections with a low- resistance ohmmeter.
 - b. Perform fall of potential test or alternative test in accordance with IEEE 81 on the main grounding electrode or system.
 - c. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, the system neutral and any derived neutral points.
 - 3. Test values:
 - a. Grounding system electrical and mechanical connections shall be free of corrosion.
 - b. Compare bolted connection resistance values to values of similar connections:
 - 1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - c. Bolt-torque levels shall be in accordance with manufacturer's published data:
 - 1) Refer to NETA ATS tables in the absence of manufacturer's published data.
 - d. The resistance between the main grounding electrode and ground shall be as specified in Section 26 05 26. Investigate point-to-point resistance values that exceed 0.5 ohm.

2.08 ADJUSTING (NOT USED)

2.09 CLEANING

- A. As specified in Section 26 05 00.
- B. After the acceptance tests have been completed, dispose of all testing expendables, vacuum all cabinets, and sweep clean all surrounding areas.

2.10 PROTECTION

- A. As specified in Section 26 05 00.

2.11 SCHEDULES (NOT USED)

END OF SECTION 26 08 50

SECTION 26 24 13 SWITCHBOARDS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Switchboards
 - 2. Switchboard accessories.
- B. Related sections:
 - 1. Section 26 05 00 - Common Work Results for Electrical.
 - 2. Section 26 05 53 - Identification for Electrical Systems.
 - 3. Section 26 08 50 - Field Electrical Acceptance Tests.
 - 4. Section 26 28 01 - Low Voltage Molded Case Circuit Breakers.
 - 5. Section 26 43 14 - Surge Protective Devices.

1.02 REFERENCES

- A. As specified in Section 26 05 00.
- B. Institute of Electrical and Electronic Engineers (IEEE).
 - 1. C57.13 - IEEE Standard Requirements for Instrument Transformers.
- C. National Electrical Manufacturers' Association (NEMA):
 - 1. PB 2 - Dead front Distribution Switchboards.
- D. Underwriters' Laboratories, Inc. (UL):
 - 1. 891 - Switchboards.

1.03 DEFINITIONS

- A. As specified in Section 26 05 00.

1.04 SYSTEM DESCRIPTION

- A. Factory assembled, wired, and tested switchboards, with major components being products of a single manufacturer, including circuit breakers, and other equipment specified in this Section and indicated on the Drawings.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 26 05 00.
- B. Product data:
 - 1. Manufacturer of the switchboard.
 - 2. Manufacturer of all component parts of the switchboard.
 - 3. Dimensions:
 - 4. Nameplate schedule.
 - a. Width.
 - b. Length.
 - c. Height.
 - d. Weight.
 - 5. Bill of material.
 - 6. Description of operation:
 - 7. Ratings:
 - a. Voltage.
 - b. Phase.
 - c. Current.
 - d. Interrupting rating (circuit breakers and fuses).
 - 8. List of recommended spare parts.
 - 9. Name of dealer's repair facility and parts stocking agreement with the factory:

- a. The agreement shall outline in detail the manufacturer's parts stocking requirements and the method by which the manufacturer's representative verifies that the stock is at an acceptable level.
 - b. The agreement should also outline the method by which the manufacturer's representative determines that the service personnel meet factory standards.
 - c. A toll-free or local phone number with 24/7 emergency monitoring/call back is required.
- 10. Furnish circuit breaker submittals as specified in:
 - a. Section 26 28 01.
 - b. Section 26 24 13.
- 11. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 26 05 00:
 - a. Manufacturer's statement of seismic qualification with substantiating test data.
- 12. Manufacturer's special seismic certification with substantiating test data.
- C. Shop Drawings:
 - 1. Complete, detailed, and scaled switchboard layout:
 - a. Front panel.
 - b. Sub-panels.
 - c. Interior panels.
 - d. Top and bottom conduit windows.
 - 2. Complete electrical wiring diagrams:
 - a. Point-to-point connections.
 - b. Internal compartment-to-compartment interconnection wiring diagrams.
 - c. Wiring identification and terminal numbers.
 - 3. Complete 3-line diagrams for each switchboard lineup. These drawings shall indicate devices comprising the switchboard assembly including, but not limited to, circuit breakers, control power, and instrument transformers, meters, and control devices. Clearly, indicate electrical ratings of devices on Drawings.
 - 4. Complete interface and connection diagrams for metering system.
 - 5. Complete bill of material list and equipment data sheets identifying appropriate information specific to the switchboard being supplied.
 - 6. Nameplate schedule.
 - 7. Before fabrication, submit Switchboard Shop Drawings for approval to the Developer's dry utility consultant and SCE.
- D. Installation instructions:
 - 1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
 - 2. For equipment installed in structures designated as seismic design category A or B:
 - a. Provide manufacturer's installation instructions and anchoring details for connecting equipment to supports and structures.
 - 3. For equipment installed in structures designated as seismic design category C, D, E, or F:
 - a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified in Section 26 05 00.
 - b. Submit anchoring drawings with supporting calculations.
- E. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.
- F. Test forms and reports:
 - 1. Submit complete factory acceptance test procedures and all forms used during the test.
 - 2. Manufacturer to furnish a certified report after the shop tests.
 - 3. Manufacturer's start-up representative to furnish a written report after the start-up:

