



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES

**Division of Facilities Construction and Management**

**DFCM**

**MULTI-STEP BIDDING PROCESS  
FOR  
CONTRACTORS**

**Request For Solicitation For  
Construction Services**

**Stage II – Electrical Contractors Bidders List FY09**

**September 18, 2008**

**GENERATOR UPGRADE  
OFFICE OF THE MEDICAL EXAMINER**

**DEPARTMENT OF HEALTH  
SALT LAKE CITY, UTAH**

**DFCM Project No. 08081390**

Envision Engineering  
244 West 300 North  
Salt Lake City, Utah 84103

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Current copies of the following documents are hereby made part of these contract documents by reference. These documents are available on the DFCM web site at <http://dfcm.utah.gov> or are available upon request from DFCM:

DFCM Supplemental General Conditions dated July 15, 2008  
DFCM General Conditions dated May 25, 2005  
DFCM Application and Certificate for Payment dated May 25, 2005

Technical Specifications:  
Drawings:

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

## INVITATION TO BID

**ONLY FIRMS PRE-QUALIFIED DURING STAGE I OF THE RFS ARE ALLOWED TO BID ON THIS PROJECT**

The State of Utah - Division of Facilities Construction and Management (DFCM) is requesting bids for the construction of the following project:

**GENERATOR UPGRADE – OFFICE OF THE MEDICAL EXAMINER**  
**DEPARTMENT OF HEALTH – SALT LAKE CITY, UTAH**  
**DFCM PROJECT NO: 08081390**

Project Description: Installation of a new generator, concrete generator pad, fencing, and various electrical modifications. Construction Cost Estimate: \$ 225,000.00.

<b>Company</b>	<b>Contact</b>	<b>Fax</b>
Electro Specialist, Inc.	Jeff Davis	(801) 572-5658
Hidden Peak Electric Co., Inc.	Derek Lee	(801) 262-5689
Integrated Controls & Electric Inc	Rick Bowen	(801) 732-0452
KGM Electric L.L.C.	Kim Madsen	(435) 835-1790
Patriot Construction	Roan Poulter	(888) 867-1845
Positive Power, LLC	George Langlois	(801) 731-8908
Power Electric Company	Joseph Gormally	(801) 288-1065
Probst Electric	Mr. Riley Probst	(435) 657-1956
Taylor Electric and Engineering	Ryan J. Taylor	(801) 413-1361
Utah Controls, Inc.	Scott Porter	(801) 990-1955
Wade Electric	Shawn L. Wade	(801) 467-3944

The bid documents will be available at 4:00 PM on Thursday, September 18, 2008 in electronic format only on CDs from DFCM at 4110 State Office Building, Salt Lake City, Utah 84114, telephone (801)538-3018 and on the DFCM web page at <http://dfcm.utah.gov>. For questions regarding this project, please contact Brian Bales, Project Manager, DFCM, at (801)-538-3417 No others are to be contacted regarding this project.

A **MANDATORY** pre-bid meeting and site visit will be held at 2:00 PM on Monday, September 22, 2008 at the Office of the Medical Examiner, 48 North Medical Drive, Salt Lake City, Utah (University of Utah Campus). Parking is limited, please plan accordingly. Reference the satellite map provided on the DFCM project web site. All pre-qualified prime contractors wishing to bid on this project must attend this meeting.

Bids must be submitted by 3:30 PM on Wednesday, October 1, 2008 to DFCM, 4110 State Office Building, Salt Lake City, Utah 84114. Bids will be opened and read aloud in the DFCM Conference Room, 4110 State Office Building, Salt Lake City, Utah. Note: Bids must be received at 4110 State Office Building by the specified time. The contractor shall comply with and require all of its subcontractors to comply with the license laws as required by the State of Utah.

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

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

**DIVISION OF FACILITIES CONSTRUCTION AND MANAGEMENT**  
**MARLA WORKMAN, CONTRACT COORDINATOR**  
4110 State Office Bldg., Salt Lake City, Utah 84114

## **STAGE II - MULTI-STEP BIDDING PROCESS**

**ONLY FIRMS PRE-QUALIFIED DURING STAGE I OF THE RFS ARE ALLOWED TO BID ON THIS PROJECT**

### **1. Invitational Bid Procedures**

The following is an overview of the invitational bid process. More detailed information is contained throughout the document. Contractors are responsible for reading and complying with all information contained in this document.

Notification: DFCM will notify each registered pre-qualified firm (via fax or e-mail) when a project is ready for Construction Services and invite them to bid on the project.

Description of Work: A description of work or plans/specifications will be given to each contractor. If required, the plans and specifications will be available on the DFCM web page at <http://dfcm.utah.gov> and on CDs from DFCM, at 4110 State Office Building, Salt Lake City, Utah 84114.

Schedule: The Stage II Schedule shows critical dates including the mandatory pre-bid site meeting (if required), the question and answer period, the bid submittal deadline, the subcontractor list submittal deadline, etc. Contractors are responsible for meeting all deadlines shown on the schedule.

Mandatory Pre-Bid Site Meeting: If a firm fails to attend a pre-bid site meeting labeled “Mandatory” they will not be allowed to bid on the project. At the mandatory meeting, contractors may have an opportunity to inspect the site, receive additional instructions and ask questions about project. The schedule contains information on the date, time, and place of the mandatory pre-bid site meeting.

Written Questions: All questions must be in writing and directed to DFCM’s project manager assigned to this project. No others are to be contacted regarding this project. The schedule contains information on the deadline for submitting questions.

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

Submitting Bids: Bids must be submitted to DFCM 4110 State Office Building, Salt Lake City, Utah 84114 by the deadline indicated on the schedule. Bids submitted after the deadline will not be accepted. Bids will be opened at DFCM on the date, time, and place indicated on the schedule.

Subcontractors List: The firm selected for the project must submit a list of all subcontractors by the deadline indicated on the schedule contained in this document.

Pre-qualified List of Contractors: Contractors shall remain on DFCM’s list of pre-qualified contractors provided: (a) they maintain a performance rating of 3.5 or greater on each project, (b) they are not suspended for failure to comply with requirements of their contract, (c) the firm has not undergone a significant reorganization involving the loss of key personnel (site superintendents, project managers, owners, etc.) to a degree such that the firm no longer meets the pre-qualification requirements outlined in Stage I, (d) the financial viability of the firm has not significantly changed, and (e) the firm is not otherwise disqualified by DFCM. Note: If a contractor fails to comply with items (a) through (e) above,

they may be removed from DFCM's list of pre-qualified contractors following an evaluation by a review committee. Contractors will be given the opportunity to address the review committee before a decision is made. Pre-qualified contractors are ONLY authorized to bid on projects within the discipline that they were originally pre-qualified under.

**2. Drawings and Specifications and Interpretations**

Drawings, specifications and other contract documents may be obtained as stated in the Invitation to Bid. If any firm is in doubt as to the meaning or interpretation of any part of the drawings, specifications, scope of work or contract documents, they shall submit, in writing, a request for interpretation to the authorized DFCM representative by the deadline identified in the schedule. Answers to questions and interpretations will be made via addenda issued by DFCM. Neither DFCM or the designer shall be responsible for incorrect information obtained by contractors from sources other than the official drawings/specifications and addenda issued by DFCM.

**3. Product Approvals**

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

**4. Addenda**

All clarifications from DFCM will be in writing and issued as an addendum to the RFS. Addenda will be posted on DFCM's web site at <http://dfcm.utah.gov>. Contractors are responsible for obtaining information contained in each addendum from the web site. Addenda issued prior to the submittal deadline shall become part of the bidding process and must be acknowledged on the bid form. Failure to acknowledge addenda shall result in disqualification from bidding. DFCM shall not be responsible for incorrect information obtained by contractors from sources other than official addenda issued by DFCM.

**5. Financial Responsibility of Contractors, Subcontractors and Sub-subcontractors**

Contractors shall respond promptly to any inquiry in writing by DFCM to any concern of financial responsibility of the Contractor, Subcontractor or Sub-subcontractor. Failure to respond may result in suspension from DFCM's list of pre-qualified contractors.

**6. Licensure**

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

**7. Permits**

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

**8. Time is of the Essence**

Time is of the essence in regard to all the requirements of the contract documents.

**9. Bids**

Before submitting a bid, each bidder shall carefully examine the contract documents; shall visit the site of the work; shall fully inform themselves as to all existing conditions and limitations; and shall include in the bid the cost of all items required by the contract documents including those added via addenda. If the bidder observes that portions of the contract documents are at variance with applicable laws, building codes, rules, regulations or contain obvious erroneous or uncoordinated information, the bidder shall promptly notify the DFCM Project Manager prior to the bidding deadline. Changes necessary to correct these issues will be made via addenda issued by DFCM.

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

Bid bond security, in the amount of five percent (5%) of the bid, made payable to the Division of Facilities Construction and Management, shall accompany bid. **THE BID BOND MUST BE ON THE BID BOND FORM PROVIDED IN THE PROCUREMENT DOCUMENTS IN ORDER TO BE CONSIDERED AN ACCEPTABLE BID.**

If the bid bond security is submitted on a form other than DFCM's required bid bond form, and the bid security meets all other legal requirements, the bidder will be allowed to provide an acceptable bid bond by the close of business on the next business day following notification by DFCM of submission of a defective bid bond security. **A cashier's check cannot be used as a substitute for a bid bond.**

**10. Listing of Subcontractors**

Listing of Subcontractors shall be as summarized in the "Instructions and Subcontractor's List Form", included as part of the contract documents. The subcontractors list shall be delivered to DFCM or faxed to DFCM at (801) 538-3677 within 24 hours of the bid opening. Requirements for listing additional subcontractors will be listed in the contract documents.

DFCM retains the right to audit or take other steps necessary to confirm compliance with requirements for the listing and changing of subcontractors. Any contractor who is found to not be in compliance with these requirements may be suspended from DFCM's list of pre-qualified contractors.

**11. Contract and Bond**

The Contractor's Agreement will be in the form provided in this document. The duration of the contract shall be for the time indicated by the project completion deadline shown on the schedule. The successful bidder, simultaneously with the execution of the Contractor's Agreement, will be required to furnish a performance bond and a payment bond, both bearing original signatures, upon the forms provided in the procurement documents.

The performance and payment bonds shall be for an amount equal to one hundred percent (100%) of the Contract Sum and secured from a company that meets the requirements specified in the requisite forms. Any bonding requirements for Subcontractors will be specified in the Supplementary General Conditions.

**12. Award of Contract**

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

**13. Right to Reject Bids**

DFCM reserves the right to reject any or all Bids.

**14. Withdrawal of Bids**

Bids may be withdrawn on written request received from bidders within 24 hours after the bid opening if the contractor has made an error in preparing the bid.

**15. DFCM Contractor Performance Rating**

As a contractor completes each project, DFCM will evaluate project performance based on the enclosed "DFCM Contractor Performance Rating" form. The ratings issued on this project may affect the firm's "pre-qualified" status and their ability to obtain future work with DFCM.



## Stage II PROJECT SCHEDULE

<b>PROJECT NAME: GENERATOR UPGRADE – OFFICE OF THE MEDICAL EXAMINER DEPARTMENT OF HEALTH – SALT LAKE CITY, UTAH</b>				
<b>DFCM PROJECT #: 08081390</b>				
<b>Event</b>	<b>Day</b>	<b>Date</b>	<b>Time</b>	<b>Place</b>
Stage II Bidding Documents Available	Thursday	September 18, 2008	4:00 PM	DFCM 4110 State Office Building SLC, UT and the DFCM web site*
Mandatory Pre-bid Site Meeting	Monday	September 22, 2008	2:00 PM	Office of the Medical Examiner 48 North Medical Drive Salt Lake City, UT (U of U Campus- see map)
Deadline for Submitting Questions	Wednesday	September 24, 2008	1:00 PM	Brian Bales– DFCM E-mail brbales@utah.gov Fax (801)-538-3267
Addendum Deadline (exception for bid delays)	Monday	September 29, 2008	2:00 PM	DFCM web site*
Prime Contractors Turn in Bid and Bid Bond	Wednesday	October 1, 2008	3:30 PM	DFCM 4110 State Office Building SLC, UT
Subcontractors List Due	Thursday	October 2, 2008	3:30 PM	DFCM 4110 State Office Building SLC, UT Fax 801-538-3677
Substantial Completion Date	Wednesday	March 25, 2009		

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



**Division of Facilities Construction and Management**

**BID FORM**

NAME OF BIDDER \_\_\_\_\_ DATE \_\_\_\_\_

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

The undersigned, responsive to the "Invitation to Bid" and in accordance with the Request for Bids for the **GENERATOR UPGRADE – OFFICE OF THE MEDICAL EXAMINER – DEPARTMENT OF HEALTH SALT LAKE CITY, UTAH - DFCM PROJECT NO. 08081390** and having examined the Contract Documents and the site of the proposed Work and being familiar with all of the conditions surrounding the construction of the proposed Project, including the availability of labor, hereby proposes to furnish all labor, materials and supplies as required for the Work in accordance with the Contract Documents as specified and within the time set forth and at the price stated below. This price is to cover all expenses incurred in performing the Work required under the Contract Documents of which this bid is a part:

I/We acknowledge receipt of the following Addenda: \_\_\_\_\_

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

\_\_\_\_\_ DOLLARS (\$\_\_\_\_\_)

(In case of discrepancy, written amount shall govern)

I/We guarantee that the Work will be Substantially Complete by **March 25, 2009**, should I/we be the successful bidder, and agree to pay liquidated damages in the amount of **\$350.00** per day for each day after expiration of the Contract Time as stated in Article 3 of the Contractor's Agreement.

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

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

The undersigned Contractor's License Number for Utah is \_\_\_\_\_.

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Upon receipt of notice of award of this bid, the undersigned agrees to execute the contract within ten (10) days, unless a shorter time is specified in Contract Documents, and deliver acceptable Performance and Payment bonds in the prescribed form in the amount of 100% of the Contract Sum for faithful performance of the contract. The Bid Bond attached, in the amount not less than five percent (5%) of the above bid sum, shall become the property of the Division of Facilities Construction and Management as liquidated damages for delay and additional expense caused thereby in the event that the contract is not executed and/or acceptable 100% Performance and Payment bonds are not delivered within time set forth.

Type of Organization: \_\_\_\_\_  
(Corporation, Partnership, Individual, etc.)

Any request and information related to Utah Preference Laws:

\_\_\_\_\_

Respectfully submitted,

\_\_\_\_\_  
Name of Bidder

ADDRESS:  
\_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_\_  
Authorized Signature

**BID BOND**

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

**KNOW ALL PERSONS BY THESE PRESENTS:**

That \_\_\_\_\_ hereinafter referred to as the "Principal," and \_\_\_\_\_, a corporation organized and existing under the laws of the State of \_\_\_\_\_, with its principal office in the City of \_\_\_\_\_ and authorized to transact business in this State and U. S. Department of the Treasury Listed, (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); hereinafter referred to as the "Surety," are held and firmly bound unto the STATE OF UTAH, hereinafter referred to as the "Obligee," in the amount of \$ \_\_\_\_\_ (5% of the accompanying bid), being the sum of this Bond to which payment the Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

**THE CONDITION OF THIS OBLIGATION IS SUCH** that whereas the Principal has submitted to Obligee the accompanying bid incorporated by reference herein, dated as shown, to enter into a contract in writing for the \_\_\_\_\_ Project.

**NOW, THEREFORE, THE CONDITION OF THE ABOVE OBLIGATION IS SUCH**, that if the said principal does not execute a contract and give bond to be approved by the Obligee for the faithful performance thereof within ten (10) days after being notified in writing of such contract to the principal, then the sum of the amount stated above will be forfeited to the State of Utah as liquidated damages and not as a penalty; if the said principal shall execute a contract and give bond to be approved by the Obligee for the faithful performance thereof within ten (10) days after being notified in writing of such contract to the Principal, then this obligation shall be null and void. It is expressly understood and agreed that the liability of the Surety for any and all defaults of the Principal hereunder shall be the full penal sum of this Bond. The Surety, for value received, hereby stipulates and agrees that obligations of the Surety under this Bond shall be for a term of sixty (60) days from actual date of the bid opening.

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

**IN WITNESS WHEREOF**, the above bounden parties have executed this instrument under their several seals on the date indicated below, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

**DATED** this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_\_ .

**Principal's name and address (if other than a corporation):**

\_\_\_\_\_  
\_\_\_\_\_

By: \_\_\_\_\_

Title: \_\_\_\_\_

**Principal's name and address (if a corporation):**

\_\_\_\_\_  
\_\_\_\_\_

By: \_\_\_\_\_

Title: \_\_\_\_\_  
(Affix Corporate Seal)

**Surety's name and address:**

\_\_\_\_\_  
\_\_\_\_\_

By: \_\_\_\_\_  
Attorney-in-Fact (Affix Corporate Seal)

STATE OF \_\_\_\_\_ )  
 ) ss.  
COUNTY OF \_\_\_\_\_ )

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

Subscribed and sworn to before me this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_.  
My Commission Expires: \_\_\_\_\_  
Resides at: \_\_\_\_\_

**Agency:** \_\_\_\_\_  
**Agent:** \_\_\_\_\_  
**Address:** \_\_\_\_\_  
**Phone:** \_\_\_\_\_

\_\_\_\_\_  
NOTARY PUBLIC

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

**Division of Facilities Construction and Management****INSTRUCTION AND SUBCONTRACTORS LIST FORM**

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

**DOLLAR AMOUNTS FOR LISTING**

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

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

**LICENSURE:**

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

**'SPECIAL EXCEPTION':**

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

**GROUNDS FOR DISQUALIFICATION:**

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

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

**CHANGES OF SUBCONTRACTORS SPECIFICALLY IDENTIFIED ON SUBLIST FORM:**

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

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

**EXAMPLE:**

Example of a list where there are only four subcontractors:

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

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

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



## CONTRACTOR'S AGREEMENT

FOR:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

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

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

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

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

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

The DFCM General Conditions ("General Conditions") dated May 25, 2005 and Supplemental General Conditions dated July 15, 2008 ("also referred to as General Conditions") and on file at the office of DFCM and available on the DFCM website, are hereby incorporated by reference as part of this Agreement and are included in the specifications for this Project. All terms used in this Contractor's Agreement shall be as defined in the Contract Documents, and in particular, the General Conditions.

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

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

CONTRACTOR'S AGREEMENT  
PAGE NO. 2

Performance Bond and a 100% Payment Bond as well as all insurance requirements of the Contractor. Said bonds have already been posted by the Contractor pursuant to State law. The required proof of insurance certificates have been delivered to DFCM in accordance with the General Conditions before the execution of this Contractor's Agreement.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



**PERFORMANCE BOND**

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

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

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

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

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

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

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

**IN WITNESS WHEREOF**, the said Principal and Surety have signed and sealed this instrument this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_\_.

**WITNESS OR ATTESTATION:**

\_\_\_\_\_

**PRINCIPAL:**

\_\_\_\_\_

By: \_\_\_\_\_

(Seal)

Title: \_\_\_\_\_

**WITNESS OR ATTESTATION:**

\_\_\_\_\_

**SURETY:**

\_\_\_\_\_

By: \_\_\_\_\_

Attorney-in-Fact (Seal)

STATE OF \_\_\_\_\_ )  
 ) ss.  
COUNTY OF \_\_\_\_\_ )

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

Subscribed and sworn to before me this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_\_.

My commission expires: \_\_\_\_\_

Resides at: \_\_\_\_\_

\_\_\_\_\_  
NOTARY PUBLIC

**Agency:** \_\_\_\_\_  
**Agent:** \_\_\_\_\_  
**Address:** \_\_\_\_\_  
**Phone:** \_\_\_\_\_

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

**PAYMENT BOND**

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

**KNOW ALL PERSONS BY THESE PRESENTS:**

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

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

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

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

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

**IN WITNESS WHEREOF**, the said Principal and Surety have signed and sealed this instrument this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_.

**WITNESS OR ATTESTATION:**

\_\_\_\_\_

**PRINCIPAL:**

\_\_\_\_\_

By: \_\_\_\_\_ (Seal)  
Title: \_\_\_\_\_

**WITNESS OR ATTESTATION:**

\_\_\_\_\_

**SURETY:**

\_\_\_\_\_

By: \_\_\_\_\_ (Seal)  
Attorney-in-Fact

STATE OF \_\_\_\_\_ )  
 ) ss.  
COUNTY OF \_\_\_\_\_ )

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

Subscribed and sworn to before me this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_.

My commission expires: \_\_\_\_\_

Resides at: \_\_\_\_\_

\_\_\_\_\_  
NOTARY PUBLIC

**Agency:** \_\_\_\_\_  
**Agent:** \_\_\_\_\_  
**Address:** \_\_\_\_\_  
**Phone:** \_\_\_\_\_

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



Division of Facilities Construction and Management

DFCM

CERTIFICATE OF SUBSTANTIAL COMPLETION

PROJECT \_\_\_\_\_ PROJECT NO: \_\_\_\_\_

AGENCY/INSTITUTION \_\_\_\_\_

AREA ACCEPTED \_\_\_\_\_

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

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

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

\_\_\_\_\_  
\_\_\_\_\_

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

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

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

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

\_\_\_\_\_  
CONTRACTOR (include name of firm) by: \_\_\_\_\_  
(Signature) DATE

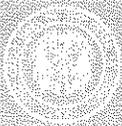
\_\_\_\_\_  
A/E (include name of firm) by: \_\_\_\_\_  
(Signature) DATE

\_\_\_\_\_  
USING INSTITUTION OR AGENCY by: \_\_\_\_\_  
(Signature) DATE

\_\_\_\_\_  
DFCM (Owner) by: \_\_\_\_\_  
(Signature) DATE

4110 State Office Building, Salt Lake City, Utah 84114  
telephone 801-538-3018 • facsimile 801-538-3267 • <http://dfcm.utah.gov>

cc: Parties Noted  
DFCM, Director

**General Contractor Performance Rating Form**

Project Name:		DFCM Project#	
Contractor:  (ABC Construction, John Doe, 111-111-1111)	A/E:  (ABC Architects, Jane Doe, 222-222-2222)	Original Contract Amount:	Final Contract Amount:
DFCM Project Manager:		Contract Date:	
Completion Date:		Date of Rating:	

Rating Guideline	QUALITY OF PRODUCT OR SERVICES	COST CONTROL	TIMELINESS OF PERFORMANCE	BUSINESS RELATIONS
<b>5-Exceptional</b>	Contractor has demonstrated an exceptional performance level in any of the above four categories that justifies adding a point to the score. Contractor performance clearly exceeds the performance levels described as "Very Good"			
<b>4-Very Good</b>	Contractor is in compliance with contract requirements and/or delivers quality product/service.	Contractor is effective in managing costs and submits current, accurate, and complete billings	Contractor is effective in meeting milestones and delivery schedule	Response to inquiries, technical/service/administrative issues is effective
<b>3-Satisfactory</b>	Minor inefficiencies/errors have been identified	Contractor is usually effective in managing cost	Contractor is usually effective in meeting milestones and delivery schedules	Response to inquires technical/service/administrative issues is somewhat effective
<b>2-Marginal</b>	Major problems have been encountered	Contractor is having major difficulty managing cost effectively	Contractor is having major difficulty meeting milestones and delivery schedule	Response to inquiries, technical/service/administrative issues is marginally effective
<b>1-Unsatisfactory</b>	Contractor is not in compliance and is jeopardizing achievement of contract objectives	Contractor is unable to manage costs effectively	Contractor delays are jeopardizing performance of contract objectives	Response to inquiries, technical/service/administrative issues is not effective

<b>1. Rate Contractors quality of workmanship, management of sub contractor performance, project cleanliness, organization and safety requirement.</b>	<b>Score</b>
<u>Agency Comments:</u>	
<u>A &amp; E Comments:</u>	
<u>DFCM Project Manager Comments:</u>	

<b>2. Rate Contractor administration of project costs, change orders and financial management of the project budget.</b>	<b>Score</b>
<u>Agency Comments:</u>	
<u>A &amp; E Comments:</u>	
<u>DFCM Project Manager Comments:</u>	

<b>3. Rate Contractor's performance and adherence to Project Schedule, delay procedures and requirements of substantial completion, inspection and punch-list performance.</b>	<b>Score</b>
<u>Agency Comments:</u>	
<u>A &amp; E Comments:</u>	
<u>DFCM Project Manager Comments:</u>	

<b>4. Evaluate performance of contractor management team including project manager, engineer and superintendent also include in the rating team's ability to work well with owner, user agency and consultants.</b>	<b>Score</b>
<u>Agency Comments:</u>	
<u>A &amp; E Comments:</u>	
<u>DFCM Project Manager Comments:</u>	

5. Rate success of Contractor's management plan, completion of the plans mitigation of project risks and performance of value engineering concepts.	Score
<u>Agency Comments:</u>	
<u>A &amp; E Comments:</u>	
<u>DFCM Project Manager Comments:</u>	

<b>Signed by:</b>	<b>Date:</b>	<b>Mean Score</b>
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**Additional Comments:**

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## SECTION 16001 - ELECTRICAL GENERAL PROVISIONS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Architectural, Structural, Mechanical and other applicable documents also apply to work of this section.

## 1.2 DESCRIPTION OF WORK:

- A. The contract documents indicate the extent of electrical work. Provide all labor, materials, equipment, supervision and service necessary for a complete electrical system as described in division 16.

## 1.3 RELATED SECTIONS:

- A. Other Divisions relating to electrical work apply to the work of this section. See other applicable Divisions including, but not necessarily limited to:

## 1.4 INTERPRETATIONS OF DRAWINGS AND SPECIFICATIONS:

- A. Prior to bidding the job, submit requests for clarification in writing to the Architect/Engineer prior to issuance of the final addendum.
- B. After signing the contract, provide all materials, labor, and equipment to meet the intent, purpose, and function of the contract documents.
- C. The following terms used in Division 16 documents are defined as follows:
  - 1. "Provide" - Means furnish, install, and connect, unless otherwise indicated.
  - 2. "Furnish" - Means purchase new and deliver in operating order to project site.
  - 3. "Install" - Means to physically install the items in-place.
  - 4. "Connect" - Means make final electrical connections for a complete operating piece of equipment. This includes providing conduit, wire, terminations, etc. as applicable.
  - 5. "Or Equivalent" - Means to provide equivalent equipment. Such equipment must be approved by the Engineer prior to bidding.

## 1.5 EXAMINATION OF SITE:

- A. Visit the site and verify existing field conditions prior to submitting bid.
- B. All costs arising from site conditions and/or preparation shall be included in the base bid. No additional charges will be allowed due to inadequate site inspection.

## 1.6 QUALITY ASSURANCE:

- A. Perform work in accordance with all governing codes, rules, and regulations including the following minimum codes (latest editions or as otherwise accepted by the Authorities Having Jurisdiction):
1. National Electric Code (NEC)
  2. International Building Code (IBC)
  3. International Fire Code (IFC)
  4. International Mechanical Code (IMC)
  5. International Plumbing Code (IPC)
  6. American Disability Act (ADA)
  7. National Electrical Safety Code (NESC)
  8. Local Codes and Ordinances
- B. Comply with all standards where applicable for equipment and materials including the following minimum standards:
1. Underwriter's Laboratories (UL)
  2. American Society for testing Materials (ASTM)
  3. Certified Ballast Manufacturers (CBM)
  4. Insulated Cable Engineers Association (ICEA)
  5. National Electrical Manufacturer's Institute (NEMA)
  6. American National Standards Institute (ANSI)
  7. Electrical Testing Laboratories (ETL)
  8. National Fire Protection Association (NFPA)
  9. Institute of Electrical and Electronics Engineers (IEEE)
  10. American Institute of Electrical Engineer's Electrical Power
  11. Systems and Grounding in Commercial Construction
  12. Illuminating Engineers Society (IES)
- C. Provide new electrical equipment conforming to all requirements as set forth in the above standards. Provide UL labeled equipment where such label is applicable.
- D. Comply with all state and local codes and ordinances. When conflicts occur among codes, standards, drawings, and/or specifications, the most stringent requirements shall govern.
- E. Obtain all permits, inspections, etc. required by authority having jurisdiction. Include all fees in bid. Provide a certificate of approval to the owner's representative from the inspection authority at completion of the work.
- F. Provide only first-class workmanship from competent workers, conforming to the best electrical construction practices.
- G. The contractor shall have a current state contracting license applicable to type of work to be performed under this contract.

## 1.7 SUBMITTALS:

- A. Shop Drawings: After the contract is awarded, but prior to manufacture or installation of any equipment, submit eight (8) complete sets of shop drawings. Partially complete sets of shop drawings are not acceptable. Submit all shop drawings in one complete submittal package. Prior to submitting shop drawings, review and certify that they are in compliance with the contract documents; Sign all approved shop drawings. Allow a minimum of two weeks for architect/engineer to review shop drawings. Refer to architectural general provision section for additional requirements.

- B. Provide equipment catalog "cut sheets", brochures and/or drawings which clearly describe the proposed equipment. Include plans, elevations, sections, isometrics, and detailed engineering and dimensional information as applicable including equipment room layouts. Electrical room layouts are required to show all electrical equipment locations for all projects that include electrical rooms. Do not submit catalog sheets which describe several different items in addition to those items to be used, unless all relevant information is clearly identified. Bind each information set in three ring binder or binders of sufficient size or sizes to enclose all information. Organize all information by section. Provide separate tabbed covers for each section of Divisions 16 indicating section number for each section requiring submittals.
- C. Include on front cover of binder or binders the name and location of the project, architect, electrical engineer, general contractor, electrical contractor, subcontractors, supplier/vendor, order number, volume, date, and any other applicable information. Certify that shop drawings are submitted in accordance with the contract documents with a written statement indicating compliance. Submittals will be reviewed and comments produced two times maximum. Additional reviews will be billed at current rates.

#### 1.8 OPERATION AND MAINTENANCE MANUALS:

- A. Submit four (4) complete sets of operating instruction and maintenance manuals for all equipment and materials provided under Divisions 16 prior to the Substantial Completion Inspection.
- B. Provide manufacturer's recommended operating and maintenance instructions, cleaning and servicing requirements, serial and model number of each piece of equipment, complete list of replacement parts, performance curves and data, wiring diagrams, warranties, and vendor's name, address, and phone numbers. Do not submit information which describes several different items in addition to those items to be used, unless all relevant information is clearly identified. Assemble all data in completely indexed volume or volumes. Engrave the job title, and name, address, and phone numbers of the contractor on the front cover and on the spine. Incomplete O&M manuals will be returned to the contractor for corrections / additions.

#### 1.9 RECORD DRAWINGS:

- A. Maintain on a daily basis a complete set of "Red-Lined Drawings", reflecting an accurate record of all work including addendums, revisions, and changes. Indicate precise dimensioned locations of all concealed work and equipment, including concealed or embedded conduit, junction boxes, etc. Record all "Red-Lined Drawing" information on a set of full sized prints of the contract drawings.
- B. Certify the "Red Lined Drawings" for correctness. Indicate on each drawing the name of the general and electrical contractors with signatures of each representative responsible for the work.
- C. The electrical engineering design firm will create record (as-built) drawings from the certified red-lined drawings; however, the general and electrical contractors retain the responsibility for the accuracy of the record drawings.

#### 1.10 WARRANTY:

- A. Ensure that the electrical system installed under this contract is in proper working order and in compliance with drawings, specifications, and/or authorized changes and is free from electrical defects. Without additional charge, replace or repair, to satisfaction of the owner's representative, except from ordinary wear and tear, any part of the installation which may fail or be determined unacceptable within a period of one (1) year after final acceptance or as

otherwise indicated in individual sections, but in no case less than one year. Warranty incandescent and fluorescent lamps only for a period of two months from the date of substantial completion.

- B. Provide complete warranty information for each item including beginning of warranty period, duration of warranty, names, addresses, and telephone numbers and procedures for filling a claim and obtaining warranty services. Written warranties and guarantees are to be submitted separately as:
  - 1. Originals bound in a binder clearly identified with the title, "WARRANTIES AND GUARANTEES," the project name, the project number, and the Contractor's business name.
  - 2. Electronic documents in \*.pdf format.

## PART 2 – PRODUCTS

### 2.1 GENERAL:

- A. All materials shall be new and shall bear the manufacturer's name, trade name, and the approved testing laboratory such as the UL label in every case where a standard has been established for that particular material. Used materials are acceptable only if specifically indicated on drawings.

### 2.2 SUBSTITUTION OF MATERIALS:

- A. Provide only specified products or products approved by addendum. Substitutions will be considered if two copies of the proposal is received at the architect's/engineer's office eight (8) working days prior to the bid day. Include in the proposal the specified and proposed catalog numbers of the equipment under consideration and a catalog cut sheet(s) with pictorial and descriptive information. Certify that the equipment proposed is equal to that specified, that it has the same electrical and physical characteristics, compatible dimensions, and meets the functional intent of the contract documents.
- B. It is the responsibility of the contractor to make all substituted equipment comply with the intent of the contract documents and bear all cost associated with conflicts arising from the use of substituted equipment.
- C. Provide samples if so required by the architect or engineer before or after bid day.

### 2.3 SPARE PARTS:

- A. Provide spare parts as specified in Divisions 16 sections. Deliver all spare parts to owner's representative prior to substantial completion.

## PART 3 – EXECUTION

### 3.1 GENERAL:

- A. Workmanship: Provide only first class workmanship from competent workers. Defective materials or workmanship will not be allowed on the project. Provide competent supervision for the work to be accomplished. Keep same foreman on the job, unless a change is authorized

by the engineer.

- B. Coordination: Prior to construction, layout electrical work and coordinate work with other trades. Sequence, coordinate, and integrate installation of materials and equipment for efficient flow of the work. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components. Coordinate with all utilities including power, communication, and data installations.
- C. Provide cutting, drilling, channeling, etc. only as necessary for proper completion of the work. Do not cut structural members unless authorization is issued in writing by the architect/engineer.
- D. Repairs: Repair damage to building, grounds, or utilities as a result of work under this contract at no additional cost to the owner.
- E. Dimensioning: Electrical drawings indicate locations for electrical equipment only in their approximate location, unless specifically dimensioned. Do not scale electrical drawings for dimensional information. Refer to architectural drawings and shop drawings where applicable for locations of all electrical equipment. Field verify all dimension on the job site.
- F. Provide block-outs, sleeves, demolition work, etc., required for installation of work specified in this division.
- G. Standards: Provide electrical installation in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- H. All workmen doing work of any nature on State of Utah projects must at all times carry their electrician's license with them and show it upon request. The acceptable ratio of apprentice to journeyman electricians on the job is 1:1.

### 3.2 REQUESTS FOR INFORMATION:

- A. When it is clearly apparent that information is not adequately described in the construction documents or when a coordination problem exists, submit a request for information (RFI) through proper contractual channels. The electrical engineering design firm will provide a response through its contractual channel. Although verbal direction may be given to expedite changes, responses are not considered part of the contract documents until a change order has been issued and signed by the Owner or his designated representative. The Contractor shall bear all costs associated with proceeding on any change order that has not been approved by the Owner or his designated representative.
- B. It is not the electrical engineering design firm's responsibility to answer questions that could clearly be answered by a thorough review of the construction documents. Should an RFI be issued by the Contractor where information was available, the electrical engineering firm will bill the contractor at the following rates:
 

1.	Principal	\$135.00 / Hr.
2.	Engineer	\$100.00 / Hr.
3.	Designer	\$ 75.00 / Hr.
4.	Construction Administrator	\$ 70.00 / Hr.
5.	Drafting	\$ 60.00 / Hr.
6.	Clerical	\$ 45.00 / Hr.

- C. Any damages caused by construction delays due to frivolous RFI's, will be born solely by the Contractor.

### 3.3 SAFETY PRECAUTIONS:

- A. Provide all necessary guards or construction barriers and take all necessary precautions to insure the safety of life and property.

### 3.4 CLEAN:

- A. Clean up all equipment, conduit, fittings, wire, packing cartons, plastic, and other debris that is a direct result of the installation of the work of this division, both during the execution, and at the conclusion, of the project. Keep the site clean and safe during the progress of the work. Clean fixtures, interior and exterior of all equipment, and raceways prior to final acceptance. Vacuum interior of all electrical panels and equipment. Correct any damaged equipment. Touch-up or repaint if necessary.

### 3.5 TEMPORARY POWER:

- A. Make arrangements with the proper institution authority for all temporary electricity.
- B. Provide temporary power, complete with metering and wiring for lighting and power outlets for construction tools and equipment. Report the initial meter reading to the owner/institution, or otherwise as may be directed.
- C. Service shall be provided with a main disconnect and all 20 ampere receptacles protected by 20 amp GFI, single-pole breakers. No attempt is made herein to specify construction power requirements for equipment in detail. Provide all electrical equipment and wiring as required.
- D. As soon as permanent power and metering is available, the temporary power supply shall be disconnected and removed from the project site.
- E. All temporary wiring shall meet the requirements of NEC Article 305 and the State Industrial Commission.

### 3.6 POWER OUTAGES:

- A. All power outages required for execution of this work shall occur during non-standard working hours and at the convenience of the owner. Any electrical service interruption will be coordinated at least 7 days in advance of the power shut-off. Include all costs for overtime work in bid. Coordinate all outages and proceed only after receiving authorization from the owner's representative. Keep all outages to an absolute minimum.

### 3.7 STORAGE AND PROTECTION OF MATERIALS:

- A. Provide storage space for storage of materials and apparatus and assume complete responsibility for all losses due to any cause whatsoever. Lost or damaged materials will be replaced at no additional cost to owner. Do not store materials and apparatus in any public thoroughfare or in any area on the site where such storage would constitute a hazard to persons in the vicinity. Protect completed work, work underway, and apparatus against loss or damage.

### 3.8 EXCAVATING FOR ELECTRICAL WORK:

- A. Verification: Prior to excavating, locate and protect existing utilities and other underground

work in a manner which will ensure that no damage or service interruption will result from excavating and backfilling. Observe all State and Local codes prior to excavating. Do not disturb walls, footings, and other structural members in any way.

- B. Protection: Provide barricades, warning signs, and illumination to protect persons from injury at excavations. Provide temporary coverings and heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install electrical work on frozen excavation bases or subbases.
- C. Coordination: Do not excavate for electrical work until the work is ready to proceed without delay.
- D. Excavated Materials: Temporarily store excavated materials near excavation in manner which will not interfere with or damage excavation or other work. Dispose of and remove excavated materials which are either in excess of quantity needed for backfilling or do not comply with the requirements for backfill material.
- E. Burial Depths: Burial depths must comply with NEC Section 300-5 (or State of Utah requirements, whichever is more stringent), unless noted otherwise on drawings.
- F. Excavation Permits: Obtain all shut-down and excavation permits as may be required for proper completion of the work.

### 3.9 BACKFILL MATERIALS:

- A. For buried conduits or cables (other than below slab-on-grade, or concrete-encased), provide 2" thickness of well-graded sand on all sides of conduits or cables.
- B. For trench backfill to within 6" of final grade, provide soil material suitable for compacting to required densities.
- C. For top 6" of excavation, provide top soil.
- D. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (percent of maximum density, ASTM D 1557), using power-driven hand-operated compaction equipment:
  - 1. Lawn/Landscaped Areas: 85 percent for cohesive soils, 95 percent for cohesionless soils.
  - 2. Paved Areas, other than roadways: 90 percent for cohesive soils, 95 percent for cohesionless soils.
- E. Where subsidence is observable at electrical work excavations during project warranty period, remove surface, add backfill material, compact, and replace surface treatment. Restore surface to original condition.

### 3.10 ROOF PENETRATIONS:

- A. Where raceways and/or cables penetrate roofing, provide 26 gauge galvanized iron roof jack, sized to fit tightly to raceway and/or cable for weather-tight seal, and with flange extending a minimum of 9" under roofing on all sides. Seal opening between raceway and roof jack with approved sealant. Coordinate all work with division 7.

## 3.11 FIRE PENETRATION SEALS:

- A. Seal all raceway and/or cable penetrations through fire-rated floors, wall, and ceilings to prevent the spread of smoke, fire, toxic gas or water through the penetration either before, during or after fire. Provide penetration sealants and fittings of ratings to match the rating of the penetrated materials so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the NEC.
- B. Sealant Systems: Provide sealants, wall wraps, partitions, caps, and other accessories complying with UL 1479 (ASTM E-814) from the following where applicable:
  - 1. 3M Fire Barrier Sealing Penetration System
  - 2. Chase Foam Fire Stop System
  - 3. Thomas and Betts Flame Safe Fire Stop System
  - 4. Nelson Fire Stop Products
- C. Fittings: Where applicable, provide OZ Type CFSF/I and CAFSF/I fire seal fittings for conduit and cable penetrations through concrete and masonry wall, floor, slabs, and similar structures.
- D. Install sealants and fittings in accordance with all manufacturer's written instructions.

## 3.12 LABELING:

- A. Engraved black plastic laminated, with white-core labels, 1/16" thick, shall be permanently attached on both the interior and exterior the following electrical equipment:
  - 1. Branch panels
  - 2. Switchgear
  - 3. Disconnect switches
  - 4. Motor starter and controls junction boxes (power and auxiliary)
  - 5. Push buttons
  - 6. Thermal switches
  - 7. Time switches
  - 8. Motor control centers
  - 9. Transformer
  - 10. Similar equipment.
  - 11. Lighting contactors and associated switches
  - 12. Junction boxes larger than 4x4x1/2.
- B. The labels shall have 1/4" high, engraved letters, such as EF-1, AC-1, Panel A, etc.
- C. Label for motor starters and/or thermal overload switches shall include heater size and F.L.A.
- D. Labels shall be red where serving emergency loads.

## 3.13 CONCRETE BASES:

- A. Housekeeping Pads: Unless otherwise noted, provide 4" high reinforced concrete bases for all floor-mounted or floor-standing electrical equipment, including but not necessarily limited to the following:
  - 1. Transformers
  - 2. Switchgear
  - 3. Motor control centers
  - 4. Generators
  - 5. Battery racks

## 6. Similar Equipment

- B. Extend bases 6" beyond equipment or mounting rails on all sides or as shown on the drawings. Notwithstanding this requirement, coordinate with equipment manufacturer, shop drawings, and height of base to ensure compliance with NEC 380-82.
- C. Concrete bases: Refer to Section 16551 – exterior area lighting.
- D. Transformer Pads: Provide and locate properly sized concrete pads for power company furnished pad mounted transformers in accordance with power company clearance requirements.

## 3.14 TESTS:

- A. Notify engineer prior to all testing specified herein at least three business days prior to testing. Engineer shall observe all tests to insure the proper operation of the electrical system.

## 3.15 PROJECT FINALIZATION AND START-UP:

- A. Upon completion of the work, have each factory representative and/or subcontractor assist in start-up and testing of their respective systems.
- B. Have each representative give personal instructions on operating and maintenance of their equipment to the owner's maintenance and/or operation personnel.
- C. Have representatives certify each system with a written statement indicating that they have performed start-up and final check out of their respective systems.

## 3.16 FINAL REVIEW:

- A. Have the project foreman accompany their reviewing parties and remove coverplates, panel covers, access panels, etc. as requested, to allow review of the entire electrical system.