- a. The report must state that the installation is complete and satisfactory, or list items requiring additional attention and a proposal for the actions.
 - b. If any items require attention after the initial start-up, a final report is required stating that the installation is complete and satisfactory.
- G. Installation instructions:
 - 1. The written instructions must detail the complete installation of the switchboard including rigging, moving, and setting into place.
 - 2. Provide anchorage instructions and requirements for the switchboard based on the seismic conditions of the site as specified in Section 26 05 00.
 - a. Stamped by a professional engineer licensed in the state where the Project is being constructed.

1.06 QUALITY ASSURANCE

- A. As specified in Section 26 05 00.
- B. The switchboard and all components shall be UL listed and labeled.
- C. Equipment shall be designed and constructed in accordance with the following standards and requirements:
 - 1. NEMA PB 2.
 - 2. UL 891.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 26 05 00.
- B. Ship switchboards to the site in dedicated air ride vans that will allow the Contractor to utilize on-site off-loading equipment.
- C. Furnish temporary equipment heaters within the switchboard to prevent condensation from forming.

1.08 PROJECT/SITE CONDITIONS

- A. As specified in Section 26 05 00

1.09 SEQUENCING

- A. Conduct the initial fault current study and submit results for Engineer's review.
- B. After successful review of the initial fault current study, submit complete equipment submittal.
- C. Conduct factory acceptance test and submit certified test results for Engineer's review.
- D. Ship equipment to the Project Site after successful completion of the factory acceptance test.
- E. Assemble equipment in the field.
- F. Conduct field acceptance test and submit results for Engineer's review.
- G. Submit manufacturer's certification that the equipment has been properly installed and is fully functional for Engineer's review.
- H. Conduct Owner's training sessions.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 26 05 00.

1.12 SYSTEM START-UP

- A. As specified in Section 26 05 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Switchboards:
 - 1. As manufactured by:
 - a. Eaton or approved equal

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

- A. Switchboard
 - 1. Complete assembly, including steel framing and covers, bus system, and breaker mounting, shall satisfy applicable provisions of UL 891 and NEMA PB-2 and the California Electrical Code for low-voltage distribution switchboards. Switchboards shall be furnished with UL labels.
 - 2. Short Circuit Current Rating: Switchboards shall be rated with a minimum short circuit current rating of 65,000 rms symmetrical amperes at 480 VAC maximum.
 - 3. Switchboards shall be floor standing, dead front, dead rear, line bussed, front operated and connected, circuit-breaker type, unless otherwise indicated and shall contain equipment indicated and specified. Switchboard shall be complete with pull, service, and distribution sections as required.
 - 4. Required equipment shall be enclosed in fully interchangeable die formed steel sectional cabinets will be absolutely rigid welded construction, plumb and uniform in size. Each cabinet shall be a separate and independent unit with assembly holes die-stamped or jig drilled; openings for interconnections shall be so placed that cabinet can be located in any position in assembly without drilling or cutting holes on job. Deliver switchboard to Project site in completely assembled sections and provide required assembly bolts and blanking plates. Front plates and doors shall be of not less than 12 gage furniture steel, completely removable, secured to cabinet with machine screws, with cup washers uniformly and symmetrically spaced. Provide hinged wire gutter covers for distribution sections. Equipment shall meet NEMA and UL standards.
 - 5. Circuit breakers shall be as follows (protective device shall be as shown on drawings):
 - a. See Section 26 28 01
 - b. Main circuit breakers shall be automatic, one-piece molded-case, trip-free, common trip, quick-make, quick-break, thermal-magnetic with solid state trips, bolted to bus with frame size and trip ratings as indicated on drawings. Voltage, amperage ratings and number of poles shall be as indicated on breakers. Main breaker shall provide a minimum short-circuit interrupting capacity as determined by utility company. Provide shunt-trip and integral ground fault devices, as indicated on drawings. Breakers shall be furnished with lockout provisions.
 - c. Feeder circuit breakers shall be automatic, one-piece molded-case, trip-free, common trip, quick-make, quick-break, thermal-magnetic or solid state type bolted to bus, with handles clearly indicating tripped position.
 - d. Breakers shall be furnished with a single handle with no tie-bar. Voltage, amperage, and number of poles shall be as indicated on Drawings. Breaker ratings shall be on handle or label. Breakers shall be furnished with lockout provisions approved by the State of California for padlocking and shall provide a minimum symmetrical short-circuit interrupting rating, as indicated on Drawings. Series rated circuit breaker combinations are not acceptable.
 - 6. Utility metering provisions shall meet requirements of serving utility and shall be furnished with necessary fittings.
 - 7. Provide switchboard silver-plated copper bus bars of same capacity as main breaker, or as indicated on Drawings, between current transformer and main section and distribution