END OF SECTION 16001

## SECTION 16072 - ELECTRICAL SUPPORTS AND SEISMIC RESTRAINTS

## PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS:

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

## 1.2 SUMMARY:

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Seismic restraints for electrical equipment and systems.
  - 3. Construction requirements for concrete bases.

## 1.3 DEFINITIONS:

- A. IBC: International Building Code.
- B. Seismic Restraint: A structural support element such as a metal framing member, a cable, an anchor bolt or stud, a fastening device, or an assembly of these items used to transmit seismic forces from an item of equipment or system to building structure and to limit movement of item during a seismic event.

## 1.4 SUBMITTALS:

- A. Product Data: Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of electrical support and seismic-restraint component used.
  - 1. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
  - 2. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Shop Drawings: Indicate materials and dimensions and identify hardware, including attachment and anchorage devices, signed and sealed by a qualified professional engineer. Include the following:
  - 1. Fabricated Supports: Representations of field-fabricated supports not detailed on Drawings.
  - 2. Seismic Restraints: Detail anchorage and bracing not defined by details or charts on Drawings. Include the following:
    - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    - b. Details: Detail fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
    - c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

- C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
  - D. Welding certificates.
  - E. Qualification Data: For professional engineer and testing agency.
  - F. Field quality-control test reports.
- 1.5 QUALITY ASSURANCE:
- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
  - B. Testing of Seismic Anchorage Devices: Comply with testing requirements in Part 3.
  - C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS:

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

### 2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS:

- A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed under this Project, with a minimum structural safety factor of five times the applied force.
- B. Steel Slotted Support Systems: Comply with MFMA-3, factory-fabricated components for field assembly.
  - 1. Available Manufacturers:
    - a. Cooper B-Line; a division of Cooper Industries.
    - b. ERICO International Corporation.
    - c. Allied Support Systems; Power-Strut Unit.
    - d. GS Metals Corp.
    - e. Michigan Hanger Co., Inc.; O-Strut Div.
    - f. National Pipe Hanger Corp.
    - g. Thomas & Betts Corporation.
    - h. Unistrut; Tyco International, Ltd.
    - i. Wesanco, Inc.
  - 2. Finishes:
    - a. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-3.
  - 3. Channel Dimensions: Selected for structural loading and applicable seismic forces.

- C. Raceway and Cable Supports: As described in NECA 1.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Verify suitability of fasteners in subparagraph below for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick.
  - 2. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Available Manufacturers:
      - 1) Hilti, Inc.
      - 2) ITW Construction Products.
      - 3) MKT Fastening, LLC.
      - 4) Simpson Strong-Tie Co. Inc.
  - 3. In the following subparagraph, use stainless steel anchors in corrosive environments.
  - 4. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    - a. Available Manufacturers:
      - 1) Cooper B-Line; a division of Cooper Industries.
      - 2) Empire Tool and Manufacturing Co., Inc
      - 3) Hilti, Inc.
      - 4) ITW Construction Products.
      - 5) MKT Fastening, LLC.
      - 6) Powers Fasteners.
  - 5. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  - 6. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
  - 7. Toggle Bolts: All-steel springhead type.
  - 8. Hanger Rods: Threaded steel.

### 2.3 SEISMIC-RESTRAINT COMPONENTS:

- A. Rated Strength, Features, and Application Requirements for Restraint Components: As defined in reports by an agency acceptable to authorities having jurisdiction.
  - 1. Structural Safety Factor: Strength in tension, shear, and pullout force of components used shall be at least five times the maximum seismic forces to which they will be subjected.
- B. Angle and Channel-Type Brace Assemblies: Steel angles or steel slotted-support-system components; with accessories for attachment to braced component at one end and to building structure at the other end.

- C. Cable Restraints: ASTM A 603, zinc-coated, steel wire rope attached to steel or stainless-steel thimbles, brackets, swivels, and bolts designed for restraining cable service.
  - 1. Available Manufacturers:
    - a. Amber/Booth Company, Inc.
    - b. Loos & Co., Inc.
    - c. Mason Industries, Inc.
  - 2. Seismic Mountings, Anchors, and Attachments: Devices as specified in Part 2 "Support, Anchorage, and Attachment Components" Article, selected to resist seismic forces.
  - 3. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod, of design recognized by an agency acceptable to authorities having jurisdiction.
  - 4. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to type and size of anchor bolts and studs used.
  - 5. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to type and size of attachment devices used.

#### 2.4 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES:

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.

### PART 3 - EXECUTION

#### 3.1 APPLICATION

- A. Comply with NECA 1 for application of hangers and supports for electrical equipment and systems, except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for raceways as within 12 inches of coupling, fitting, and box, at each 90 degrees bend, minimum of two supports per ten foot run. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with single-bolt conduit clamps, or as otherwise required by an agency acceptable to authorities having jurisdiction.

#### 3.2 SUPPORT AND SEISMIC-RESTRAINT INSTALLATION:

- A. Comply with NECA 1 for installation requirements, except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, raceways may be supported by openings through structure members, as permitted in NFPA 70.
- C. Install seismic-restraint components using methods approved by the evaluation service

providing required submittals for component.

- D. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
  - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 Spring-tension clamps.
  - 7. To Light Steel: Sheet metal screws.
  - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- G. Do not drill or core cut holes for anchors or use powder-activated fasteners in post-tension slabs, joists, and beams.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS:

- A. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### 3.4 CONCRETE BASES:

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and seismic criteria at Project.
- B. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so expansion anchors will be a minimum of 10 bolt diameters from edge of the base.
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of the base.

2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
6. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete."

### 3.5 INSTALLATION OF SEISMIC-RESTRAINT COMPONENTS:

- A. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Restraint Cables: Provide slack within maximums recommended by manufacturer.
- D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

### 3.6 FIELD QUALITY CONTROL:

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing: Test pullout resistance of seismic anchorage devices.
  1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
  3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  5. Test to 90 percent of rated proof load of device.
  6. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- C. Record test results.

END OF SECTION 16072

## SECTION 16080 - ELECTRICAL DEMOLITION

## PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B. This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to electrical demolition.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of electrical demolition work is indicated by drawings.
- B. Electrical demolition items are shown to give a basic description of the extent of demolition work, but may not be inclusive.
- C. Do not assume that the electrical drawings reflect as-built conditions. Visit and observe the project prior to submitting bid and determine extent of electrical demolition work.

## 1.3 QUALITY ASSURANCE:

- A. Standards: Refer to Section 16001 - Electrical General Provisions as applicable.

## PART 2 – PRODUCTS - Not used.

## PART 3 – EXECUTION

## 3.1 GENERAL:

- A. Demolition work shall be laid out in advance to eliminate unnecessary cutting, drilling, channeling, etc. Where such cutting, drilling, or channeling becomes necessary, perform with care, use skilled mechanics of the trades involved. Cutting work of other contractors shall be done only with the consent of that contractor. Cutting of structural members is not permitted. Repair damage to building and equipment as a result of electrical demolition work under this contract at no additional cost to owner.
- B. Obtain permission from the architect before penetrating any ceiling, floor, and wall surfaces.

## 3.2 METHODS:

- A. Disconnect and remove any/all fixtures, devices, equipment, etc. required for proper completion of the work whether shown or not.
- B. Relocate, rewire, and/or reconnect any/all fixtures, devices, equipment, etc. that for any reason obstructs construction.
- C. Maintain circuit integrity and continuity of all existing circuits/feeders, and systems that interfere with or are interrupted by remodel work, unless those circuits/feeders are to be abandoned

completely. Maintain all circuits and systems in operation during construction. Provide temporary panels, temporary wiring and conduits, etc. as required.

- D . Leave all existing fixtures, devices, equipment, etc. In portions of the building not being remodeled, in working condition.
- E . Remove and dispose of all raceways, conductors, boxes, devices, equipment, etc., that are not to be reused. Terminate at accessible junction box by providing proper knockout closure, tape conductors, and label as "spare" with circuit no., Zone no., or other characteristic identifying source.
- F . Existing raceways may be reused, if in place, where in compliance with the contract documents and the National Electrical Code. Upgrade and/or provide new conduit supports where necessary for all raceways being reused. Insure integrity of existing raceways before re-use.
- G . Return to owner all light fixtures which are to be removed. Dispose of all light fixtures if so directed by owner in accordance with local environmental laws and policies. Those fixtures indicated for re-use shall be thoroughly cleaned, repaired as required, re-lamped, and installed as indicated. When storing fixtures for reuse, store in area and/or provide protective covering that will keep construction dust and materials off fixtures.
- H . Completely remove all telephone or data cables which are to be removed back to source or as directed by owner.
- I . Disconnect and remove all sound system equipment including speakers, amplifiers, etc. And return to owner. Completely remove and dispose of all associated conduit and wire.

### 3.3 PATCHING AND REPAIR:

- A . Finished Surfaces: The electrical contractor is responsible for patching and repair of all existing interior surfaces pertaining to the installation of work under this Division, unless specifically noted elsewhere in the contract documents. Where patching and repair is necessary, surfaces shall be finished (painted, etc.) to match the adjacent materials, finished, and colors. Requirements of other Divisions such as Division 9 - finishes shall apply.
- B . Hard Surfaces: Whenever excavation or trenching is required for the installation of electrical work, it shall be the responsibility of the electrical contractor to make repairs and/or replacements of hard finish surfaces such as concrete, asphalt, etc. Requirements of other Divisions such as Division 2 – Existing Conditions shall apply.

### 3.4 CONCEALING:

- A . All raceways shall be concealed within the ceilings, walls, and floors, except in locations where exposed raceways are specifically permitted, such as equipment rooms and unfinished storage areas.
- B . Surface-mounted raceways or systems shall be permitted only where approved by Architect/Engineer.

END OF SECTION 16080

## SECTION 16110 - CONDUIT RACEWAYS

## PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B. This section is a Division 16 General Provisions section, and is part of each Division 16 sections making reference to conduit raceways.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of raceways is indicated by drawings and schedules.
- B. Types of raceways in this section include the followings:
  - 1. Rigid Metal Conduit
  - 2. PVC Externally Coated Rigid Steel Conduit
  - 3. Intermediate Metal Conduit
  - 4. Electrical Metallic Tubing
  - 5. Flexible Metal Conduit
  - 6. Liquid-tight Flexible Metal Conduit
  - 7. Rigid Non-metallic Conduit

## 1.3 QUALITY ASSURANCE:

- A. Standards: Refer to Section 16001 - Electrical General Provisions as applicable. Provide conduit raceway installation in accordance with recommendations of the American Iron and Steel Institute "Design Manual on Steel Electrical Raceways", latest edition.
- B. Manufacturers: Firms regularly engaged in the manufacture of raceway of types and sizes required, whose products have been in satisfactory service for not less than three (3) years.
- C. Shop Drawings: Not required.

## PART 2 – PRODUCTS

## 2.1 CONDUITS:

- A. Rigid Metal Conduit (RMC): Provide zinc-coated, hot-dipped galvanized, rigid metallic conduit in accordance with Federal Specification WW-C-0581 and ANSI C80.1.
- B. PVC Externally Coated Rigid Metal Conduit: Provide hot-dipped galvanized, rigid metallic conduit externally coated with Polyvinyl Chloride (PVC) in accordance with ANSI C80.1 and NEMA Std. Pub. No. RN 1.
- C. Intermediate Metal Conduit (IMC): Provide hot-dipped galvanized, intermediate metal conduit in accordance with Federal Specification WW-C-581.
- D. Electric Metallic Tubing (EMT): Provide electric metal tubing in accordance with Federal

Specification WW-C-563 and ANSI C80.3.

- E. Flexible Metal Conduit: Provide zinc-coated, flexible metal conduit in accordance with Federal Specification WW-C-566.
- F. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight, flexible metal conduit, constructed of single strip, flexible continuous, interlocked, and double-wrapped steel, galvanized inside and outside, coated with liquid-tight jacket of flexible Polyvinyl Chloride (PVC).
- G. Rigid Non-Metallic Conduit: Provide rigid non-metallic conduit (PVC) in accordance with ANSI/NEMA TC 2, Type 1 for concrete encasement, Type 2 for direct burial.

## 2.2 FITTINGS:

- A. Rigid Metal Conduit, Intermediate Metal Conduit, and PVC Externally Coated Rigid Metal Conduit: Provide fully-threaded, malleable steel fittings, rain-tight and concrete-tight as applicable. Provide double locknuts and metal bushings at all conduit terminations. Install OZ Type B bushings on conduits 1-1/4" and larger.
- B. Electric Metallic Tubing: Provide insulated throat, non-indenter, set screw, malleable steel fittings. Screws must have a full set. Provide concrete-tight compression-type fittings in suspended slabs. All EMT fittings shall be fabricated from steel. Die-cast fittings or fittings made from pot metal shall not be allowed. Indenter type fittings are not acceptable. Install OZ Type B bushings on conduits 1" and larger.
- C. Flexible Metal Conduit: Provide flexible metal conduit fittings in accordance with Federal Specification W-F-406, Type 1, Class 1, and Style A. Commercial "greenfield" not less than 1/2" diameter or as otherwise specified on drawings is acceptable.
- D. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight flexible metal conduit fittings in accordance with Federal Specification W-F-406, Type 1, Class 3, Style G.
- E. Non-Metallic Conduit: Provide non-metallic conduit fittings (PVC) in accordance with ANSI/NEMA TC 3 to match conduit types and materials.
- F. Expansion Fittings: OZ Type AX, or equivalent to suit application.
- G. Sealing Bushings: Provide OZ Type FSK, WSK, or CSMI as required by application. Provide OZ Type CSB internal sealing bushings.
- H. Cable Supports: Provide OZ cable supports for vertical risers, type as required by application.

## 2.3 SIZES:

- A. Provide conduits in sizes as indicated in contract documents or as otherwise specified herein, but not less than 3/4".

## PART 3 – EXECUTION

### 3.1 GENERAL:

- A. Install raceway and accessories in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA Standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

### 3.2 LOCATIONS:

- A. Rigid Metal Conduit and Fittings: Use for conduit bends greater than 22 degrees where buried below grade or slab on grade. Install RMC where raceway passes vertically through slab-on-grade. Where raceways penetrate building, manholes, or vault walls and floors below grade, provide RMC for a minimum distance of 10' on the exterior side of the floor or wall. Use RMC for exposed runs where conduit is subject to moisture, weather, or mechanical injury. Use in hazardous locations in accordance with all NEC requirements.
- B. Intermediate Metal Conduit and Fittings: Use for exposed runs where conduit is subject to moisture, weather, or mechanical injury. Use in hazardous locations in accordance with all NEC requirements.
- C. Electric Metal Tubing and Fittings: Use for above-grade feeders, branch circuits, and signal and control circuit, unless specifically noted otherwise on drawings. Install in suspended slabs subject to local code requirements and fire rating considerations.
- D. Flexible Metal Conduit and Fittings: Use as whips for lighting fixtures, fixed equipment where not exposed to weather or moisture, other devices where required by NEC, and as requested by the Engineer. Maximum length not to exceed 6', unless specifically approved by the Electrical Engineer.
- E. Liquid-Tight Flexible Metal Conduit and Fittings: Use for connection to motor terminal boxes, fixed equipment where subject to moisture or weather, and other equipment subject to movement or vibration. Maximum length not to exceed 6', unless specified otherwise.
- F. Rigid Non-Metallic Conduit and Fittings: Use for below-grade service entrances, feeders, branch circuits, and signal and control circuit, unless specifically noted otherwise on drawings. Do not use above grade.

### 3.3 METHODS:

- A. Maintain a minimum of 12" clearance between steam or hot water lines or other hot surfaces. Where such clearance is impractical, insulate conduit with approved materials.
- B. Install conduits parallel with or at right angles to lines of the structure. Route conduits symmetrically where possible.
- C. Field bends and offsets shall be made without flattening, kinking, rippling or destroying the smooth internal bore or surface of the conduit and to not less than NEC minimum radius. Conduit that shows signs of rippling or kinking shall not be installed. Conduits installed with wrinkles or kinks or otherwise in an unworkmanlike manner shall be replaced at no additional cost to owner.
- D. Precaution shall be exercised to prevent accumulation of water, dirt or concrete in the conduits during the execution of the project. Conduits in which water or foreign matter has been permitted to accumulate shall be thoroughly cleaned or the conduits runs replaced where such accumulation cannot be removed by methods approved the engineer.
- E. Any conduit which pierces airtight spaces or plenums shall be sealed to prevent air leakage with mastic acceptable to the Architect.

### 3.4 CONCEALING:

- A. All raceways shall be concealed within the ceilings, walls, and floors, except in locations where

exposed raceways are specifically permitted, such as equipment rooms and unfinished storage areas. In equipment rooms, if lighting raceways are run exposed, installation shall not be done until piping and duct work layout has been determined in order that lighting boxes may be located so as to avoid being covered by overhead ducts and piping. If lighting raceways in equipment rooms are concealed in the structural ceiling slab, after mechanical work is complete, exposed conduit extensions shall be run to locate lighting fixtures where they are not obscured by work of other trades.

### 3.5 BURIED CONDUITS:

- A. Comply with all burial depths as defined in NEC Section 300-5. Bury all conduits at least 24" below grade, unless specifically indicated otherwise on drawings. Provide magnetic 6" wide "Yellow Warning" ribbon 12" directly above conduit and 6" below finished grade measured from the top of the conduit or duct bank. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single marker.
- B. Slope all conduits toward manholes or pull boxes for proper drainage. Use weep holes. Gravel drainage pockets are not permitted.
- C. Coat all metal conduits with an approved asphaltic compound or wrap with two layers of PVC tape.
- D. Under Concrete Slab on Grade: Horizontal conduit must be installed a minimum of 2" below the bottom of the concrete slab. Conduits should not be installed in concrete slabs.
- E. Concrete Encasement: Where concrete-encasement is indicated on drawings, provide ductbank construction using red 3000 psi at 28 day strength concrete. Provide minimum 4" cover on all sides of exterior conduits. Provide conduit spacers where applicable. Coat all metal conduits with an approved asphaltic compound or wrap with two layers of PVC tape.
- F. Where conduits are extended for future use, cap and clearly mark.

### 3.6 ELECTRICAL CONTINUITY:

- A. Provide electrically continuous conduit systems throughout.

### 3.7 FIELD CUTS AND THREADS:

- A. Cut all conduits square. Remove all sharp or rough edges and ream all burrs, inside and outside. Provide clean sharp threads on RMC and IMC.
- B. Engage at least five full threads on all RMC and IMC fittings. Before couplings or fittings are attached, apply one coat of red lead or zinc chromate to male threads of RMC or IMC. Apply coat of red lead, zinc chromate or special compound recommended by manufacture to conduit where conduit protective coating is damaged.

### 3.8 CONDUIT ENDS:

- A. Cap all spare conduits. Cap or plug conduit ends during construction to prevent entrance of foreign material.

### 3.9 SPARE CONDUITS:

- A. Provide five (5) 3/4" empty conduits from panel stubbed into accessible ceiling space and five (5) 3/4" conduits into accessible floor space. When floor is not accessible, provide six (6) 3/4" empty conduits from panel stubbed into accessible ceiling space. Cap and label all conduits.

- B. Install a 200 lb. polypropylene pull cord in each empty conduit run.

3.10 HAZARDOUS LOCATIONS:

- A. Install RMC and IMC in all hazardous locations as defined by the NEC. Provide suitable fittings, seal-offs, boxes, etc. to comply with all NEC requirements and/or as shown on the drawings. Provide inspection fittings with hazardous location rated drains to prevent water from accumulating in conduit runs.

3.11 CLEANING:

- A. Pull mandril and swab through all conduits before installing conductors.

END OF SECTION 16110

## SECTION 16120 - CONDUCTORS AND CABLES

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A . Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B . This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to conductors and cables.

## 1.2 DESCRIPTION OF WORK:

- A . This section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.
- B . Types of conductors and cables in this section include the following:
  - 1. Copper Conductors.
- C . Applications for conductors and cables required for project include:
  - 1. Electrical service.
  - 2. Feeders.
  - 3. Branch Circuits.

## 1.3 SUBMITTALS:

- A . Product Data: For each type of conductor and/or cable indicated.
- B . Field Quality-Control Test Reports: From Contractor. Refer to Section 16001 – General Electrical Provisions.

## 1.4 QUALITY ASSURANCE:

- A . Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B . Comply with NFPA 70.

## PART 2 - PRODUCTS

## 2.1 GENERAL:

- A . Manufacturers: In other Part 2 articles where subparagraph titles below introduce lists, provide products by the manufacturer specified, subject to compliance with requirements.
- B . Ambient Conditions: Conductors used for branch circuits in areas where the ambient conditions exceed 30 degree C. shall be provided with insulation approved for that temperature.

- C . Wire Sizes: As indicated on electrical drawings or as specified herein, but in no case less than No. 12 AWG.

## 2.2 COPPER CONDUCTORS:

- A . Manufacturers:
  - 1. American Insulated Wire Corporation; a Leviton Company.
  - 2. General Cable Corporation.
  - 3. Senator Wire & Cable Company.
  - 4. Southwire Company.
- B . Refer to Part 3 "Conductor and Cable Applications" Article for application requirements.
- C . References and Ratings:
  - 1. ICEA S-95-658 / NEMA WC70.
  - 2. ASTM.
  - 3. UL Standard 83.
  - 4. UL Standard 1063 (MTW).
  - 5. Federal Specification J-C-30B.
  - 6. NEC.
- D . Conductor Material: Copper.
- E . Stranding: Solid conductor for No. 12 AWG, stranded for No. 10 AWG and larger.
- F . Conductor Insulation Types: Thermoplastic-insulated, Type THHN / THWN-2.