sections; also, full height of breaker space in distribution portions. Copper bus shall have current density of 1000A per square inch of cross section. Bus structure shall be free-fitted, and shall have sufficient strength to withstand short-circuit as indicated on drawings. Connections shall be securely bolted together with corrosion-resistant plated carbon steel, minimum grade five machine screws secured with constant pressure-type locking devices. Bus bar bracing shall be designed to withstand maximum available short-circuit current. Connections for cables to circuit breakers, switches and motor control devices shall be heavy-duty mechanical pressure type terminal lugs. Provide service cable lugs as required by utility company. Cables and internal wiring shall be supported with suitable cleats.

8. Switchboard distribution sections shall be furnished with full height bussing. Unused spaces shall be provided with blank covers. Switchboards, as complete units, shall be given single short-circuit current ratings by manufacturer. Such ratings shall be established by actual tests by manufacturer, in accordance with UL specifications, on equipment constructed similarly to the furnished switchboard.
9. Provide a large nameplate identifying switchboard, indicating service voltage, originating power source, function and current rating. Nameplate shall be furnished with 3/16 inch engraved black letters on white background. Name plate shall be mechanically fastened to switchboard.
10. Provide labels for circuit breakers, disconnect switches, and or other disconnecting means in switchboards. Label shall indicate name of load served, name or room number and if in different building, name of building. If equipment is installed in same room as source, label should indicate source name and "in this room".
 - a. Labels shall be as specified in Section 26 05 53.
11. Paint cabinets, framework and plates inside and out with one coat of rust-resistant metal primer and one coat of enamel, baked on, or lacquer sprayed on.
12. Manufacture boards according to reviewed Shop Drawings. Switchboard shall meet requirements of legally constituted authorities having jurisdiction, and respective serving utility.
13. Switchboards installed outdoors shall be weatherproof NEMA Type 3R enclosure. Enclosure construction shall be formed of code gage galvanized steel with enamel finish. Heavy-duty, three-point latching, vault type door handles with padlocking provisions shall be furnished on doors. Padlocks shall be furnished keyed to Corbin No. 60 keys. Switchboards installed outdoors shall be specifically required to maintain service during extreme outdoor ambient temperatures of a minimum of 150 degrees Fahrenheit in NEMA Type 3R enclosures.
14. For grounded wye electrical service switchboards rated more than 150 volts, to ground and 1,000 amperes or more, provide ground fault protection for main protective device. Ground fault protection shall be UL listed, with ground sensor encircling phase conductors and neutral conductors integral with the main protective device. Provide testing of ground fault protection system by an independent recognized testing laboratory. Testing lab shall provide necessary testing equipment at the Project site and perform a certified test on ground protection system in presence of the Project Inspector. The ground fault setting shall be selected to coordinate with downstream circuit protective devices. Verify that the system neutral is grounded at the service entrance switchboard only, except neutrals of step down distribution transformers. For branch circuit protective devices, rated 800 amps or more, provide ground fault protection where shown on the drawings, or as described above, for main protective device. Coordinate settings with main protective device ground fault protection.
15. Connections to bussing shall be securely bolted together with corrosion-resistant plated carbon steel, minimum grade five machine screws secured with constant pressure-type locking devices.
16. Arc Flash Reduction Maintenance Switch: The Arcflash Reduction Maintenance System shall allow the operator to enable a maintenance mode using a 5 position switch which

enables a preset accelerated instantaneous override trip to reduce arc flash energy. A blue LED on the trip unit shall indicate the trip unit is in the maintenance mode.