## 2.3 CONNECTORS AND SPLICES:

- A . Manufacturers:
  - 1. AMP Incorporated/Tyco International.
  - 2. Hubbell/Anderson.
  - 3. O-Z/Gedney; EGS Electrical Group LLC.
  - 4. 3M Company; Electrical Products Division.
- B . Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- C . Splices for wire sizes #10 and smaller shall be screw-on type similar to scotch or ideal wing nut connectors. Crimp-on splices designed to be used without wire stripping are not acceptable.

## PART 3 – EXECUTION

### 3.1 GENERAL:

- A. Install conductors, cables, and accessories as indicated, in compliance with manufacturer's written instruction, applicable requirements of NEC, NECA's "Standards of Installation", and in accordance with recognized industry practices to ensure that products fulfill requirements.

### 3.2 CONDUCTOR AND CABLE APPLICATIONS:

- A. Service Entrance: As indicated on the electrical drawings.
- B. Feeders: As indicated on the electrical drawings.
- C. Branch Circuits:
  - 1. Exposed, including in crawlspaces: Copper conductors in raceway.
  - 2. Concealed in ceilings, walls, and partitions: Copper conductors in raceways.
  - 3. Concealed in concrete and below slabs-on-grade: Copper conductors in raceway.
- D. Cord Drops, Reels, and Portable Appliance Connections: Flexible cord.
- E. Class 1 Control Circuits: Copper conductors in raceway.

### 3.3 INSTALLATION:

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- D. When raceway is not required, install concealed cables parallel and perpendicular to surfaces of structural members, and follow surface contours where possible.
- E. Support cables according to other applicable specification sections.
- F. Seal around cables penetrating fire-rated elements to comply with applicable fire stop specification sections.
- G. Color Coding: Color code secondary service, feeder, and branch circuit conductors. Colors shall remain consistent throughout the project and shall match existing coding system where applicable.
  - 1. Conductor sizes No. 6 AWG and smaller: Colored insulation.
  - 2. Conductors sizes No. 4 AWG and larger: 2 inch (51 mm) band of Colored adhesive marking tape applied at all terminations, junction boxes, and pull boxes.
  - 3. Branch circuit switched-legs and travelers: Colored insulation (in colors other than those indicated below).
  - 4. Color-code 120/208V system conductors:
    - a) Phase A: Black.
    - b) Phase B: Red.
    - c) Phase C: Blue.
    - d) Neutral: White.
    - e) Ground: Green.
    - f) Isolated Ground: Green with yellow tracer.
  - 5. Color-code 277/480V system conductors:
    - a) Phase A: Brown.
    - b) Phase B: Orange.
    - c) Phase C: Yellow.
    - d) Neutral: White with colored stripe or gray.
    - e) Ground: Green.

## 3.4 HOMERUN CIRCUITS:

- A. Homerun circuits may be combined in common conduits at the option of the contractor in compliance with the following:
1. Three-Phase Installations: Not more than three single-phase circuits with common neutral in one conduit, unless specifically noted otherwise, if each circuit is from a different phase (a, b, or c).
  2. Single-Phase Installations: Not more than two single-phase circuits with common neutral in one conduit, unless specifically noted otherwise, if each circuit is from a different phase (a or b).

## 3.5 NEUTRAL CONDUCTORS:

- A. LIGHTING CIRCUITS: Where multiple circuits serving lighting are run in a single raceway (see paragraph above for allowable number or circuits per conduit), a common neutral shall be allowed. When any one circuit is serving fluorescent lighting loads, provide an oversized neutral conductor. Size the neutral conductor one size (AWG) larger than the largest phase conductor.
- B. OUTLET CIRCUITS: Where multiple circuits serving electrical outlets are run in a single raceway (see paragraph above for allowable number of circuits per conduit), a shared common neutral is allowed.

## 3.6 VOLTAGE DROP:

- A. Provide branch circuit conductors in sizes such that voltage drop for branch circuits do not exceed 3 percent at the farthest outlet. Provide service, feeder, and branch circuit conductors so that the voltage drop on the entire electrical system does not exceed 5 percent at the farthest outlet. This shall be strictly followed regardless of the conductor sizes indicated on the electrical drawings. Increase conductor sizes (and conduits where necessary to comply with NEC conduit fill requirements) as necessary to accommodate this requirement. Calculations shall be based on the following:
1. Lighting Branch Circuits: Connected load plus 25% spare.
  2. Appliance and Equipment Branch Circuits: Nameplate or NEC required load.
  3. 120V Convenience Outlet Branch Circuits: 12 amps minimum, but in no case less than NEC loading requirements. Use the following schedule:

<u>Distance (feet)</u>	<u>Wire Size (AWG)</u>
0-80	#12
81-125	#10
126-200	#8
201-320	#6

4. Use the NEC method to calculate voltage drop.

## 3.7 CONNECTIONS:

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack. Use pig tails when wiring outlets.

### 3.8 FIELD QUALITY CONTROL:

- A. Testing: Perform the following field quality-control testing:
  - 1. Visual and Mechanical Inspection:
    - a) Inspect cables for physical damage and proper connection in accordance with the electrical construction documents.
    - b) Test cable mechanical connections to manufacturer's recommended values with a calibrated torque wrench.
    - c) Check cable color coding for compliance with electrical specifications.
  - 2. Electrical Tests:
    - a) Perform insulation resistance test on each conductors for feeders 100 amps and greater with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 minute.
    - b) Perform continuity test to insure proper cable connection.
  - 3. Test Values:
    - a) Minimum insulation resistance values shall not be less than two megohms.
- B. Test Reports: Prepare a written report and submit to the Electrical Engineer at the completion of the project. The report shall include the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 16120

## SECTION 16135 - ELECTRICAL BOXES AND FITTINGS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A . Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B . This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to electrical boxes and fittings.

## 1.2 DESCRIPTION OF WORK:

- A . Extent of electrical boxes and fittings work is indicated by drawings and schedules.
- B . Types of electrical boxes and fittings in this section include the following:
  - 1. Outlet Boxes
  - 2. Junction Boxes
  - 3. Pull Boxes
  - 4. Conduit Bodies
  - 5. Bushings
  - 6. Locknuts
  - 7. Knockout Closures
  - 8. Miscellaneous Boxes and Fittings

## 1.3 QUALITY ASSURANCE:

- A . Standards: Refer to Section 16001 - Electrical General Provisions as applicable.
- B . Manufacturers: Firms regularly engaged in the manufacturer of boxes and fittings required, whose products have been in satisfactory service for not less than three years.
- C . Shop Drawings: Submit shop drawings on floor boxes only where required.

## PART 2 - PRODUCTS

## 2.1 INTERIOR OUTLET BOXES:

- A . General: Provide one piece, galvanized or cadmium-plated, flat-rolled, sheet steel interior outlet boxes of types, shapes, and sizes to suit respective location and installation. Construct with stamped knockouts on back and sides and with threaded screw holes. Provide corrosion-resistant screws for securing boxes, covers, and wiring devices. Size all junction boxes in accordance with NEC Table 370-16(a), with a minimum box size of 4" x 4" x 1-1/2". Where three raceway entries are made, provide outlet boxes with a minimum depth of 2-1/8". Where four or more raceway entries are made, provide outlet boxes with a minimum depth of 4-11/16". Gangable boxes shall not be used.
- B . Switch, Telephone, and Receptacle Outlets: Provide outlet boxes not less than 4" square, with adapting tile or plaster covers where necessary to set flush with finished surfaces. Where three raceway entries are made, provide outlet boxes with a minimum depth of 2-1/8". Gang boxes

shall be used where more than one switch or device is located at one point. Sectional Boxes are not acceptable. In masonry walls where tile or plaster ring cannot be used, install a single-gang 3-1/2" deep box minimum, unless otherwise noted. Where four or more raceway entries are made, provide outlet boxes with a minimum depth of 4-11/16".

C . Lighting Outlets:

1. Lay-in Grid: Outlets for recessed fixtures in acoustical tile ceilings shall be located to center on a single tile or at the intersection of four tiles.
2. Surface-mounted: Provide 4" square octagonal outlet boxes for surface-mounted, ceiling fixture outlets. Mount each box independently of the conduit on standard 3/8" stud or approved box hangar where applicable. Include backing and supports as required to carry 200 lbs. Where three or more raceway entrances are made, use a minimum box depth of 2-1/8".

2.2 WEATHERPROOF OUTLET BOXES:

- A . Provide corrosion-resistant, cast-metal weatherproof outlet boxes, of types, shapes, and sizes, with threaded conduit ends, cast metal coverplates with spring-hinged waterproof caps, face plate gaskets, and corrosion-resistant fasteners.

2.3 JUNCTION AND PULL BOXES:

- A . Provide code-gauge sheet steel junction and pull boxes, with removable screw-on covers and welded seams, of types, shapes, and sizes to suit each respective location and installation. Size all junction and pull boxes in accordance with NEC 370-28. Provide stainless steel nuts, bolts, screws, and washer.

2.4 CONDUIT BODIES:

- A . Provide galvanized, cast-metal conduit bodies of type, shapes, and sizes to suit respective locations and installation. Construct with threaded conduit entrance ends and removable covers. Provide corrosion-resistant screws.
- B . Aluminum boxes and fitting shall not be permitted.

2.5 CONDUIT CONNECTIONS:

- A . Box connectors 3/4" and larger shall be insulated, throat-type or equal type plastic bushings. Provide double locknuts and insulating plastic bushings for RMC and IMC terminating at panels and boxes.
- B . Where RMC penetrates building, manholes, or vault walls and floors below grade, provide sealing bushings with external membrane clamps as applicable. Provide segmented internal sealing bushings in all raceways penetrating building walls and slabs below grade, and in all above grade raceway penetrations susceptible to moisture migration into building through raceway. Where RMC terminates in manhole, vault, or pull box, provide insulated grounding bushings. Also see Section 16135 – Electrical Boxes and Fittings.
- C . Install OZ type "B" connectors for all conduits 1" and larger.
- D . Provide cable supports in all vertical risers in accordance with NEC 300-19.

2.6 EXPANSION FITTINGS:

- A . Provide expansion joint fittings in all conduit runs crossing structural expansion joints, whether

above-grade, in slab-on-grade, or in suspended slabs. Provide OZ type "AX" or approved equivalent, size to the raceway.

### 2.7 ACCESSORIES:

- A. Provide all accessories including, but not necessarily limited to, bushings, knockout closures, locknuts, offset connectors, etc. of types, shapes, and sizes to suit respective locations and installation. Construct of corrosion-resistant steel.

## PART 3 – EXECUTION

### 3.1 GENERAL:

- A. Install electrical boxes and fittings in accordance with manufacturer's written instruction, applicable requirements of the NEC, NEMA Standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

### 3.2 METHODS:

- A. Where outlet boxes are subject to weather or moisture, install weatherproof outlet boxes.
- B. Remove knockouts only for entering conduits. Provide knockout closures to cap unused knockout holes where blanks are mistakenly removed.
- C. Do not use condulets in place of elbows or junction boxes. Condulets in sizes 2" or larger shall not be used, unless specifically approved by the electrical engineer.
- D. Install boxes and conduit bodies in readily accessible locations. Install recessed boxes with faces of boxes or rings flush with finished surfaces. Seal all openings between outlet box and adjacent surfaces with plaster, grout, or similar suitable material.
- E. For stud construction, install boxes with rigid supports using metal bar hangers, or 2" X 4", 1" X 6" wood bridging between studs with screws. Welding or nailing boxes directly to metal joist and studs is not acceptable. Boxes set opposite in common wall shall have at least 10" of conduit between them. Securely fasten outlet boxes to structural surfaces to which attached.
- F. For concrete or masonry construction, solidly embed electrical boxes in concrete and masonry. Provide box supports as required to keep outlet boxes flush with finished surfaces.
- G. Coordinate location of all outlet boxes with millwork, back splashes, tackboards, etc.
- H. Install junction boxes or condulets in conduit runs as required at 100 foot maximum intervals on long runs. This shall apply to concrete junction boxes in grade and junction boxes within the building.
- I. Provide electrical connections for installed boxes.

### 3.3 IDENTIFICATION:

- A. Mark circuit number on exterior side of junction boxes located in ceilings such that circuits numbers are readily identifiable. For outlet boxes in wall, mark circuit numbers on interior sides of outlet boxes.

B. Identification labels shall be as follows:

Normal Power	Black with White letters
Emergency Power	Red with White Letters
UPS	Orange with White Letters

END OF SECTION 16135

## SECTION 16180 - OVERCURRENT PROTECTIVE DEVICES

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B. This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to overcurrent protective devices.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of overcurrent protective devices is indicated by drawings and schedules and is specified herein.
- B. Type of overcurrent protective devices in this section include the following:
  - 1. Molded Case Circuit Breakers
  - 2. Electronic Circuit Breakers
  - 3. Ground Fault Protection

## 1.3 QUALITY ASSURANCE:

- A. STANDARDS: Refer to Section 16001 - Electrical General Provisions as applicable.
- B. SUBMITTALS:
  - 1. SHOP DRAWINGS: Submit manufacturer's data on overcurrent protective devices including specifications, time-current trip characteristics curves, mounting requirements, installation instructions, etc. Submit dimensioned drawings of overcurrent protective devices.
  - 2. Equipment Room Layouts: Submit dimensioned drawings of all equipment rooms indicating spatial relationships to other proximate equipment. Insure that all code required clearances are maintained.

## PART 2 – PRODUCTS

## 2.1 GENERAL:

- A. Provide overcurrent protective devices and ancillary components of types, sizes, ratings, and electrical characteristics indicated. Provide enclosures in NEMA ratings as indicated and suitable for applications.

## 2.2 MOLDED CASE CIRCUIT BREAKERS:

## A. MANUFACTURERS:

Subject to compliance with all requirements, provide molded case circuit breakers from one of the following:

- 1. Cutler-Hammer

2. General Electric
3. Siemens
4. Square D

B. MOLDED CASE CIRCUIT BREAKERS:

1. Provide factory-assembled, molded case circuit breakers as integral components of lighting and appliance panelboards, power panelboards, switchboards, and for individual mounting as indicated. Provide thermal magnetic, molded case circuit breakers of amperages, voltages, types, and short circuit current ratings indicated. Provide bolt-on type breakers only. Construct with quick-break, quick-break mechanism with inverse-time delay and instantaneous trip protection for each pole. Provide breakers rated for ambient temperatures to suit respective applications. Provide mechanical screw type removable copper connector lugs of size to accommodate conductors specified.
2. Provide breakers that have interrupting ratings greater than or equal to the specified fault current. Provide fully-rated systems only. Series-rated systems are not acceptable, unless specifically noted otherwise.

2.3 ELECTRONIC CIRCUIT BREAKERS:

A. VENDORS:

Subject to compliance with all requirements, provide electronic circuit breakers from one of the following:

1. Cutler-Hammer
2. General Electric
3. Siemens
4. Square D

B. ELECTRONIC CIRCUIT BREAKERS:

1. Provide factory-assembled, electric circuit breakers as integral components of power panelboards and switchboards. Unless noted otherwise on drawings, provide electronic circuit breakers in accordance with requirements as set forth in "MOLDED CASE CIRCUIT BREAKERS" above and with features as follows:
2. Provide electronic circuit breakers having the following selectable settings:
  - a) Long time pickup and delay.
  - b) Short time pickup and delay with  $I^2T$  In and  $I^2T$  Out features.
  - c) Instantaneous.
  - d) Ground fault pickup and delay with  $I^2T$  In and  $I^2T$  Out features.
3. Provide electronic circuit breakers having the following additional features:
  - a) 80% rated.
  - b) True RMS sensing.
  - c) Interchangeable rating plugs.
  - d) Thermal and magnetic backup protection.
  - e) Long time and ground fault memory.

2.4 GROUND FAULT PROTECTION:

A. GROUND FAULT PROTECTION:

1. Provide ground fault protection systems to operate shunt trip or electric trip of thermal magnetic circuit breakers or bolted pressure switches and/or as integral components of electronic circuit breakers where indicated on drawings and as required to meet all the

requirements as set forth in the NEC. Provide ground fault protection by means of a zero sequence ground fault sensor and ground fault relay. Provide power for ground fault relay through output of current sensor. Provide relay with current settings from 100 through 1200 amperes and time delay of .1 through 1 second. Provide cover that inhibits tampering with settings after installation. Provide means of testing the ground fault system without tripping the breaker or switch to meet the on-site testing requirements of the NEC. Provide visual trip indication for ground fault trip occurrences. Provide all interconnecting wiring as required.

### PART 3 - EXECUTION

#### 3.1 GENERAL:

- A. Install overcurrent protective devices in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

#### 3.2 SIZING FUSES:

- A. Size all fuses in accordance with manufacturer's written recommendations, whether fuse size is indicated on drawings or not. If nuisance tripping occurs, increase fuse size and disconnect if necessary as required to provide nuisance-free tripping. Adjust fuse size for proper ambient temperature, frequent starting and stopping of motor loads, and for loads with long start times.

#### 3.3 IDENTIFICATION:

- A. Provide 1/16" thick black plastic laminate labels with 1/4" high lettering on the exterior of each disconnect indicating name of disconnect or load served. Bolt labels to enclosure. Mark on interior cover the source of power by indicating the panel and circuit number.
- B. Provide red plastic laminate label for disconnects supplied by emergency power.

#### 3.4 MOUNTING:

- A. Mount disconnects as indicated, but in no case higher than 6'-6" from finished floor to top of disconnect. Anchor enclosures firmly to walls and structural surfaces.
- B. Provide 4" high concrete pad under floor-standing disconnects.

#### 3.5 SETTINGS:

- A. Adjust settings of overcurrent protective devices as directed by engineer.

#### 3.6 TESTING OF GROUND FAULT PROTECTION:

- A. Have all ground fault protection systems tested by authorized factory representative for proper operation. Replace all malfunctioning units. A complete record of current trip level and time required to trip the disconnecting device shall be submitted to the owner.

END OF SECTION 16180

## SECTION 16420 - SERVICE ENTRANCE

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B. This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to service entrances.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of service entrance work is indicated by drawings and schedules and is specified herein.
- B. Work under this section includes the following:
  - 1. Raceways and Conductors
  - 2. Service Entrance Switchboards and/or Panelboards
  - 3. Overcurrent Protective Devices and/or disconnects

## 1.3 QUALITY ASSURANCE:

- A. STANDARDS: Refer to Section 16001 - Electrical General Provisions as applicable.
- B. SUBMITTALS:
  - 1. Shop Drawings: Submit manufacturer's data on service entrance equipment and accessories. Submit dimensioned drawings of service entrance equipment.
  - 2. Equipment Room Layouts: Submit dimensioned drawings of all equipment rooms containing service entrance equipment indicating spatial relationships to other proximate equipment. Insure that all code required clearances are maintained.

## PART 2 - PRODUCTS

## 2.1 GENERAL:

- A. Provide service entrance equipment and accessories of types, sizes, ratings, and electrical characteristics indicated or as otherwise required to provide a complete system. See other applicable sections.

## 2.2 RACEWAYS AND CONDUCTORS:

- A. Provide service entrance raceways and conductors in accordance with Section 16110 - Conduit Raceways, and Section 16120 - Conductors and Cables.

## 2.3 SERVICE ENTRANCE SWITCHBOARDS AND/OR PANELBOARDS:

- A. Provide service entrance switchboards and/or panelboards in accordance with Section 16182 - Switchboards, and Section 16160 - Panelboards. Rate all service switchboards and/or panelboards as service entrance equipment.

2.4 OVERCURRENT PROTECTIVE DEVICES AND/OR DISCONNECTS:

- A. Provide overcurrent protective devices and/or disconnects in service switchboards and/or panelboards in accordance with Section 16180 - Overcurrent Protective Devices, and Section 16170 - Disconnect Switches.

PART 3 - EXECUTION

3.1 GENERAL:

- A. Install service entrance equipment and accessories in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

3.2 COORDINATION:

- A. Coordinate all service entrance work with owner.

END OF SECTION 16420

## SECTION 16452 – GROUNDING

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B. This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to grounding.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of grounding work is indicated by drawings and schedules and is specified herein.
- B. Ground the complete electrical installation including the system neutral, metallic conduits and raceways, boxes, fittings, devices, cabinets, equipment, and separately derived systems in accordance with the NEC and all other applicable codes to provide a permanent, continuous, low impedance, grounding system.
- C. Provide grounding system such that the resistance from the service entrance ground bus, through the grounding electrode to earth is not greater than 5 ohms.

## 1.3 QUALITY ASSURANCE:

- A. STANDARDS: Refer to Section 16001 - Electrical General Provisions as applicable.
- B. TESTING: Submit results of ground resistance testing as specified in this section. Include name of testing agency with report. Include test results in operation and maintenance manuals.

## PART 2 – PRODUCTS

## 2.1 GENERAL:

- A. Provide grounding equipment and accessories of types, sizes, ratings, and electrical characteristics indicated or as otherwise required to provide a complete system.

## 2.2 GROUNDING CONDUCTORS:

- A. Unless noted otherwise, provide grounding conductors with stranding and insulation types to match phase conductors. Provide conductors with green insulation if possible; otherwise wrap with green tape. Size ground conductors as indicated on drawings. Do not size ground conductors smaller than that allowable by NEC.

## 2.3 GROUND RODS:

- A. Provide copper clad, steel, 3/4" diameter by 10' long, ground rods ( Weaver, Cadweld, or equivalent).
- B. Provide precast concrete box 9-1/2" W. x 16" L. x 18" D. with light duty concrete cover for non-traffic areas or rated steel plate for traffic areas. Provide covers with lifting holes. Engrave

cover with "Ground Rod".

#### 2.4 INSULATED GROUNDING BUSHINGS:

- A. Provide plated malleable iron body with 150 degree Centigrade molded plastic insulating throat, lay-in grounding lug with hardened stainless steel fasteners (OZ Gedney BLG or equivalent).

#### 2.5 CONNECTION TO PIPES:

- A. Provide heavy duty, cast bronze, ground clamp systems with silicon bronze bolts and nuts (OZ Gedney G Series - B or equivalent).

#### 2.6 CONNECTIONS TO STRUCTURAL STEEL, GROUND RODS, OR SPLICES:

- A. Provide exothermic welds. (Cadweld or equivalent)

#### 2.7 BONDING JUMPERS:

- A. Provide bonding jumpers with hot dip galvanized malleable or ductile iron clamps, hot dip galvanized steel U-bolts, and tinned copper braids (OZ Gedney BJ Series or equivalent).

#### 2.8 GROUND BUS:

- A. Provide 1/4" x 4", copper ground bus complete with insulators and brackets in lengths and at mounting heights as indicated on drawings. Furnish complete with drilled holes and lugs to accommodate grounding conductors.

### PART 3 - EXECUTION

#### 3.1 GENERAL:

- A. Install grounding systems in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

#### 3.2 CLEANING:

- A. Thoroughly clean all metal contact surfaces prior to installation of clamp-on connectors.

#### 3.3 SEPARATELY DERIVED SYSTEMS:

- A. Ground each separately derived system in accordance with NEC Section 250.30 unless otherwise indicated on drawings.
  1. Conductor from separately derived systems.
  2. Conductor from insulated ground bushings on service entrance conduits.
  3. Additional ground rods as required to achieve resistance value specified.
  4. Additional items indicated on drawings.

#### 3.4 EQUIPMENT BONDING AND GROUNDING:

- A. Provide an NEC sized conductor, whether indicated or not on the drawings, in raceways as follows:

1. Non-metallic conduits and ducts.
2. Distribution feeders.
3. Motor and equipment branch circuits.
4. Device and lighting branch circuits.
5. Full length of all multi-outlet assemblies and other surface wireways.

### 3.5 ADDITIONAL GROUNDING INSTALLATION REQUIREMENTS:

- A. Provide grounding bushings on all service conduit and conduits installed in concentric/eccentric knock-outs or reducing washer at panelboards, cabinets, and gutters.
- B. Provide bonding jumpers across expansion and deflection couplings in conduit runs, across pipe connections at water meters, and across dielectric couplings in metallic cold water piping system. Connection to water piping system shall be made electrically continuous by connecting to the street side of the water main valve and/or installing additional bonding jumpers across the meter, valves or service unions that might be disconnected.
- C. Provide bonding wire in all flexible conduits.
- D. Isolated Ground Circuits: Circuits used for isolated ground outlets shall be run in separate raceways or shall have a separate green insulated ground conductor installed and tagged for identification at all outlet and junction boxes.

### 3.6 TEST WELLS:

- A. All ground rods shall be driven external to building and shall be located in ground well boxes. Locate in landscaped areas where possible.

### 3.7 TESTING:

- A. Obtain and record ground resistance measurements both from service entrance ground bus to the ground electrode and from the ground electrode to earth. Install additional bonding and grounding electrodes as required to comply with resistance limits specified under this Section. Use independent testing agency for all testing.

END OF SECTION 16452

SECTION F-162CHAIN-LINK FENCES

## Description

F-162-1.1 This item shall consist of furnishing and erecting a chain-link fence in accordance with these specifications and the details shown on the plans and in conformity with the lines and grades shown on the plans or established by the Engineer.

## Materials

F-162-2.1 Fabric. The chain-link fence fabric shall be a woven 9-gauge galvanized steel wire in a 2-inch (50 mm) mesh and shall meet the requirements of ASTM A 392, Class 2.

F-162-2.3 Posts, Rails and Braces. Posts, rails, and braces shall conform to the requirements of ASTM F 1043 or ASTM F 1083 as follows:

Galvanized tubular steel pipe shall conform to the requirements of Group IA, (Schedule 40) coatings conforming to Type A, or Group IC (High Strength Pipe), External coating Type B, and internal coating Type B or D.

Composite posts shall conform to the strength requirements of ASTM 1043 or ASTM F 1083. The strength loss of composite posts shall not exceed 10 percent when subjected to 3,600 hours of exposure to light and water in accordance with ASTM G 23, ASTM G 26, and ASTM G 53.

Posts, rails, and braces, with the exception of galvanized steel conforming to ASTM F 1043 or ASTM F 1083, Group IA, type A, or aluminum alloy, shall demonstrate the ability to withstand testing in salt spray in accordance with ASTM B 117 as follows:

External:	1,000 hours with a maximum of 5 percent red rust
Internal:	650 hours with a maximum of 5 percent red rust

The dimensions of the posts, rails, and braces shall be in accordance with Tables I through VI of Federal Specification RR-F-191/3D.

F-162-2.4 Gates. Gate frames shall consist of the posts shall consist of galvanized steel pipe and shall conform to the specifications for the same material under paragraph F- 162-2.3. The fabric shall be of the same type material as used in the fence.

Structural members of gates shall be fully welded by a method that will provide a continuous weld on all sides and faces of joints at exposed edges. Surplus welding material shall be removed.

F-162-2.5 Wire Ties and Tension Wires. Wire ties for use in conjunction with a given type of fabric shall be of the same material and coating weight identified with the fabric type. Tension wire shall be 7-gauge marcelled steel wire with the same coating as the fabric type and shall conform to ASTM A 824.

All material shall conform to Federal Specification RR-F-191/4D.

F-162-2.6 Miscellaneous Fittings and Hardware. Miscellaneous steel fittings and hardware for use with zinc-coated steel fabric shall be of commercial grade steel or better quality, wrought or cast as appropriate to the article, and sufficient in strength to provide a balanced design when used in conjunction with fabric posts, and wires of the quality specified herein. All steel fittings and hardware shall be protected with a zinc coating applied in conformance with ASTM A 153. Barbed wire support arms shall withstand a load of 250 pounds (113 kg) applied vertically to the outermost end of the arm.

F-162-2.7 Concrete. Concrete shall be of a commercial grade with a minimum 28-day compressive strength of 3000 psi (17.2 MPa).

F-162-2.8 Marking. Each roll of fabric shall carry a tag showing the kind of base metal (steel, aluminum, or aluminum alloy number), kind of coating, the gauge of the wire, the length of fencing in the roll, and the name of the manufacturer. Posts, wire, and other fittings shall be identified as to manufacturer, kind of base metal (steel, aluminum, or aluminum alloy number), and kind of coating.

F-162-2.9 Submittals. Prior to purchasing fence materials, the Contractor shall submit information to the Engineer for those materials proposed for use during construction. The submittal shall show the appropriate ASTM or Federal Specification and a statement that the material does or does not comply with the applicable specification. The submittal shall include the following items:

- a. chain-link fabric
- b. pipe for posts, rails and braces
- c. wire ties
- d. tension wires
- e. fittings and hardware
- f. concrete
- g. gate shop drawings

Submittals shall comply with procedures set forth in the "Shop Drawing and Sample Submittals" section of the General Conditions. Allow ten days for review by the Engineer, excluding delivery time to and from the Contractor.

No material shall be delivered until the submittal has been accepted by the Engineer and returned to the Contractor.

#### Construction Methods

F-162-3.1 Installing Posts. All posts shall be set in concrete at the required dimensions, depths, and spacing shown on the plans and details. The post holes shall be in proper alignment so that there is a minimum of 3 inches (75 mm) of concrete on all sides of the posts. The concrete shall be thoroughly compacted around the posts by tamping or vibrating and shall have a smooth finish slightly higher than the ground and sloped to drain away from the posts. All posts shall be set plumb and to the required grade and alignment. No materials shall be installed on the posts, nor shall the posts be disturbed in any manner within 7 days after the individual post footing is completed.

Should rock or pavement be encountered at a depth less than the planned footing depth, a hole 2 inches (50 mm) larger than the greatest dimension of the posts shall be drilled to a depth of 12 inches (300 mm). After the posts are set, the remainder of the drilled hole shall be filled with grout, composed of one part portland cement and two parts mortar sand. Any remaining space above the rock or pavement shall be filled with concrete in the manner described above.

In lieu of drilling through the rock, the rock may be excavated to the required footing depth. No extra compensation shall be made for drilling or rock excavation.

F-162-3.2 Installing Top Rails. The top rail shall be continuous and shall pass through the post tops. The coupling used to join the top rail lengths shall allow for expansion.

F-162-3.3 Installing Braces. Horizontal brace rails, with diagonal truss rods and turnbuckles, shall be installed at all terminal posts.

F-162-3.4 Installing Fabric. The wire fabric shall be firmly attached to the posts and braced in the manner shown on the plans. All wire shall be stretched taut and shall be installed to the required elevations. The fence shall generally follow the finished concert/ asphalt, with the bottom of the fence fabric no less than 1 inch (25 mm) or more than 2 inches (50 mm) from the surface.

F-162-3.5 Clean Up. The Contractor shall remove from the vicinity of the completed work all tools, equipment, extra fence parts, etc. used during construction.

#### Material Requirements

ASTM A 121	Specification for Zinc-Coated (Galvanized) Steel Barbed Wire
ASTM A 153	Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 392	Specification for Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A 446	Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
ASTM A 824	Specification for Metallic-Coated Steel Marcellled tension Wire for Use with Chain Link Fence
ASTM A 1011	Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength, Low-Alloy and High-Strength Low-Alloy with Improved Formability
ASTM B 117	Practice for Operating Salt Spray (Fog) Apparatus
ASTM F 1043	Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework
ASTM F 1083	Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
Fed. Spec.	Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails RR-F-191/3 and Braces)
Fed. Spec. RR-F-191/4	Fencing, Wire and Post, Metal (Chain-Link Fence Accessories)

\*\* End of Section F-162 \*\*

## SECTION 16610 - EMERGENCY ELECTRICAL SYSTEMS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B. This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to emergency electrical systems.

## 1.2 DESCRIPTION OF WORK:

- A. Types of emergency system components specified in this section include the following:
  - 1. Emergency Diesel Generator Sets
  - 2. Automatic Transfer Switches
  - 3. Exhaust and Fuel Systems
  - 4. Weather Protective Enclosure
  - 5. Remote Annunciator Panel

## 1.3 QUALITY ASSURANCE:

- A. STANDARDS: Refer to Section 16001 - Electrical General Provisions as applicable.
- B. REQUIREMENTS OF REGULATORY AGENCIES:
  - 1. The electric generating system consists of a prime mover, generator, governor, coupling and all controls which must have been tested as a complete unit on a representative engineering model as required by NFPA 110-1985. The tests, being potentially damaging to the equipment tested, must not be performed on the equipment to be sold, but on a separate prototype model.
  - 2. Conform to N.E.C. and applicable inspection authorities.
  - 3. Transfer switches to be labeled under UL 1008.
- C. SHOP DRAWINGS: Submit dimensioned shop drawings of all emergency electrical system components and accessories including but not necessarily limited to emergency generator, protective enclosure, fuel tank, automatic transfer switch, battery charger, all instruments and accessories, and fuel piping requirements. Show accurately scaled layouts of system components. Submittals shall include complete system interconnection wiring diagrams and manufacturer's warranty form indicating compliance with these specifications.
- D. OWNER'S MANUALS: Four (4) sets of owner's manuals specific to the product supplied must accompany delivery of the equipment. General operating instruction, preventive maintenance, wiring diagrams, schematics and parts exploded views specific to this model must be included.

## PART 2 – PRODUCTS

## 2.1 MANUFACTURERS:

- A. Engine Generator Sets: This engine generator sets and equipment from one of the following:
  - 1. Caterpillar

2. Onan
3. Kohler
4. Smith Detroit Diesel
5. Generac

B. Automatic Transfer Switches: Provide automatic transfer switches and accessories from one of the following manufacturers:

1. ASCO
2. Onan
3. Russelectric
4. Zenith
5. Kohler
6. Generac

## 2.2 GENERAL:

A. Provide emergency electrical system components and specified herein and as shown on the drawings. Provide systems and components capable of start and load transfer within 10 seconds of power outages.

B. Please note that the generator is to deliver the specified KW rating as indicated on the drawings. Increase rating of generator as required for altitude and temperature ratings as follows:

1. Altitude: 5500 Feet Above Sea Level
2. Maximum Ambient Temperature: 50 Degrees C.
3. Minimum Ambient Temperature: 0 Degrees C.

## 2.3 ENGINE-GENERATOR SET:

A. Engine: Provide 60 hertz alternating-current standby diesel engine driven generator units of voltage, phase, and capacities indicated. Base rating of electric sets upon operation after deducting power required for output for all necessary operating accessories including radiator fans, fuel pumps, etc. and under environmental conditions specified. Provide electric sets rated and capable of producing KW specified at 0.8 power factor. Certify performance of the electric set series by means of independent testing laboratory tests for full power rating stability, and voltage and frequency regulation. Provide stationary, water-cooled, full diesel, compression ignition, four stroke cycle, multi-cylinder or single cylinder, in-line or V-type engine. Arrange engine for direct connection to an alternator current generator; do not exceed engine speed of 1800 RPM at full rated load.

B. Alternator: Provide direct connected, engine driven, single bearing, synchronous type alternator with electrical characteristics indicated.

1. Instantaneous Voltage Dip: Limit voltage dip of engine generator set to less than 30 percent upon application of full rated power. Accomplish voltage regulation by means of a solid state voltage regulator. Inherently regulated machines are acceptable in sizes under 6 KW.
  - a. Stability: 1 percent of its mean value at any constant load from no load to full load for solid state regulators.
  - b. Regulation: Plus or minus 2 percent maximum so load to full load for solid state regulators.
2. Where more than 40 percent of the load is comprised of rectifiers and/or thyristors, provide power to voltage regulator by means of ceramic type permanent magnet pilot

excitor, capable or 80 percent automatic controlled SCR/Thyristor loading.

- C. Lubrication System: Equip engine with a pressure lubricated system. Provide spin-on type full flow lubricating oil filter. Equip filters with bypass valve to insure oil circulation if filters are clogged. Include dipstick oil level indicator.
- D. Air Cleaner: Provide reusable element air cleaner of size and type recommended by the engine manufacturer.
- E. Starting: Equip engine with a 12 volt electric starting motor of sufficient capacity to crank the engine at a speed which will allow full diesel starting of the engine. Disengage starter automatically when engine starts.
- F. Batteries: Provide rack-mounted, heavy duty, lead acid battery set of adequate voltage and amperage capacity to start and operate the engine. Provide sufficient capacity for cranking the engine for at least 30 seconds at firing speed with capacity for starting the diesel engine a minimum of four times. Provide capacity and voltage recommended by engine manufacturer. Provide all intercell and connecting battery cables as required.
- G. Battery Charger: Provide an automatic dual rate battery charger manufactured by the engine-generator set supplier. The automatic equalizer system shall monitor and limit the charge current to 10 amps. The output voltage is to be determined by the charge current rate. The charger must have a maximum open circuit voltage of 35 volts and be protected against a reverse polarity connection. The battery charger is to be factory installed on the generator set. Due to line voltage drop concerns, a battery charger mounted in the transfer switch will be unacceptable.
- H. Water Jacket Heater: Equip engine with thermostatically controlled water jacket heater. The heater voltage shall be 120 volt single phase for smaller units or 480 volt single-phase for larger units in KW rating as recommended by the manufacturer. Make all connections to water jacket heaters.
- I. Engine Instruments: Provide a unit mounted console with the following gauges:
  - 1. Run-stop-remote switch
  - 2. Remote starting, 12-volt, 2 wire
  - 3. Coolant temperature gauge
  - 4. Field circuit breaker
  - 5. DC voltmeter
  - 6. Running time meter
  - 7. Lamp test switch
  - 8. Engine preheat switch
  - 9. Oil pressure gauge
  - 10. Fault reset switch
  - 11. Cycle cranking
  - 12. Time delay start/stop
  - 13. 7-Light engine monitor with individual 1/2 amp relay signals and a common alarm contact for each of the following conditions:
    - a. Run
    - b. Pre-warning for low oil pressure
    - c. Pre-warning for high coolant temp
    - d. Low oil pressure shutdown
    - e. High coolant temperature shutdown
    - f. Overcrank shutdown
    - g. Overspeed shutdown

- J. Exhaust System: An exhaust silencer shall be provided of the size as recommended by the manufacturer and shall be of critical grade. Wrap the entire exhaust system, from manifold to roof or wall penetration with exhaust insulation. The silencer(s) shall be mounted on the weather protective enclosure with the use of a flexible, seamless, stainless steel exhaust connection and rain cap. All components must be properly sized to assure operation without excessive back pressure when installed.
  - K. Engine Protection Devices: Provide the following engine protection devices with indicating light annunciation for each device:
    - 1. Low-Oil pressure cut-out
    - 2. High air temperature cut-out
    - 3. Overspeed Cut-out
  - L. Mounting: Equip electric set with a suitable base for mounting on a level surface.
  - M. Isolators: Provide spring isolators between the electric set and base. Spring isolators between the engine and the base are acceptable if in accordance with manufacturer's recommendations.
  - N. Fuel: Provide engine capable of satisfactory performance on commercial grade diesel fuel as recommended by the manufacturer.
  - O. Governor: Equip engine with an electronic governor to maintain frequency within the limits as required to properly serve computer and electronic equipment.
  - P. Fuel System:
    - 1. Equip engine with primary and secondary fuel filters with replaceable elements, and an engine driven fuel pump, all mounted on the engine. Provide fuel system piping of size and type recommended by the engine manufacturer.
    - 2. The fuel system shall include a base-mounted fuel tank sized for 24 hours of run time at full load. It shall have the structural integrity to support the engine-generator set. Minimum features shall include all welded double-wall construction, a lockable fuel filler cap, fuel gauge, fuel line check valve and fittings for fuel supply, return, fill and vent. This tank must be supplied and warranted by the engine-generator set manufacturer and be factory installed. The tank shall be provided with a complete leak detection system and control panel.
  - Q. Weather Protective Enclosure: The engine-generator set shall be factory enclosed in a heavy gauge steel enclosure constructed with corner posts, coated with electro statically applied zinc and finished with baked enamel paint. The enclosure is to have large, hinged doors to allow access to the engine, alternator and control panel. Each door is to be fitted with stainless steel, lockable hardware with identical keys. Padlocks do not meet this specification.
  - R. Main Line Circuit Breaker: Provide a main line circuit breaker in rating as indicated on the drawings, but in no case greater than that recommended by the generator manufacturer. Provide a breaker with AIC rating as required to safely interrupt and clear the maximum available fault current of the alternator to meet all NEC requirements.
- 2.4 AUTOMATIC TRANSFER SWITCHES
- A. General: Automatic transfer switches shall be furnished by the manufacturer of the engine-generator set so as to maintain system compatibility and local service responsibility for the complete emergency power system. It shall be listed by Underwriter's Laboratory, Standard 1008 with circuit breaker protection. Representative production samples of the transfer switch

supplied shall have demonstrated through tests the ability to withstand at least 10,000 mechanical operation cycles. One operation cycle is the electrically operated transfer from normal to emergency and back to normal. Wiring must comply with NEC table 373-6(b).

- B. Ratings & Performance: Refer to electrical drawings for switch rating requirements. Where transfer switch is fed from an upstream overcurrent protection device having ground fault protection, provide a four pole unit with switched neutral.
- C. Construction:
1. The transfer switch shall be double throw construction, positively electrically and mechanically interlocked to prevent simultaneous closing and mechanically held in both normal and emergency positions. Independent break before make action shall be used to positively prevent dangerous source to source connections. When switching the neutral, this action prevents the objectionable ground currents and nuisance ground fault tripping that can result from overlapping designs. The transfer switch shall be approved for manual operation. The electrical operating means shall be by electric solenoid. Every portion of the contactor is to be positively mechanically connected. No clutch or friction drive mechanism is allowed, and parts are to be kept to a minimum. This transfer switch shall not contain integral overcurrent devices in the main power circuit, including molded case circuit breakers or fuses.
  2. The transfer switch electrical actuator shall have an independent disconnect means to disable the electrical operation during manual switching. Maximum electrical transfer time in either direction shall be 160 milliseconds, exclusive of time delays. Main switch contacts shall be high pressure silver alloy contacts to resist burning and pitting for long life operation.
  3. There shall be one SPDT, 10 ampere, 250 volt auxiliary switch on both normal and emergency sides, operated by the transfer switch. Full rated neutral bar with lugs for normal, emergency and load conductors shall be provided inside the cabinet.
- D. Controls:
1. All control equipment shall be mounted on the inside of the cabinet door in a metal lockable enclosure with transparent safety shield to protect all solid state circuit boards. This will allow for ease of service access when main cabinet lockable door is open, but to prevent access by unauthorized personnel. Control boards shall have installed cover plates to avoid shock hazard while making control adjustments. The solid state voltage sensors and time delay modules shall be plug-in circuit boards with silver or gold contacts for ease of service.
  2. A solid state undervoltage sensor shall monitor all phases of the normal source and provide adjustable ranges for field adjustments for specific applications needs. Pick-up and drop-out settings shall be adjustable from a minimum of 70% to a maximum of 95% of nominal voltage. A utility sensing interface shall be used, stepping down line voltage to 24VAC, helping to protecting the printed circuit board from voltage spikes and increasing personnel safety when troubleshooting.
  3. Signal the engine-generator set to start in the event of a power interruption. A set of contacts shall close to start the engine and open for engine shutdown. A solid state time delay start (adjustable, .1 to 10 seconds) shall delay this signal to avoid nuisance start-ups on momentary voltage dips or power outages.
  4. Transfer the load to the engine-generator set after it reached proper voltage (adjustable, 70% to 90%) and frequency (adjustable, 80% to 90%). A solid state time delay (adjustable, 5 seconds to 3 minutes) shall delay this transfer to allow the engine-generator to warm-up before application of load. There shall be a switch to bypass this warm-up timer when immediate transfer is required.
  5. Retransfer the load to the line after normal power restoration. A return to utility timer (adjustable, 1 to 30 minutes) shall delay this transfer to avoid short term normal power restoration.