B. ACCESSORIES

1. Power monitor:
 - a. As specified on Drawings.
2. Surge protective devices:
 - a. As specified in Section 26 43 14.

2.06 MIXES (NOT USED)

2.07 FABRICATION (NOT USED)

2.08 FINISHES

- A. Chemically clean all steel surfaces before painting.
- B. Color per City of Tulare

2.09 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 26 05 00.
- B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.
- C. General:
 1. Furnish cables, conduit, lugs, bolts, expansion anchors, sealants, and other accessories needed to complete the installation of the switchboard.
 2. Physically assemble and install the switchboard in the location and layout indicated on the Drawings.
 3. Make bus splice connections.
 4. Perform work in accordance with manufacturer's instructions and shop drawings.
 5. Furnish components and equipment as required to complete the installation.
 6. Replace hardware lost or damaged during the installation or handling to provide a complete installation.
 7. Weld and/or bolt switchboard frame to leveling channels embedded in the concrete housekeeping pad:
 - a. Provide structural leveling channels in accordance with manufacturer's recommendations to provide proper alignment of the units.
 - b. The installation shall meet the seismic requirements of the site.
- D. Provide the services of a qualified manufacturer's representative to:
 1. Inspect, verify, and certify that the mechanical installation meets the manufacturer's requirements.
 2. Make control connections across the shipping splits.
 3. Install and align all circuit breakers.
 4. Perform field tests.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

- A. Factory tests:

1. The Owner and Engineer will witness the factory acceptance test as specified in Section 26 05 00 and the latest edition of NETA ATS standard.
2. Test the complete switchgear at the manufacturer's establishment.
 - a. Completely assemble, wire and test the switchboard:
 - 1) Detailed inspections before and after assembly to assure correctness of design and workmanship.
 - 2) Provide groups of wires leaving the shipping-assembled equipment with terminal blocks with suitable numbering strips.
- B. Owner training:
 1. As specified in Section 26 05 00.

3.08 FIELD QUALITY CONTROL

- A. As specified in Section 26 05 00.
- B. Provide manufacturer's services for the following:
 1. Make all bus splice connections.
 2. Make all control connections across shipping splits.
 3. Ensure that all items furnished are in proper operating condition:
 - a. Technician must be completely knowledgeable in the operation, maintenance, and start-up of the electrical system.
 4. Furnish a written report after start-up signed by the manufacturer's authorized representative:
 - a. Report must state that the installation is complete and meets all of the manufacturer's requirements.
 - b. List any items requiring additional attention.

3.09 ADJUSTING

- A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

3.10 CLEANING

- A. As specified in Section 26 05 00.

3.11 PROTECTION

- A. As specified in Section 26 05 00.

3.12 SCHEDULES (NOT USED)

END OF SECTION 26 24 13

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SECTION 26 28 01
LOW VOLTAGE MOLDED CASE CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Low voltage molded case circuit breakers.
- B. Related sections:
 - 1. Section 26 05 00 - Common Work Results for Electrical.
 - 2. Section 26 05 74 - Electrical System Studies.

1.02 REFERENCES

- A. As specified in Section 26 05 00.
- B. National Electrical Manufacturers Association (NEMA):
 - 1. AB 3. - Molded Case Circuit Breakers and Their Application.
- C. Underwriter's Laboratories (UL):
 - 1. 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 - 2. 943 - Ground Fault Circuit Interrupters.

1.03 DEFINITIONS

- A. As specified in Section 26 05 00.
- B. In accordance with UL 489.

1.04 SYSTEM DESCRIPTION

- A. Molded case thermal magnetic or motor circuit protector type circuit breakers as indicated on the Drawings and connected to form a completed system.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Sections 01 33 00 and 26 05 00.
- B. Product data:
 - 1. Catalog cut sheets.
 - 2. Manufacturer's time-current curves for all molded case circuit breakers furnished.

1.06 QUALITY ASSURANCE

- A. As specified in Section 26 05 00.
- B. Low voltage molded case circuit breakers shall be UL listed and labeled.

1.07 DELIVERY, STORAGE AND HANDLING

- A. As specified in Section 26 05 00.

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 26 05 00.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 26 05 00.

1.12 SYSTEM START-UP

- A. As specified in Section 26 05 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
 - 1. Eaton/Cutler-Hammer.
 - 2. General Electric Company.
 - 3. Schneider Electric/Square D Company.
 - 4. ABB.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

- A. General:
 - 1. Conforming to UL 489.
 - 2. Operating mechanism:
 - a. Quick-make, quick-break, non-welding silver alloy contacts.
 - b. Common Trip, Open and Close for multi-pole breakers such that all poles open and close simultaneously.
 - c. Mechanically trip free from the handle.
 - d. Trip indicating handle - automatically assumes a position midway between the manual ON and OFF positions to clearly indicate the circuit breaker has tripped.
 - e. Lockable in the "OFF" position.
 - 3. Arc extinction:
 - a. In arc chutes.
 - 4. Voltage and current ratings:
 - a. Minimum ratings as indicated on the Drawings.
 - b. Minimum frame size 100A.
 - 5. Interrupting ratings:
 - a. Minimum ratings as indicated on the Drawings.
 - b. Not less than the rating of the assembly (panelboard, switchboard, motor control center, etc.)
- B. Motor circuit protectors:
 - 1. Instantaneous only circuit breaker as part of a listed combination motor controller.
 - 2. Each pole continuously adjustable in a linear scale with 'LO' and 'HI' settings factory calibrated.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

- A. Terminals:
 - 1. Line and load terminals suitable for the conductor type, size, and number of conductors in accordance with UL 489.
- B. Case:
 - 1. Molded polyester glass reinforced.
 - 2. Ratings clearly marked.
- C. Trip units:
 - 1. Provide thermal magnetic or solid-state trip units as indicated on the Drawings.
 - 2. Thermal magnetic:
 - a. Instantaneous short circuit protection.
 - b. Inverse time delay overload.
 - c. Ambient or enclosure compensated by means of a bimetallic element.
 - 3. Solid state:

- a. With the following settings as indicated on the Drawings.
 - 1) Adjustable long time current setting.
 - 2) Adjustable long time delay.
 - 3) Adjustable short time pickup.
 - 4) Adjustable short time delay.
 - 5) Adjustable instantaneous pickup.
 - 6) Adjustable ground fault pickup as indicated on the Drawings.
 - 7) Adjustable ground fault delay as indicated on the Drawings.
- D. Molded case circuit breakers for use in panelboards:
 - 1. Bolt-on type.
 - a. Plug-in type breakers are not acceptable.
 - 2. Ground fault trip devices as indicated on the Drawings.

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. Test breakers in accordance with:
 - 1. UL 489.
 - 2. Manufacturer's standard testing procedures.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. Install breakers to correspond to the accepted shop drawings.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

- A. As specified in Section 26 05 00.

3.08 ADJUSTING

- A. Adjust trip settings in accordance with Protective Device Coordination Study as accepted by the Engineer and in accordance with manufacturer's recommendations.
- B. Adjust motor circuit protectors in accordance with NEC and the manufacturer's recommendation based on the nameplate values of the installed motor.

3.09 CLEANING (NOT USED)

3.10 PROTECTION

- A. As specified in Section 26 05 00.

3.11 SCHEDULES (NOT USED)

END OF SECTION 26 28 01

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SECTION 26 43 14
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. High-energy surge protective devices.
- B. Related sections:
 - 1. Section 26 05 00 - Common Work Results for Electrical.
 - 2. Section 26 08 50 - Field Electrical Acceptance Tests.

1.02 REFERENCES

- A. As specified in Section 26 05 00.
- B. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. C62.41 – Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits.
 - 2. C62.45 – Guide on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
 - 3. C62.62- Standard Test Specifications for Surge Protective Devices for Low Voltage AC Power Circuits.
- C. Underwriters Laboratory:
 - 1. 1449, 4th Edition, Standard for Surge Protective Devices.