6. The operating power for transfer and retransfer shall be obtained from the source to which the load is being transferred. Controls shall provide an automatic retransfer of the load from emergency to normal if the emergency source fails with the normal source available.
7. Signal the engine-generator to stop after the load retransfers to normal. A solid state engine cool down timer (adjustable, 1 to 30 minutes) shall permit the engine to run unloaded to cool down before shutdown.
8. Provide an engine minimum run timer (adjustable, 5 to 30 minutes) to ensure an adequate engine run period.
9. Provide a solid state plant exercise clock to set the day and time of generator set exercise period. Actual time of day and exercise time shall be displayed. The clock shall have a one week cycle and be powered by the load side of the transfer switch. A battery must be supplied to maintain the circuit board energized when the load side of the transfer switch is de-energized. Include a switch to select if the load will transfer to the engine-generator set during the exercise period.
10. The transfer switch shall have a time delay neutral feature to provide a time delay (adjustable, .1 to 10 seconds) during the transfer in either direction, during which time the load is isolated from both power sources. This allows residual voltage components of motors or other inductive loads (such as transformers) to decay before completing the switching cycle. A switch will be provided to bypass this feature when immediate transfer is required.
11. Front mounted controls shall include a selector switch to provide for a NORMAL TEST mode with full use of time delays, FAST TEST mode which bypasses all time delays to allow for testing the entire system in less than one minute, or AUTOMATIC mode to set the system for normal operation.
12. Provide bright lamps to indicate the transfer switch position in either UTILITY (white) or EMERGENCY (red). A third lamp is needed to indicate STANDBY OPERATING (amber). These lights must be energized from utility or the engine-generator set.
13. Provide manual operating handle to allow for manual transfer. This handle must be mounted inside the lockable enclosure so accessible only by authorized personnel.
14. Provide a safety disconnect switch to prevent load transfer and automatic engine start while performing maintenance. This switch will also be used for manual transfer switch operation.
15. Provide LED status lights to give a visual readout of the operating sequence. This shall include utility on, engine warm-up, engine warm-up bypass, standby voltage "ready", standby frequency "ready", standby on, transfer to standby, return to utility, engine cool down, engine minimum run and fast test mode.

## 2.5 REMOTE ANNUNCIATOR PANEL:

- A. General: Provide remote annunciator panel with the following features:
  1. Provide visual indication of 20 separate alarm conditions. The panels shall monitor and be labeled as follows:
    - a. GENSET RUNNING (Green)
    - b. HIGH TEMP (Amber)
    - c. LOW OIL PRESS (Amber)
    - d. LOW TEMP (Amber)
    - e. LOW FUEL (Amber)
    - f. HIGH TEMP (Red)
    - g. LOW OIL PRESS (Red)
    - h. OVERCRANK (Red)
    - i. OVERSPEED (Red)
    - j. NOT IN AUTO (Red-flashing)
    - k. BLANK (Red)
    - l. BLANK (Red)

2. Switchable lenses and alarm horn function.
3. Removable legend plates for engraving alarm or status labels.
4. Alarm silence button on annunciator resets circuit for any subsequent fault condition whether or not initial fault has been cleared.
5. Designed for operation at 24 VDC, with negative ground signals.
6. Stainless steel front panel for flush or surface mounting. Refer to drawings for mounting requirements.
7. Knockouts for conduit connections.
8. Replaceable 25,000 hour high intensity lamps for easy readability, high reliability, and low power consumption.
9. Lamp Test/Alarm silence switch.

### PART 3 - EXECUTION

#### 3.1 GENERAL:

- A. Install emergency electrical systems in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

#### 3.2 MOUNTING:

##### A. Generator Sets:

1. Housekeeping Pads: Unless noted otherwise, provide 6" high steel reinforced concrete pad for generator sets. Adjust height of pad and steel reinforce in accordance with all manufacturer's recommendations - verify prior to installation. Refer to "Concrete Bases" under Section 16001 - Electrical General Provisions.

##### B. Transfer Switches:

1. Anchor switches firmly to walls and structural surfaces.
2. Housekeeping Pads: Provide housekeeping pads in accordance with "Concrete Bases" under Section 16001 - Electrical General Provisions.

#### 3.3 FACTORY TESTING:

- A. Before shipment of the equipment, the engine-generator set shall be tested under rated load and power factor for performance and proper functioning of control and interfacing circuits. Tests shall include:
  1. Verifying all safety shutdowns are functioning properly.
  2. Single step load pick-up per NFPA 110-1985, Paragraph 5-13.2.6.
  3. Transient and voltage dip responses and steady state voltage and speed (frequency) checks.

#### 3.4 SERVICE:

- A. Supplier of the electric set and associated items shall have permanent service facilities in this trade area. These facilities shall comprise a permanent force of factory trained service personnel on 24 hour call, experienced in servicing this type of equipment, providing warranty and routine maintenance service to afford the owner maximum protection. Delegation of this service responsibility for any of the equipment listed herein will not be considered fulfillment of these specifications. Service contracts shall also be available.

**3.5 WARRANTY:**

- A. The standby electric generating system components, complete engine-generator, instrumentation panel, and automatic transfer switch shall be warranted by the manufacturer against defective materials and factory workmanship for a period of one year. Such defective parts shall be repaired or replaced at the manufacturer's option, free of charge for travel and labor. The warranty period shall commence when the standby power system is first placed into service. Multiple warranties for individual components (engine, alternator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided. Also, in the judgment of the specifying authority, the manufacturer supplying the warranty for the complete system must have the financial strength and technical expertise with all components supplied to provide adequate warranty support.

**3.6 CHECKOUT & STARTUP:**

- A. The supplier of the electric generating plant and associated items covered herein shall provide factory trained technicians to checkout the completed installation and to perform an initial startup inspection to include:
  - 1. Ensuring the engine starts (both hot and cold) within the specified time.
  - 2. Verification of engine parameters within specification.
  - 3. Set no load frequency and voltage.
  - 4. Test all automatic shutdowns of the engine-generator.

**3.7 LOAD BANK TEST:**

- A. Conduct a load bank test to the rated KW of the generator for a minimum of four hours.

**3.8 MISCELLANEOUS:**

- A. Provide engine lubricating oil, fuel, engine coolant, filters, etc. for system testing. After testing, refill all fluids to capacity for final acceptance.
- B. Provide line voltage wiring for battery chargers, heaters, and leak detection system.
- C. Provide low voltage control and monitoring wiring for all transfer switches and remote annunciators as may be specified.

END OF SECTION 16610

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## SECTION 16001 - ELECTRICAL GENERAL PROVISIONS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Architectural, Structural, Mechanical and other applicable documents also apply to work of this section.

## 1.2 DESCRIPTION OF WORK:

- A. The contract documents indicate the extent of electrical work. Provide all labor, materials, equipment, supervision and service necessary for a complete electrical system as described in division 16.

## 1.3 RELATED SECTIONS:

- A. Other Divisions relating to electrical work apply to the work of this section. See other applicable Divisions including, but not necessarily limited to:

## 1.4 INTERPRETATIONS OF DRAWINGS AND SPECIFICATIONS:

- A. Prior to bidding the job, submit requests for clarification in writing to the Architect/Engineer prior to issuance of the final addendum.
- B. After signing the contract, provide all materials, labor, and equipment to meet the intent, purpose, and function of the contract documents.
- C. The following terms used in Division 16 documents are defined as follows:
  - 1. "Provide" - Means furnish, install, and connect, unless otherwise indicated.
  - 2. "Furnish" - Means purchase new and deliver in operating order to project site.
  - 3. "Install" - Means to physically install the items in-place.
  - 4. "Connect" - Means make final electrical connections for a complete operating piece of equipment. This includes providing conduit, wire, terminations, etc. as applicable.
  - 5. "Or Equivalent" - Means to provide equivalent equipment. Such equipment must be approved by the Engineer prior to bidding.

## 1.5 EXAMINATION OF SITE:

- A. Visit the site and verify existing field conditions prior to submitting bid.
- B. All costs arising from site conditions and/or preparation shall be included in the base bid. No additional charges will be allowed due to inadequate site inspection.

## 1.6 QUALITY ASSURANCE:

- A. Perform work in accordance with all governing codes, rules, and regulations including the following minimum codes (latest editions or as otherwise accepted by the Authorities Having Jurisdiction):
1. National Electric Code (NEC)
  2. International Building Code (IBC)
  3. International Fire Code (IFC)
  4. International Mechanical Code (IMC)
  5. International Plumbing Code (IPC)
  6. American Disability Act (ADA)
  7. National Electrical Safety Code (NESC)
  8. Local Codes and Ordinances
- B. Comply with all standards where applicable for equipment and materials including the following minimum standards:
1. Underwriter's Laboratories (UL)
  2. American Society for testing Materials (ASTM)
  3. Certified Ballast Manufacturers (CBM)
  4. Insulated Cable Engineers Association (ICEA)
  5. National Electrical Manufacturer's Institute (NEMA)
  6. American National Standards Institute (ANSI)
  7. Electrical Testing Laboratories (ETL)
  8. National Fire Protection Association (NFPA)
  9. Institute of Electrical and Electronics Engineers (IEEE)
  10. American Institute of Electrical Engineer's Electrical Power
  11. Systems and Grounding in Commercial Construction
  12. Illuminating Engineers Society (IES)
- C. Provide new electrical equipment conforming to all requirements as set forth in the above standards. Provide UL labeled equipment where such label is applicable.
- D. Comply with all state and local codes and ordinances. When conflicts occur among codes, standards, drawings, and/or specifications, the most stringent requirements shall govern.
- E. Obtain all permits, inspections, etc. required by authority having jurisdiction. Include all fees in bid. Provide a certificate of approval to the owner's representative from the inspection authority at completion of the work.
- F. Provide only first-class workmanship from competent workers, conforming to the best electrical construction practices.
- G. The contractor shall have a current state contracting license applicable to type of work to be performed under this contract.

## 1.7 SUBMITTALS:

- A. Shop Drawings: After the contract is awarded, but prior to manufacture or installation of any equipment, submit eight (8) complete sets of shop drawings. Partially complete sets of shop drawings are not acceptable. Submit all shop drawings in one complete submittal package. Prior to submitting shop drawings, review and certify that they are in compliance with the contract documents; Sign all approved shop drawings. Allow a minimum of two weeks for architect/engineer to review shop drawings. Refer to architectural general provision section for additional requirements.

- B. Provide equipment catalog "cut sheets", brochures and/or drawings which clearly describe the proposed equipment. Include plans, elevations, sections, isometrics, and detailed engineering and dimensional information as applicable including equipment room layouts. Electrical room layouts are required to show all electrical equipment locations for all projects that include electrical rooms. Do not submit catalog sheets which describe several different items in addition to those items to be used, unless all relevant information is clearly identified. Bind each information set in three ring binder or binders of sufficient size or sizes to enclose all information. Organize all information by section. Provide separate tabbed covers for each section of Divisions 16 indicating section number for each section requiring submittals.
- C. Include on front cover of binder or binders the name and location of the project, architect, electrical engineer, general contractor, electrical contractor, subcontractors, supplier/vendor, order number, volume, date, and any other applicable information. Certify that shop drawings are submitted in accordance with the contract documents with a written statement indicating compliance. Submittals will be reviewed and comments produced two times maximum. Additional reviews will be billed at current rates.

#### 1.8 OPERATION AND MAINTENANCE MANUALS:

- A. Submit four (4) complete sets of operating instruction and maintenance manuals for all equipment and materials provided under Divisions 16 prior to the Substantial Completion Inspection.
- B. Provide manufacturer's recommended operating and maintenance instructions, cleaning and servicing requirements, serial and model number of each piece of equipment, complete list of replacement parts, performance curves and data, wiring diagrams, warranties, and vendor's name, address, and phone numbers. Do not submit information which describes several different items in addition to those items to be used, unless all relevant information is clearly identified. Assemble all data in completely indexed volume or volumes. Engrave the job title, and name, address, and phone numbers of the contractor on the front cover and on the spine. Incomplete O&M manuals will be returned to the contractor for corrections / additions.

#### 1.9 RECORD DRAWINGS:

- A. Maintain on a daily basis a complete set of "Red-Lined Drawings", reflecting an accurate record of all work including addendums, revisions, and changes. Indicate precise dimensioned locations of all concealed work and equipment, including concealed or embedded conduit, junction boxes, etc. Record all "Red-Lined Drawing" information on a set of full sized prints of the contract drawings.
- B. Certify the "Red Lined Drawings" for correctness. Indicate on each drawing the name of the general and electrical contractors with signatures of each representative responsible for the work.
- C. The electrical engineering design firm will create record (as-built) drawings from the certified red-lined drawings; however, the general and electrical contractors retain the responsibility for the accuracy of the record drawings.

#### 1.10 WARRANTY:

- A. Ensure that the electrical system installed under this contract is in proper working order and in compliance with drawings, specifications, and/or authorized changes and is free from electrical defects. Without additional charge, replace or repair, to satisfaction of the owner's representative, except from ordinary wear and tear, any part of the installation which may fail or be determined unacceptable within a period of one (1) year after final acceptance or as

otherwise indicated in individual sections, but in no case less than one year. Warranty incandescent and fluorescent lamps only for a period of two months from the date of substantial completion.

- B. Provide complete warranty information for each item including beginning of warranty period, duration of warranty, names, addresses, and telephone numbers and procedures for filling a claim and obtaining warranty services. Written warranties and guarantees are to be submitted separately as:
  - 1. Originals bound in a binder clearly identified with the title, "WARRANTIES AND GUARANTEES," the project name, the project number, and the Contractor's business name.
  - 2. Electronic documents in \*.pdf format.

## PART 2 – PRODUCTS

### 2.1 GENERAL:

- A. All materials shall be new and shall bear the manufacturer's name, trade name, and the approved testing laboratory such as the UL label in every case where a standard has been established for that particular material. Used materials are acceptable only if specifically indicated on drawings.

### 2.2 SUBSTITUTION OF MATERIALS:

- A. Provide only specified products or products approved by addendum. Substitutions will be considered if two copies of the proposal is received at the architect's/engineer's office eight (8) working days prior to the bid day. Include in the proposal the specified and proposed catalog numbers of the equipment under consideration and a catalog cut sheet(s) with pictorial and descriptive information. Certify that the equipment proposed is equal to that specified, that it has the same electrical and physical characteristics, compatible dimensions, and meets the functional intent of the contract documents.
- B. It is the responsibility of the contractor to make all substituted equipment comply with the intent of the contract documents and bear all cost associated with conflicts arising from the use of substituted equipment.
- C. Provide samples if so required by the architect or engineer before or after bid day.

### 2.3 SPARE PARTS:

- A. Provide spare parts as specified in Divisions 16 sections. Deliver all spare parts to owner's representative prior to substantial completion.

## PART 3 – EXECUTION

### 3.1 GENERAL:

- A. Workmanship: Provide only first class workmanship from competent workers. Defective materials or workmanship will not be allowed on the project. Provide competent supervision for the work to be accomplished. Keep same foreman on the job, unless a change is authorized

by the engineer.

- B. Coordination: Prior to construction, layout electrical work and coordinate work with other trades. Sequence, coordinate, and integrate installation of materials and equipment for efficient flow of the work. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components. Coordinate with all utilities including power, communication, and data installations.
- C. Provide cutting, drilling, channeling, etc. only as necessary for proper completion of the work. Do not cut structural members unless authorization is issued in writing by the architect/engineer.
- D. Repairs: Repair damage to building, grounds, or utilities as a result of work under this contract at no additional cost to the owner.
- E. Dimensioning: Electrical drawings indicate locations for electrical equipment only in their approximate location, unless specifically dimensioned. Do not scale electrical drawings for dimensional information. Refer to architectural drawings and shop drawings where applicable for locations of all electrical equipment. Field verify all dimension on the job site.
- F. Provide block-outs, sleeves, demolition work, etc., required for installation of work specified in this division.
- G. Standards: Provide electrical installation in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- H. All workmen doing work of any nature on State of Utah projects must at all times carry their electrician's license with them and show it upon request. The acceptable ratio of apprentice to journeyman electricians on the job is 1:1.

### 3.2 REQUESTS FOR INFORMATION:

- A. When it is clearly apparent that information is not adequately described in the construction documents or when a coordination problem exists, submit a request for information (RFI) through proper contractual channels. The electrical engineering design firm will provide a response through its contractual channel. Although verbal direction may be given to expedite changes, responses are not considered part of the contract documents until a change order has been issued and signed by the Owner or his designated representative. The Contractor shall bear all costs associated with proceeding on any change order that has not been approved by the Owner or his designated representative.
- B. It is not the electrical engineering design firm's responsibility to answer questions that could clearly be answered by a thorough review of the construction documents. Should an RFI be issued by the Contractor where information was available, the electrical engineering firm will bill the contractor at the following rates:
 

1.	Principal	\$135.00 / Hr.
2.	Engineer	\$100.00 / Hr.
3.	Designer	\$ 75.00 / Hr.
4.	Construction Administrator	\$ 70.00 / Hr.
5.	Drafting	\$ 60.00 / Hr.
6.	Clerical	\$ 45.00 / Hr.

- C. Any damages caused by construction delays due to frivolous RFI's, will be born solely by the Contractor.

### 3.3 SAFETY PRECAUTIONS:

- A. Provide all necessary guards or construction barriers and take all necessary precautions to insure the safety of life and property.

### 3.4 CLEAN:

- A. Clean up all equipment, conduit, fittings, wire, packing cartons, plastic, and other debris that is a direct result of the installation of the work of this division, both during the execution, and at the conclusion, of the project. Keep the site clean and safe during the progress of the work. Clean fixtures, interior and exterior of all equipment, and raceways prior to final acceptance. Vacuum interior of all electrical panels and equipment. Correct any damaged equipment. Touch-up or repaint if necessary.

### 3.5 TEMPORARY POWER:

- A. Make arrangements with the proper institution authority for all temporary electricity.
- B. Provide temporary power, complete with metering and wiring for lighting and power outlets for construction tools and equipment. Report the initial meter reading to the owner/institution, or otherwise as may be directed.
- C. Service shall be provided with a main disconnect and all 20 ampere receptacles protected by 20 amp GFI, single-pole breakers. No attempt is made herein to specify construction power requirements for equipment in detail. Provide all electrical equipment and wiring as required.
- D. As soon as permanent power and metering is available, the temporary power supply shall be disconnected and removed from the project site.
- E. All temporary wiring shall meet the requirements of NEC Article 305 and the State Industrial Commission.

### 3.6 POWER OUTAGES:

- A. All power outages required for execution of this work shall occur during non-standard working hours and at the convenience of the owner. Any electrical service interruption will be coordinated at least 7 days in advance of the power shut-off. Include all costs for overtime work in bid. Coordinate all outages and proceed only after receiving authorization from the owner's representative. Keep all outages to an absolute minimum.

### 3.7 STORAGE AND PROTECTION OF MATERIALS:

- A. Provide storage space for storage of materials and apparatus and assume complete responsibility for all losses due to any cause whatsoever. Lost or damaged materials will be replaced at no additional cost to owner. Do not store materials and apparatus in any public thoroughfare or in any area on the site where such storage would constitute a hazard to persons in the vicinity. Protect completed work, work underway, and apparatus against loss or damage.

### 3.8 EXCAVATING FOR ELECTRICAL WORK:

- A. Verification: Prior to excavating, locate and protect existing utilities and other underground

work in a manner which will ensure that no damage or service interruption will result from excavating and backfilling. Observe all State and Local codes prior to excavating. Do not disturb walls, footings, and other structural members in any way.

- B. Protection: Provide barricades, warning signs, and illumination to protect persons from injury at excavations. Provide temporary coverings and heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install electrical work on frozen excavation bases or subbases.
- C. Coordination: Do not excavate for electrical work until the work is ready to proceed without delay.
- D. Excavated Materials: Temporarily store excavated materials near excavation in manner which will not interfere with or damage excavation or other work. Dispose of and remove excavated materials which are either in excess of quantity needed for backfilling or do not comply with the requirements for backfill material.
- E. Burial Depths: Burial depths must comply with NEC Section 300-5 (or State of Utah requirements, whichever is more stringent), unless noted otherwise on drawings.
- F. Excavation Permits: Obtain all shut-down and excavation permits as may be required for proper completion of the work.

### 3.9 BACKFILL MATERIALS:

- A. For buried conduits or cables (other than below slab-on-grade, or concrete-encased), provide 2" thickness of well-graded sand on all sides of conduits or cables.
- B. For trench backfill to within 6" of final grade, provide soil material suitable for compacting to required densities.
- C. For top 6" of excavation, provide top soil.
- D. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (percent of maximum density, ASTM D 1557), using power-driven hand-operated compaction equipment:
  - 1. Lawn/Landscaped Areas: 85 percent for cohesive soils, 95 percent for cohesionless soils.
  - 2. Paved Areas, other than roadways: 90 percent for cohesive soils, 95 percent for cohesionless soils.
- E. Where subsidence is observable at electrical work excavations during project warranty period, remove surface, add backfill material, compact, and replace surface treatment. Restore surface to original condition.

### 3.10 ROOF PENETRATIONS:

- A. Where raceways and/or cables penetrate roofing, provide 26 gauge galvanized iron roof jack, sized to fit tightly to raceway and/or cable for weather-tight seal, and with flange extending a minimum of 9" under roofing on all sides. Seal opening between raceway and roof jack with approved sealant. Coordinate all work with division 7.