1.03 DEFINITIONS

- A. As specified in Section 26 05 00.
- B. Specific definitions:
 - 1. SPD: Surge protective device.
 - 2. SAD: Silicon avalanche diode.
 - 3. MOV: Metal oxide varistor.
 - 4. MCOV: Maximum continuous operating voltage.
 - 5. In: Nominal discharge current.
 - 6. VPR: Voltage protection rating.
 - 7. SCCR: Short circuit current rating.

1.04 SYSTEM DESCRIPTION

- A. Surge protective devices as an integral component of the electrical equipment or externally mounted as indicated on the Drawings.

1.05 SUBMITTALS

- A. Furnish submittals as specified in Section 26 05 00.
- B. Product data:
 - 1. Furnish complete product data confirming detailed compliance or exception statements to all provisions of this Section.
 - 2. Manufacturer's catalog cut sheets indicating:
 - a. Manufacturer and model numbers.
 - b. Ratings of each SPD include but not limited to:
 - 1) Short circuit current rating.
 - 2) Nominal discharge current.
 - 3) Maximum continuous operating voltage.
 - 4) Voltage protection rating.
 - 5) System voltage.
 - 6) System frequency.
 - 7) Surge current capacity.

3. Submit independent test data from a nationally recognized testing laboratory verifying the following:
 - a. Overcurrent protection.
 - b. UL 1449.
- C. Shop drawings:
 1. Provide electrical and mechanical drawings by the manufacturer that detail:
 - a. Unit dimensions.
 - b. Weights.
 - c. Components.
 - d. Field connection locations.
 - e. Mounting provisions.
 - f. Connection details.
 - g. Wiring diagram.
- D. Operation and maintenance manuals:
 1. Provide the manufacturer's manual with installation, start-up, spare parts lists, and operating instructions for the specified system.

1.06 QUALITY ASSURANCE

- A. As specified in Section 26 05 00.
- B. Provide SPD units that are designed, manufactured, tested and installed in compliance with the following codes and standards:
 1. Institute of Electrical and Electronics Engineers (IEEE C62.41, C62.45, C62.62).
 2. Federal Information Processing Standards Publication 94 (FIPS PUB 94).
 3. National Electrical Manufacturer Association.
 4. National Fire Protection Association (NFPA 20, 75 and 780).
 5. National Electric Code (NFPA 70).
 6. Underwriters Laboratories (UL 1449 4th Edition and UL 1283).
 7. International Electrotechnical Commission (IEC 801).

1.07 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 26 05 00.

1.08 PROJECT OR SITE CONDITIONS

- A. As specified in Section 26 05 00.

1.09 SEQUENCING

- A. Coordinate with and provide SPD equipment to the electrical equipment manufacturer before final assembly and factory testing.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

- A. As specified in Section 26 05 00.
- B. Extended warranty:
 1. Furnish a manufacturer's full 5-year parts and labor warranty from the date of shipment against any part failure when installed in compliance with the manufacturer's written instructions, UL listing requirements, and any applicable national, state, or local electrical codes.
 2. Warranty shall include:
 - a. Direct, factory-trained employees must be available within 48 hours for assessment of the problem.
 - b. A 24-hour toll-free 800-number for warranty support.

1.12 SYSTEM START-UP

- A. As specified in Section 26 05 00.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. One of the following or equal:
 - 1. Liebert.
 - 2. Eaton/Cutler-Hammer.
 - 3. Schneider Electric/Square D.
 - 4. General Electric.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

- A. Provide Type 1 or Type 2 SPD units as required for the locations indicated on the Drawings.
- B. Electrical requirements:
 - 1. SPD (Surge Protection Device) ratings are to be consistent with the nominal system operating voltage, phase, and configuration as indicated on the Drawings.
 - 2. MCOV (Maximum Continuous Operating Voltage):
 - a. For the SPD and all components in the suppression path (including all MOVs, SADs, and selenium cells): Greater than 115 percent of the nominal system operating voltage.
 - 3. Operating frequency:
 - a. 47 to 63 hertz.
 - 4. SCCR (Short Circuit Current Rating):
 - a. 65 kAIC minimum, but not less than the equipment it is connected to as indicated on the Drawings.
 - b. The SCCR shall be marked on the SPD in accordance with UL 1449 and the NEC.
 - 5. Nominal discharge current In:
 - a. 20 kA.
 - 6. Maximum VPR:

Modes	<u>240/120</u>	<u>208Y/120</u>	480Y/277
L-N, L-G, N-G	900	900	1,500
L-L	1,200	1,200	2000

- 7. Peak surge current:
 - a. Service entrance locations:
 - 1) 240 kA per phase minimum.
 - 2) 120 kA per mode minimum.
 - b. Branch locations:
 - 1) 120 kA per phase, minimum.
 - 2) 60 kA per mode minimum.
- C. Protection modes:
 - 1. Provide SPD protection modes as follows:
 - a. Line to Neutral (L-N) where applicable.
 - b. Line to Ground (L-G).
 - c. Neutral to Ground (N-G), where applicable.
- D. Environmental requirements:
 - 1. Storage temperature:
 - a. -40 degrees to +50 degrees Celsius.
 - 2. Operating temperature:

- a. -0 degrees to +60 Celsius.
- 3. Relative humidity:
 - a. 5 percent to 95 percent.
- 4. Audible noise:
 - a. Less than 45 dBA at 5 feet (1.5 m).
- 5. Operating altitude:
 - a. Zero to 12,000 feet above sea level.
- E. Provide surge protective devices that are suitable for application in IEEE C62.41 Category A, B and C3 environments, as tested to IEEE C62.45.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

- A. Enclosure:
 - 1. Located in electrical equipment as or in an external NEMA 12 enclosure indicated on the Drawings.
 - a. NEMA Type 12 enclosure:
 - 1) No ventilation openings.
 - b. Hinged cover requiring a tool for internal access.
 - c. Internal drawing pocket.
 - d. All monitoring indications must be visible without opening the door.
- B. Internal connections:
 - 1. Provide low impedance copper plates for intra-unit connections:
 - a. Attach surge modules using bolted connections to the plates for low impedance connections.
 - 2. Size all connections, conductors, and terminals for the specified surge current capacity.
- C. Surge diversion modules:
 - 1. MOV:
 - a. Where multiple MOVs are used in parallel, utilize computer-matched MOVs to within 1-volt variance and tested for manufacturer's defects.
- D. Overcurrent protection:
 - 1. Individually fuse all components, including suppression, filtering, and monitoring components:
 - a. Rated to allow maximum specified nominal discharge current capacity.
 - b. Overcurrent protection that limits specified surge currents is not acceptable.
- E. Connections:
 - 1. Provide terminals to accommodate wire sizes up to #2 AWG.

2.07 ACCESSORIES

- A. Unit status indicators:
 - 1. Provide red and green solid-state indicators, with printed labels, on the front cover to redundantly indicate on-line unit status:
 - a. The absence of the green light and the presence of the red light indicate that surge protection is reduced and service is needed to restore full operation.
 - b. Indicates the status of protection on each mode or phase.
- B. Dry contacts for remote monitoring:
 - 1. Electrically isolated Form C dry contacts (1 A/125 VAC) for remote monitoring of system integrity, and indication of under voltage, phase and/or power loss.
- C. Provide an audible alarm which activates under any fault condition.
 - 1. Provide an alarm On/Off switch to silence the alarm.
 - 2. A visible LED will confirm whether alarm is On or Disabled.
 - 3. Locate both switches and the audible alarm on the unit's front cover.

- D. Provide transient counter to count transient voltage surges:
 - 1. LCD readout located on the unit's front cover.
 - 2. Counter to utilize batteries with a 10-year nominal life or non-volatile memory to maintain accurate counts in the event of power loss.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

- A. Permanently affix surge rating to the SPD.
- B. Perform manufacturer's standard factory test.
 - 1. Perform testing in accordance with UL 1449.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. As specified in Section 26 05 00.
- B. Follow the manufacturer's recommended installation practices and comply with all applicable codes.
- C. Special techniques:
 - 1. Install the SPD with as short and straight conductors including ground conductor as practically possible:
 - a. Twist the input conductors together to reduce input conductor inductance.
 - 2. Do not subject SPD to insulation resistance testing.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

- A. As specified in Section 01 75 17.

3.08 FIELD QUALITY CONTROL

- A. As specified in Section 26 08 50.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

- A. As specified in Section 26 05 00.

3.12 SCHEDULES (NOT USED)

END OF SECTION 26 43 14