## 3.11 FIRE PENETRATION SEALS:

- A. Seal all raceway and/or cable penetrations through fire-rated floors, wall, and ceilings to prevent the spread of smoke, fire, toxic gas or water through the penetration either before, during or after fire. Provide penetration sealants and fittings of ratings to match the rating of the penetrated materials so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the NEC.
- B. Sealant Systems: Provide sealants, wall wraps, partitions, caps, and other accessories complying with UL 1479 (ASTM E-814) from the following where applicable:
  - 1. 3M Fire Barrier Sealing Penetration System
  - 2. Chase Foam Fire Stop System
  - 3. Thomas and Betts Flame Safe Fire Stop System
  - 4. Nelson Fire Stop Products
- C. Fittings: Where applicable, provide OZ Type CFSF/I and CAFSF/I fire seal fittings for conduit and cable penetrations through concrete and masonry wall, floor, slabs, and similar structures.
- D. Install sealants and fittings in accordance with all manufacturer's written instructions.

## 3.12 LABELING:

- A. Engraved black plastic laminated, with white-core labels, 1/16" thick, shall be permanently attached on both the interior and exterior the following electrical equipment:
  - 1. Branch panels
  - 2. Switchgear
  - 3. Disconnect switches
  - 4. Motor starter and controls junction boxes (power and auxiliary)
  - 5. Push buttons
  - 6. Thermal switches
  - 7. Time switches
  - 8. Motor control centers
  - 9. Transformer
  - 10. Similar equipment.
  - 11. Lighting contactors and associated switches
  - 12. Junction boxes larger than 4x4x1/2.
- B. The labels shall have 1/4" high, engraved letters, such as EF-1, AC-1, Panel A, etc.
- C. Label for motor starters and/or thermal overload switches shall include heater size and F.L.A.
- D. Labels shall be red where serving emergency loads.

## 3.13 CONCRETE BASES:

- A. Housekeeping Pads: Unless otherwise noted, provide 4" high reinforced concrete bases for all floor-mounted or floor-standing electrical equipment, including but not necessarily limited to the following:
  - 1. Transformers
  - 2. Switchgear
  - 3. Motor control centers
  - 4. Generators
  - 5. Battery racks

## 6. Similar Equipment

- B. Extend bases 6" beyond equipment or mounting rails on all sides or as shown on the drawings. Notwithstanding this requirement, coordinate with equipment manufacturer, shop drawings, and height of base to ensure compliance with NEC 380-82.
- C. Concrete bases: Refer to Section 16551 – exterior area lighting.
- D. Transformer Pads: Provide and locate properly sized concrete pads for power company furnished pad mounted transformers in accordance with power company clearance requirements.

## 3.14 TESTS:

- A. Notify engineer prior to all testing specified herein at least three business days prior to testing. Engineer shall observe all tests to insure the proper operation of the electrical system.

## 3.15 PROJECT FINALIZATION AND START-UP:

- A. Upon completion of the work, have each factory representative and/or subcontractor assist in start-up and testing of their respective systems.
- B. Have each representative give personal instructions on operating and maintenance of their equipment to the owner's maintenance and/or operation personnel.
- C. Have representatives certify each system with a written statement indicating that they have performed start-up and final check out of their respective systems.

## 3.16 FINAL REVIEW:

- A. Have the project foreman accompany their reviewing parties and remove coverplates, panel covers, access panels, etc. as requested, to allow review of the entire electrical system.

END OF SECTION 16001

## SECTION 16072 - ELECTRICAL SUPPORTS AND SEISMIC RESTRAINTS

## PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS:

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

## 1.2 SUMMARY:

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Seismic restraints for electrical equipment and systems.
  - 3. Construction requirements for concrete bases.

## 1.3 DEFINITIONS:

- A. IBC: International Building Code.
- B. Seismic Restraint: A structural support element such as a metal framing member, a cable, an anchor bolt or stud, a fastening device, or an assembly of these items used to transmit seismic forces from an item of equipment or system to building structure and to limit movement of item during a seismic event.

## 1.4 SUBMITTALS:

- A. Product Data: Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of electrical support and seismic-restraint component used.
  - 1. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
  - 2. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Shop Drawings: Indicate materials and dimensions and identify hardware, including attachment and anchorage devices, signed and sealed by a qualified professional engineer. Include the following:
  - 1. Fabricated Supports: Representations of field-fabricated supports not detailed on Drawings.
  - 2. Seismic Restraints: Detail anchorage and bracing not defined by details or charts on Drawings. Include the following:
    - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    - b. Details: Detail fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
    - c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

- C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
  - D. Welding certificates.
  - E. Qualification Data: For professional engineer and testing agency.
  - F. Field quality-control test reports.
- 1.5 QUALITY ASSURANCE:
- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
  - B. Testing of Seismic Anchorage Devices: Comply with testing requirements in Part 3.
  - C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS:

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

### 2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS:

- A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed under this Project, with a minimum structural safety factor of five times the applied force.
- B. Steel Slotted Support Systems: Comply with MFMA-3, factory-fabricated components for field assembly.
  - 1. Available Manufacturers:
    - a. Cooper B-Line; a division of Cooper Industries.
    - b. ERICO International Corporation.
    - c. Allied Support Systems; Power-Strut Unit.
    - d. GS Metals Corp.
    - e. Michigan Hanger Co., Inc.; O-Strut Div.
    - f. National Pipe Hanger Corp.
    - g. Thomas & Betts Corporation.
    - h. Unistrut; Tyco International, Ltd.
    - i. Wesanco, Inc.
  - 2. Finishes:
    - a. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-3.
  - 3. Channel Dimensions: Selected for structural loading and applicable seismic forces.

- C. Raceway and Cable Supports: As described in NECA 1.
- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Verify suitability of fasteners in subparagraph below for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick.
  - 2. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Available Manufacturers:
      - 1) Hilti, Inc.
      - 2) ITW Construction Products.
      - 3) MKT Fastening, LLC.
      - 4) Simpson Strong-Tie Co. Inc.
  - 3. In the following subparagraph, use stainless steel anchors in corrosive environments.
  - 4. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    - a. Available Manufacturers:
      - 1) Cooper B-Line; a division of Cooper Industries.
      - 2) Empire Tool and Manufacturing Co., Inc
      - 3) Hilti, Inc.
      - 4) ITW Construction Products.
      - 5) MKT Fastening, LLC.
      - 6) Powers Fasteners.
  - 5. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  - 6. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
  - 7. Toggle Bolts: All-steel springhead type.
  - 8. Hanger Rods: Threaded steel.

### 2.3 SEISMIC-RESTRAINT COMPONENTS:

- A. Rated Strength, Features, and Application Requirements for Restraint Components: As defined in reports by an agency acceptable to authorities having jurisdiction.
  - 1. Structural Safety Factor: Strength in tension, shear, and pullout force of components used shall be at least five times the maximum seismic forces to which they will be subjected.
- B. Angle and Channel-Type Brace Assemblies: Steel angles or steel slotted-support-system components; with accessories for attachment to braced component at one end and to building structure at the other end.

- C. Cable Restraints: ASTM A 603, zinc-coated, steel wire rope attached to steel or stainless-steel thimbles, brackets, swivels, and bolts designed for restraining cable service.
  - 1. Available Manufacturers:
    - a. Amber/Booth Company, Inc.
    - b. Loos & Co., Inc.
    - c. Mason Industries, Inc.
  - 2. Seismic Mountings, Anchors, and Attachments: Devices as specified in Part 2 "Support, Anchorage, and Attachment Components" Article, selected to resist seismic forces.
  - 3. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod, of design recognized by an agency acceptable to authorities having jurisdiction.
  - 4. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to type and size of anchor bolts and studs used.
  - 5. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to type and size of attachment devices used.

#### 2.4 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES:

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.

### PART 3 - EXECUTION

#### 3.1 APPLICATION

- A. Comply with NECA 1 for application of hangers and supports for electrical equipment and systems, except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for raceways as within 12 inches of coupling, fitting, and box, at each 90 degrees bend, minimum of two supports per ten foot run. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with single-bolt conduit clamps, or as otherwise required by an agency acceptable to authorities having jurisdiction.

#### 3.2 SUPPORT AND SEISMIC-RESTRAINT INSTALLATION:

- A. Comply with NECA 1 for installation requirements, except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, raceways may be supported by openings through structure members, as permitted in NFPA 70.
- C. Install seismic-restraint components using methods approved by the evaluation service

providing required submittals for component.

- D. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
  - E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
    - 1. To Wood: Fasten with lag screws or through bolts.
    - 2. To New Concrete: Bolt to concrete inserts.
    - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
    - 4. To Existing Concrete: Expansion anchor fasteners.
    - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
    - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 Spring-tension clamps.
    - 7. To Light Steel: Sheet metal screws.
    - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
  - F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
  - G. Do not drill or core cut holes for anchors or use powder-activated fasteners in post-tension slabs, joists, and beams.
- 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS:
- A. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.
  - B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
  - C. Field Welding: Comply with AWS D1.1/D1.1M.
- 3.4 CONCRETE BASES:
- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and seismic criteria at Project.
  - B. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so expansion anchors will be a minimum of 10 bolt diameters from edge of the base.
    - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of the base.

2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
6. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete."

### 3.5 INSTALLATION OF SEISMIC-RESTRAINT COMPONENTS:

- A. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Restraint Cables: Provide slack within maximums recommended by manufacturer.
- D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

### 3.6 FIELD QUALITY CONTROL:

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing: Test pullout resistance of seismic anchorage devices.
  1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
  3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  5. Test to 90 percent of rated proof load of device.
  6. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- C. Record test results.

END OF SECTION 16072

## SECTION 16080 - ELECTRICAL DEMOLITION

## PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B. This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to electrical demolition.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of electrical demolition work is indicated by drawings.
- B. Electrical demolition items are shown to give a basic description of the extent of demolition work, but may not be inclusive.
- C. Do not assume that the electrical drawings reflect as-built conditions. Visit and observe the project prior to submitting bid and determine extent of electrical demolition work.

## 1.3 QUALITY ASSURANCE:

- A. Standards: Refer to Section 16001 - Electrical General Provisions as applicable.

## PART 2 – PRODUCTS - Not used.

## PART 3 – EXECUTION

## 3.1 GENERAL:

- A. Demolition work shall be laid out in advance to eliminate unnecessary cutting, drilling, channeling, etc. Where such cutting, drilling, or channeling becomes necessary, perform with care, use skilled mechanics of the trades involved. Cutting work of other contractors shall be done only with the consent of that contractor. Cutting of structural members is not permitted. Repair damage to building and equipment as a result of electrical demolition work under this contract at no additional cost to owner.
- B. Obtain permission from the architect before penetrating any ceiling, floor, and wall surfaces.

## 3.2 METHODS:

- A. Disconnect and remove any/all fixtures, devices, equipment, etc. required for proper completion of the work whether shown or not.
- B. Relocate, rewire, and/or reconnect any/all fixtures, devices, equipment, etc. that for any reason obstructs construction.
- C. Maintain circuit integrity and continuity of all existing circuits/feeders, and systems that interfere with or are interrupted by remodel work, unless those circuits/feeders are to be abandoned

completely. Maintain all circuits and systems in operation during construction. Provide temporary panels, temporary wiring and conduits, etc. as required.

- D . Leave all existing fixtures, devices, equipment, etc. In portions of the building not being remodeled, in working condition.
- E . Remove and dispose of all raceways, conductors, boxes, devices, equipment, etc., that are not to be reused. Terminate at accessible junction box by providing proper knockout closure, tape conductors, and label as "spare" with circuit no., Zone no., or other characteristic identifying source.
- F . Existing raceways may be reused, if in place, where in compliance with the contract documents and the National Electrical Code. Upgrade and/or provide new conduit supports where necessary for all raceways being reused. Insure integrity of existing raceways before re-use.
- G . Return to owner all light fixtures which are to be removed. Dispose of all light fixtures if so directed by owner in accordance with local environmental laws and policies. Those fixtures indicated for re-use shall be thoroughly cleaned, repaired as required, re-lamped, and installed as indicated. When storing fixtures for reuse, store in area and/or provide protective covering that will keep construction dust and materials off fixtures.
- H . Completely remove all telephone or data cables which are to be removed back to source or as directed by owner.
- I . Disconnect and remove all sound system equipment including speakers, amplifiers, etc. And return to owner. Completely remove and dispose of all associated conduit and wire.

### 3.3 PATCHING AND REPAIR:

- A . Finished Surfaces: The electrical contractor is responsible for patching and repair of all existing interior surfaces pertaining to the installation of work under this Division, unless specifically noted elsewhere in the contract documents. Where patching and repair is necessary, surfaces shall be finished (painted, etc.) to match the adjacent materials, finished, and colors. Requirements of other Divisions such as Division 9 - finishes shall apply.
- B . Hard Surfaces: Whenever excavation or trenching is required for the installation of electrical work, it shall be the responsibility of the electrical contractor to make repairs and/or replacements of hard finish surfaces such as concrete, asphalt, etc. Requirements of other Divisions such as Division 2 – Existing Conditions shall apply.

### 3.4 CONCEALING:

- A . All raceways shall be concealed within the ceilings, walls, and floors, except in locations where exposed raceways are specifically permitted, such as equipment rooms and unfinished storage areas.
- B . Surface-mounted raceways or systems shall be permitted only where approved by Architect/Engineer.

END OF SECTION 16080

## SECTION 16110 - CONDUIT RACEWAYS

## PART 1 – GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B. This section is a Division 16 General Provisions section, and is part of each Division 16 sections making reference to conduit raceways.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of raceways is indicated by drawings and schedules.
- B. Types of raceways in this section include the followings:
  - 1. Rigid Metal Conduit
  - 2. PVC Externally Coated Rigid Steel Conduit
  - 3. Intermediate Metal Conduit
  - 4. Electrical Metallic Tubing
  - 5. Flexible Metal Conduit
  - 6. Liquid-tight Flexible Metal Conduit
  - 7. Rigid Non-metallic Conduit

## 1.3 QUALITY ASSURANCE:

- A. Standards: Refer to Section 16001 - Electrical General Provisions as applicable. Provide conduit raceway installation in accordance with recommendations of the American Iron and Steel Institute "Design Manual on Steel Electrical Raceways", latest edition.
- B. Manufacturers: Firms regularly engaged in the manufacture of raceway of types and sizes required, whose products have been in satisfactory service for not less than three (3) years.
- C. Shop Drawings: Not required.

## PART 2 – PRODUCTS

## 2.1 CONDUITS:

- A. Rigid Metal Conduit (RMC): Provide zinc-coated, hot-dipped galvanized, rigid metallic conduit in accordance with Federal Specification WW-C-0581 and ANSI C80.1.
- B. PVC Externally Coated Rigid Metal Conduit: Provide hot-dipped galvanized, rigid metallic conduit externally coated with Polyvinyl Chloride (PVC) in accordance with ANSI C80.1 and NEMA Std. Pub. No. RN 1.
- C. Intermediate Metal Conduit (IMC): Provide hot-dipped galvanized, intermediate metal conduit in accordance with Federal Specification WW-C-581.
- D. Electric Metallic Tubing (EMT): Provide electric metal tubing in accordance with Federal

Specification WW-C-563 and ANSI C80.3.

- E. Flexible Metal Conduit: Provide zinc-coated, flexible metal conduit in accordance with Federal Specification WW-C-566.
- F. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight, flexible metal conduit, constructed of single strip, flexible continuous, interlocked, and double-wrapped steel, galvanized inside and outside, coated with liquid-tight jacket of flexible Polyvinyl Chloride (PVC).
- G. Rigid Non-Metallic Conduit: Provide rigid non-metallic conduit (PVC) in accordance with ANSI/NEMA TC 2, Type 1 for concrete encasement, Type 2 for direct burial.

## 2.2 FITTINGS:

- A. Rigid Metal Conduit, Intermediate Metal Conduit, and PVC Externally Coated Rigid Metal Conduit: Provide fully-threaded, malleable steel fittings, rain-tight and concrete-tight as applicable. Provide double locknuts and metal bushings at all conduit terminations. Install OZ Type B bushings on conduits 1-1/4" and larger.
- B. Electric Metallic Tubing: Provide insulated throat, non-indenter, set screw, malleable steel fittings. Screws must have a full set. Provide concrete-tight compression-type fittings in suspended slabs. All EMT fittings shall be fabricated from steel. Die-cast fittings or fittings made from pot metal shall not be allowed. Indenter type fittings are not acceptable. Install OZ Type B bushings on conduits 1" and larger.
- C. Flexible Metal Conduit: Provide flexible metal conduit fittings in accordance with Federal Specification W-F-406, Type 1, Class 1, and Style A. Commercial "greenfield" not less than 1/2" diameter or as otherwise specified on drawings is acceptable.
- D. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight flexible metal conduit fittings in accordance with Federal Specification W-F-406, Type 1, Class 3, Style G.
- E. Non-Metallic Conduit: Provide non-metallic conduit fittings (PVC) in accordance with ANSI/NEMA TC 3 to match conduit types and materials.
- F. Expansion Fittings: OZ Type AX, or equivalent to suit application.
- G. Sealing Bushings: Provide OZ Type FSK, WSK, or CSMI as required by application. Provide OZ Type CSB internal sealing bushings.
- H. Cable Supports: Provide OZ cable supports for vertical risers, type as required by application.

## 2.3 SIZES:

- A. Provide conduits in sizes as indicated in contract documents or as otherwise specified herein, but not less than 3/4".

## PART 3 – EXECUTION

### 3.1 GENERAL:

- A. Install raceway and accessories in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA Standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

### 3.2 LOCATIONS:

- A. Rigid Metal Conduit and Fittings: Use for conduit bends greater than 22 degrees where buried below grade or slab on grade. Install RMC where raceway passes vertically through slab-on-grade. Where raceways penetrate building, manholes, or vault walls and floors below grade, provide RMC for a minimum distance of 10' on the exterior side of the floor or wall. Use RMC for exposed runs where conduit is subject to moisture, weather, or mechanical injury. Use in hazardous locations in accordance with all NEC requirements.
- B. Intermediate Metal Conduit and Fittings: Use for exposed runs where conduit is subject to moisture, weather, or mechanical injury. Use in hazardous locations in accordance with all NEC requirements.
- C. Electric Metal Tubing and Fittings: Use for above-grade feeders, branch circuits, and signal and control circuit, unless specifically noted otherwise on drawings. Install in suspended slabs subject to local code requirements and fire rating considerations.
- D. Flexible Metal Conduit and Fittings: Use as whips for lighting fixtures, fixed equipment where not exposed to weather or moisture, other devices where required by NEC, and as requested by the Engineer. Maximum length not to exceed 6', unless specifically approved by the Electrical Engineer.
- E. Liquid-Tight Flexible Metal Conduit and Fittings: Use for connection to motor terminal boxes, fixed equipment where subject to moisture or weather, and other equipment subject to movement or vibration. Maximum length not to exceed 6', unless specified otherwise.
- F. Rigid Non-Metallic Conduit and Fittings: Use for below-grade service entrances, feeders, branch circuits, and signal and control circuit, unless specifically noted otherwise on drawings. Do not use above grade.

### 3.3 METHODS:

- A. Maintain a minimum of 12" clearance between steam or hot water lines or other hot surfaces. Where such clearance is impractical, insulate conduit with approved materials.
- B. Install conduits parallel with or at right angles to lines of the structure. Route conduits symmetrically where possible.
- C. Field bends and offsets shall be made without flattening, kinking, rippling or destroying the smooth internal bore or surface of the conduit and to not less than NEC minimum radius. Conduit that shows signs of rippling or kinking shall not be installed. Conduits installed with wrinkles or kinks or otherwise in an unworkmanlike manner shall be replaced at no additional cost to owner.
- D. Precaution shall be exercised to prevent accumulation of water, dirt or concrete in the conduits during the execution of the project. Conduits in which water or foreign matter has been permitted to accumulate shall be thoroughly cleaned or the conduits runs replaced where such accumulation cannot be removed by methods approved the engineer.
- E. Any conduit which pierces airtight spaces or plenums shall be sealed to prevent air leakage with mastic acceptable to the Architect.

### 3.4 CONCEALING:

- A. All raceways shall be concealed within the ceilings, walls, and floors, except in locations where

exposed raceways are specifically permitted, such as equipment rooms and unfinished storage areas. In equipment rooms, if lighting raceways are run exposed, installation shall not be done until piping and duct work layout has been determined in order that lighting boxes may be located so as to avoid being covered by overhead ducts and piping. If lighting raceways in equipment rooms are concealed in the structural ceiling slab, after mechanical work is complete, exposed conduit extensions shall be run to locate lighting fixtures where they are not obscured by work of other trades.

### 3.5 BURIED CONDUITS:

- A. Comply with all burial depths as defined in NEC Section 300-5. Bury all conduits at least 24" below grade, unless specifically indicated otherwise on drawings. Provide magnetic 6" wide "Yellow Warning" ribbon 12" directly above conduit and 6" below finished grade measured from the top of the conduit or duct bank. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single marker.
- B. Slope all conduits toward manholes or pull boxes for proper drainage. Use weep holes. Gravel drainage pockets are not permitted.
- C. Coat all metal conduits with an approved asphaltic compound or wrap with two layers of PVC tape.
- D. Under Concrete Slab on Grade: Horizontal conduit must be installed a minimum of 2" below the bottom of the concrete slab. Conduits should not be installed in concrete slabs.
- E. Concrete Encasement: Where concrete-encasement is indicated on drawings, provide ductbank construction using red 3000 psi at 28 day strength concrete. Provide minimum 4" cover on all sides of exterior conduits. Provide conduit spacers where applicable. Coat all metal conduits with an approved asphaltic compound or wrap with two layers of PVC tape.
- F. Where conduits are extended for future use, cap and clearly mark.

### 3.6 ELECTRICAL CONTINUITY:

- A. Provide electrically continuous conduit systems throughout.

### 3.7 FIELD CUTS AND THREADS:

- A. Cut all conduits square. Remove all sharp or rough edges and ream all burrs, inside and outside. Provide clean sharp threads on RMC and IMC.
- B. Engage at least five full threads on all RMC and IMC fittings. Before couplings or fittings are attached, apply one coat of red lead or zinc chromate to male threads of RMC or IMC. Apply coat of red lead, zinc chromate or special compound recommended by manufacture to conduit where conduit protective coating is damaged.

### 3.8 CONDUIT ENDS:

- A. Cap all spare conduits. Cap or plug conduit ends during construction to prevent entrance of foreign material.

### 3.9 SPARE CONDUITS:

- A. Provide five (5) 3/4" empty conduits from panel stubbed into accessible ceiling space and five (5) 3/4" conduits into accessible floor space. When floor is not accessible, provide six (6) 3/4" empty conduits from panel stubbed into accessible ceiling space. Cap and label all conduits.

- B. Install a 200 lb. polypropylene pull cord in each empty conduit run.

3.10 HAZARDOUS LOCATIONS:

- A. Install RMC and IMC in all hazardous locations as defined by the NEC. Provide suitable fittings, seal-offs, boxes, etc. to comply with all NEC requirements and/or as shown on the drawings. Provide inspection fittings with hazardous location rated drains to prevent water from accumulating in conduit runs.

3.11 CLEANING:

- A. Pull mandril and swab through all conduits before installing conductors.

END OF SECTION 16110

## SECTION 16120 - CONDUCTORS AND CABLES

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A . Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B . This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to conductors and cables.

## 1.2 DESCRIPTION OF WORK:

- A . This section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.
- B . Types of conductors and cables in this section include the following:
  - 1. Copper Conductors.
- C . Applications for conductors and cables required for project include:
  - 1. Electrical service.
  - 2. Feeders.
  - 3. Branch Circuits.

## 1.3 SUBMITTALS:

- A . Product Data: For each type of conductor and/or cable indicated.
- B . Field Quality-Control Test Reports: From Contractor. Refer to Section 16001 – General Electrical Provisions.

## 1.4 QUALITY ASSURANCE:

- A . Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B . Comply with NFPA 70.

## PART 2 - PRODUCTS

## 2.1 GENERAL:

- A . Manufacturers: In other Part 2 articles where subparagraph titles below introduce lists, provide products by the manufacturer specified, subject to compliance with requirements.
- B . Ambient Conditions: Conductors used for branch circuits in areas where the ambient conditions exceed 30 degree C. shall be provided with insulation approved for that temperature.

- C . Wire Sizes: As indicated on electrical drawings or as specified herein, but in no case less than No. 12 AWG.

## 2.2 COPPER CONDUCTORS:

- A . Manufacturers:
  - 1. American Insulated Wire Corporation; a Leviton Company.
  - 2. General Cable Corporation.
  - 3. Senator Wire & Cable Company.
  - 4. Southwire Company.
- B . Refer to Part 3 "Conductor and Cable Applications" Article for application requirements.
- C . References and Ratings:
  - 1. ICEA S-95-658 / NEMA WC70.
  - 2. ASTM.
  - 3. UL Standard 83.
  - 4. UL Standard 1063 (MTW).
  - 5. Federal Specification J-C-30B.
  - 6. NEC.
- D . Conductor Material: Copper.
- E . Stranding: Solid conductor for No. 12 AWG, stranded for No. 10 AWG and larger.
- F . Conductor Insulation Types: Thermoplastic-insulated, Type THHN / THWN-2.

## 2.3 CONNECTORS AND SPLICES:

- A . Manufacturers:
  - 1. AMP Incorporated/Tyco International.
  - 2. Hubbell/Anderson.
  - 3. O-Z/Gedney; EGS Electrical Group LLC.
  - 4. 3M Company; Electrical Products Division.
- B . Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- C . Splices for wire sizes #10 and smaller shall be screw-on type similar to scotch or ideal wing nut connectors. Crimp-on splices designed to be used without wire stripping are not acceptable.

## PART 3 – EXECUTION

### 3.1 GENERAL:

- A. Install conductors, cables, and accessories as indicated, in compliance with manufacturer's written instruction, applicable requirements of NEC, NECA's "Standards of Installation", and in accordance with recognized industry practices to ensure that products fulfill requirements.

### 3.2 CONDUCTOR AND CABLE APPLICATIONS:

- A. Service Entrance: As indicated on the electrical drawings.
- B. Feeders: As indicated on the electrical drawings.
- C. Branch Circuits:
  - 1. Exposed, including in crawlspaces: Copper conductors in raceway.
  - 2. Concealed in ceilings, walls, and partitions: Copper conductors in raceways.
  - 3. Concealed in concrete and below slabs-on-grade: Copper conductors in raceway.
- D. Cord Drops, Reels, and Portable Appliance Connections: Flexible cord.
- E. Class 1 Control Circuits: Copper conductors in raceway.

### 3.3 INSTALLATION:

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- D. When raceway is not required, install concealed cables parallel and perpendicular to surfaces of structural members, and follow surface contours where possible.
- E. Support cables according to other applicable specification sections.
- F. Seal around cables penetrating fire-rated elements to comply with applicable fire stop specification sections.
- G. Color Coding: Color code secondary service, feeder, and branch circuit conductors. Colors shall remain consistent throughout the project and shall match existing coding system where applicable.
  - 1. Conductor sizes No. 6 AWG and smaller: Colored insulation.
  - 2. Conductors sizes No. 4 AWG and larger: 2 inch (51 mm) band of Colored adhesive marking tape applied at all terminations, junction boxes, and pull boxes.
  - 3. Branch circuit switched-legs and travelers: Colored insulation (in colors other than those indicated below).
  - 4. Color-code 120/208V system conductors:
    - a) Phase A: Black.
    - b) Phase B: Red.
    - c) Phase C: Blue.
    - d) Neutral: White.
    - e) Ground: Green.
    - f) Isolated Ground: Green with yellow tracer.
  - 5. Color-code 277/480V system conductors:
    - a) Phase A: Brown.
    - b) Phase B: Orange.
    - c) Phase C: Yellow.
    - d) Neutral: White with colored stripe or gray.
    - e) Ground: Green.

## 3.4 HOMERUN CIRCUITS:

- A. Homerun circuits may be combined in common conduits at the option of the contractor in compliance with the following:
1. Three-Phase Installations: Not more than three single-phase circuits with common neutral in one conduit, unless specifically noted otherwise, if each circuit is from a different phase (a, b, or c).
  2. Single-Phase Installations: Not more than two single-phase circuits with common neutral in one conduit, unless specifically noted otherwise, if each circuit is from a different phase (a or b).

## 3.5 NEUTRAL CONDUCTORS:

- A. LIGHTING CIRCUITS: Where multiple circuits serving lighting are run in a single raceway (see paragraph above for allowable number or circuits per conduit), a common neutral shall be allowed. When any one circuit is serving fluorescent lighting loads, provide an oversized neutral conductor. Size the neutral conductor one size (AWG) larger than the largest phase conductor.
- B. OUTLET CIRCUITS: Where multiple circuits serving electrical outlets are run in a single raceway (see paragraph above for allowable number of circuits per conduit), a shared common neutral is allowed.

## 3.6 VOLTAGE DROP:

- A. Provide branch circuit conductors in sizes such that voltage drop for branch circuits do not exceed 3 percent at the farthest outlet. Provide service, feeder, and branch circuit conductors so that the voltage drop on the entire electrical system does not exceed 5 percent at the farthest outlet. This shall be strictly followed regardless of the conductor sizes indicated on the electrical drawings. Increase conductor sizes (and conduits where necessary to comply with NEC conduit fill requirements) as necessary to accommodate this requirement. Calculations shall be based on the following:
1. Lighting Branch Circuits: Connected load plus 25% spare.
  2. Appliance and Equipment Branch Circuits: Nameplate or NEC required load.
  3. 120V Convenience Outlet Branch Circuits: 12 amps minimum, but in no case less than NEC loading requirements. Use the following schedule:

<u>Distance (feet)</u>	<u>Wire Size (AWG)</u>
0-80	#12
81-125	#10
126-200	#8
201-320	#6

4. Use the NEC method to calculate voltage drop.

## 3.7 CONNECTIONS:

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack. Use pig tails when wiring outlets.

### 3.8 FIELD QUALITY CONTROL:

- A. Testing: Perform the following field quality-control testing:
  - 1. Visual and Mechanical Inspection:
    - a) Inspect cables for physical damage and proper connection in accordance with the electrical construction documents.
    - b) Test cable mechanical connections to manufacturer's recommended values with a calibrated torque wrench.
    - c) Check cable color coding for compliance with electrical specifications.
  - 2. Electrical Tests:
    - a) Perform insulation resistance test on each conductors for feeders 100 amps and greater with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 minute.
    - b) Perform continuity test to insure proper cable connection.
  - 3. Test Values:
    - a) Minimum insulation resistance values shall not be less than two megohms.
- B. Test Reports: Prepare a written report and submit to the Electrical Engineer at the completion of the project. The report shall include the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 16120

## SECTION 16135 - ELECTRICAL BOXES AND FITTINGS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A . Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B . This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to electrical boxes and fittings.

## 1.2 DESCRIPTION OF WORK:

- A . Extent of electrical boxes and fittings work is indicated by drawings and schedules.
- B . Types of electrical boxes and fittings in this section include the following:
  - 1. Outlet Boxes
  - 2. Junction Boxes
  - 3. Pull Boxes
  - 4. Conduit Bodies
  - 5. Bushings
  - 6. Locknuts
  - 7. Knockout Closures
  - 8. Miscellaneous Boxes and Fittings

## 1.3 QUALITY ASSURANCE:

- A . Standards: Refer to Section 16001 - Electrical General Provisions as applicable.
- B . Manufacturers: Firms regularly engaged in the manufacturer of boxes and fittings required, whose products have been in satisfactory service for not less than three years.
- C . Shop Drawings: Submit shop drawings on floor boxes only where required.

## PART 2 - PRODUCTS

## 2.1 INTERIOR OUTLET BOXES:

- A . General: Provide one piece, galvanized or cadmium-plated, flat-rolled, sheet steel interior outlet boxes of types, shapes, and sizes to suit respective location and installation. Construct with stamped knockouts on back and sides and with threaded screw holes. Provide corrosion-resistant screws for securing boxes, covers, and wiring devices. Size all junction boxes in accordance with NEC Table 370-16(a), with a minimum box size of 4" x 4" x 1-1/2". Where three raceway entries are made, provide outlet boxes with a minimum depth of 2-1/8". Where four or more raceway entries are made, provide outlet boxes with a minimum depth of 4-11/16". Gangable boxes shall not be used.
- B . Switch, Telephone, and Receptacle Outlets: Provide outlet boxes not less than 4" square, with adapting tile or plaster covers where necessary to set flush with finished surfaces. Where three raceway entries are made, provide outlet boxes with a minimum depth of 2-1/8". Gang boxes

shall be used where more than one switch or device is located at one point. Sectional Boxes are not acceptable. In masonry walls where tile or plaster ring cannot be used, install a single-gang 3-1/2" deep box minimum, unless otherwise noted. Where four or more raceway entries are made, provide outlet boxes with a minimum depth of 4-11/16".

C . Lighting Outlets:

1. Lay-in Grid: Outlets for recessed fixtures in acoustical tile ceilings shall be located to center on a single tile or at the intersection of four tiles.
2. Surface-mounted: Provide 4" square octagonal outlet boxes for surface-mounted, ceiling fixture outlets. Mount each box independently of the conduit on standard 3/8" stud or approved box hangar where applicable. Include backing and supports as required to carry 200 lbs. Where three or more raceway entrances are made, use a minimum box depth of 2-1/8".

2.2 WEATHERPROOF OUTLET BOXES:

- A . Provide corrosion-resistant, cast-metal weatherproof outlet boxes, of types, shapes, and sizes, with threaded conduit ends, cast metal coverplates with spring-hinged waterproof caps, face plate gaskets, and corrosion-resistant fasteners.

2.3 JUNCTION AND PULL BOXES:

- A . Provide code-gauge sheet steel junction and pull boxes, with removable screw-on covers and welded seams, of types, shapes, and sizes to suit each respective location and installation. Size all junction and pull boxes in accordance with NEC 370-28. Provide stainless steel nuts, bolts, screws, and washer.

2.4 CONDUIT BODIES:

- A . Provide galvanized, cast-metal conduit bodies of type, shapes, and sizes to suit respective locations and installation. Construct with threaded conduit entrance ends and removable covers. Provide corrosion-resistant screws.
- B . Aluminum boxes and fitting shall not be permitted.

2.5 CONDUIT CONNECTIONS:

- A . Box connectors 3/4" and larger shall be insulated, throat-type or equal type plastic bushings. Provide double locknuts and insulating plastic bushings for RMC and IMC terminating at panels and boxes.
- B . Where RMC penetrates building, manholes, or vault walls and floors below grade, provide sealing bushings with external membrane clamps as applicable. Provide segmented internal sealing bushings in all raceways penetrating building walls and slabs below grade, and in all above grade raceway penetrations susceptible to moisture migration into building through raceway. Where RMC terminates in manhole, vault, or pull box, provide insulated grounding bushings. Also see Section 16135 – Electrical Boxes and Fittings.
- C . Install OZ type "B" connectors for all conduits 1" and larger.
- D . Provide cable supports in all vertical risers in accordance with NEC 300-19.

2.6 EXPANSION FITTINGS:

- A . Provide expansion joint fittings in all conduit runs crossing structural expansion joints, whether

above-grade, in slab-on-grade, or in suspended slabs. Provide OZ type "AX" or approved equivalent, size to the raceway.

### 2.7 ACCESSORIES:

- A. Provide all accessories including, but not necessarily limited to, bushings, knockout closures, locknuts, offset connectors, etc. of types, shapes, and sizes to suit respective locations and installation. Construct of corrosion-resistant steel.

## PART 3 – EXECUTION

### 3.1 GENERAL:

- A. Install electrical boxes and fittings in accordance with manufacturer's written instruction, applicable requirements of the NEC, NEMA Standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

### 3.2 METHODS:

- A. Where outlet boxes are subject to weather or moisture, install weatherproof outlet boxes.
- B. Remove knockouts only for entering conduits. Provide knockout closures to cap unused knockout holes where blanks are mistakenly removed.
- C. Do not use condulets in place of elbows or junction boxes. Condulets in sizes 2" or larger shall not be used, unless specifically approved by the electrical engineer.
- D. Install boxes and conduit bodies in readily accessible locations. Install recessed boxes with faces of boxes or rings flush with finished surfaces. Seal all openings between outlet box and adjacent surfaces with plaster, grout, or similar suitable material.
- E. For stud construction, install boxes with rigid supports using metal bar hangers, or 2" X 4", 1" X 6" wood bridging between studs with screws. Welding or nailing boxes directly to metal joist and studs is not acceptable. Boxes set opposite in common wall shall have at least 10" of conduit between them. Securely fasten outlet boxes to structural surfaces to which attached.
- F. For concrete or masonry construction, solidly embed electrical boxes in concrete and masonry. Provide box supports as required to keep outlet boxes flush with finished surfaces.
- G. Coordinate location of all outlet boxes with millwork, back splashes, tackboards, etc.
- H. Install junction boxes or condulets in conduit runs as required at 100 foot maximum intervals on long runs. This shall apply to concrete junction boxes in grade and junction boxes within the building.
- I. Provide electrical connections for installed boxes.

### 3.3 IDENTIFICATION:

- A. Mark circuit number on exterior side of junction boxes located in ceilings such that circuits numbers are readily identifiable. For outlet boxes in wall, mark circuit numbers on interior sides of outlet boxes.

B. Identification labels shall be as follows:

Normal Power	Black with White letters
Emergency Power	Red with White Letters
UPS	Orange with White Letters

END OF SECTION 16135

## SECTION 16160 – PANELBOARDS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B. This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to panelboards.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of panelboard work is indicated by drawings and schedules and is specified herein.
- B. Type of panelboards in this section include the following:
  - 1. Lighting and Appliance Panelboards
  - 2. Power Distribution Panelboards

## 1.3 QUALITY ASSURANCE:

- A. STANDARDS: Refer to Section 16001 - Electrical General Provisions as applicable.
- B. SUBMITTALS:
  - 1. Shop Drawings: Submit dimensioned drawings of panelboards and enclosures showing accurately scaled layouts of enclosures. Include schedule of devices, including, but not necessarily limited to, circuit breakers, fusible switches, fuses, ground-fault circuit interrupters, and accessories.
  - 2. Equipment Room Layouts: Submit dimensioned drawings of all equipment rooms indicating spatial relationships to other proximate equipment. Insure that all code required clearances are maintained.

## PART 2 – PRODUCTS

## 2.1 MANUFACTURERS:

- A. Subject to compliance with all requirements, provide products from one of the follows:
  - 1. Cutler-Hammer, Eaton Corp.
  - 2. General Electric Co.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D Co.

## 2.2 GENERAL:

- A. Provide panelboards, enclosures, and ancillary components, of types, sizes, and ratings indicated. Provide overcurrent protective devices, etc. as indicated on drawings for a complete installation.

- B. Where "Spaces" or "Blanks" are indicated on panelboard schedules, provide drilled bus and mounting hardware ready to receive breaker or fusible switch of size indicated on panelboard schedule.

### 2.3 PANELBOARD ENCLOSURES:

- A. Provide Code gauge, galvanized or rust-resistant sheet steel enclosures in sizes and NEMA types to suit respective applications. The size of the wiring gutters and gauge of steel shall be in accordance with the latest NEMA Standards Publication and latest UL standards for panelboards. Flush locks shall not protrude beyond the front of the door. Key all enclosures alike and provide three keys at completion of the project. Fronts shall have adjustable indicating trim clamps, which shall be completely concealed when the doors are closed. Doors shall be mounted by completely concealed steel hinges. A circuit directory frame and card, with clear plastic covering shall be provided on the inside of the door. The directory cards shall be typewritten to identify each circuit service. Provide panel enclosures with doors hinged to enclosures. Provide ANSI-61 painted finish.

### 2.4 LIGHTING AND APPLIANCE PANELBOARDS:

- A. Provide dead-front, safety-type lighting and appliance panelboards of types and electrical characteristic indicated. Provide Copper bus bars, full-sized neutral bus, and ground bus. Provide insulated/isolated ground buses where indicated. Include overcurrent protective devices and switches in quantities, ratings, types, and arrangements shown. See Section 16180 - Overcurrent Protective Devices.
- B. Rate devices, bussing, supports, etc. equal to or greater than the short circuit current rating indicated. Provide fully-rated systems only. Series-rated systems are not acceptable, unless specifically noted otherwise.

### 2.5 POWER DISTRIBUTION PANELBOARDS:

- A. Provide dead-front, safety-type lighting and appliance panelboards of types and electrical characteristic indicated. Provide wall-mounted or floor-standing power distribution panelboards as indicated. Provide panelboards suitable for use as service equipment where required. Provide aluminum Copper bus bars, full-sized neutral bus, and ground bus. Provide insulated/isolated ground buses where indicated. Include overcurrent protective devices and switches in quantities, ratings, types, and arrangements shown. See Section 16180 - Overcurrent Protective Devices.
- B. Rate devices, bussing, supports, etc. equal to or greater than the short circuit current rating indicated. Provide fully-rated systems only. Series-rated systems are not acceptable, unless specifically noted otherwise.

## PART 3 - EXECUTION

### 3.1 GENERAL:

- A. Install panelboards in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

### 3.2 IDENTIFICATION:

- A. Provide 1/16" thick black plastic laminate labels with 1/4" high lettering on both the interior and

exterior of each panelboard enclosure indicating name of panelboard. Bolt and nut or rivet labels to enclosure. (Sheet metal screws are not acceptable).

- B. All subpanels shall be labeled to identify the main panel that supplies the feeder circuit.
- C. Provide red plastic laminate label for panelboards supplied by emergency power.
- D. Provide orange plastic laminate label for panelboards supplied by UPS power.

### 3.3 MOUNTING:

- A. Mount panelboards as indicated, but in no case higher than 6'-6" from finished floor to top of panel. Anchor enclosures firmly to walls and structural surfaces.
- B. Provide 4" high concrete pad under floor-standing power distribution panelboards.

### 3.4 CIRCUIT DIRECTORIES:

- A. For lighting and appliance panelboards, provide typed panelboard circuit directories. Indicate load description or name and location. Utilize actual building room numbers, not architectural room numbers used on drawings. Label the panel and circuit that feed this panel.
- B. For power distribution panelboards, provide 1/16" thick black plastic laminate labels with 1/4" high lettering for each load served.
  - 1. Provide red plastic laminate label for emergency loads.
  - 2. If circuits are changed in a panel, type the new circuit designation and glue on existing circuit directory. Do not discard existing panelboard schedule unless all circuits have been changed.

### 3.5 WIRING METHODS:

- A. Arrange conductors neatly within enclosure, and secure with suitable nylon ties.
- B. Panelboards shall not be used for junction or splicing boxes or as a raceway.

### 3.6 ARRANGEMENT OF OVERCURRENT PROTECTIVE DEVICES:

- A. The overcurrent protective devices shall be in the same sequence and labeled as the panel schedule on the drawings.

END OF SECTION 16160

## SECTION 16180 - OVERCURRENT PROTECTIVE DEVICES

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B. This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to overcurrent protective devices.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of overcurrent protective devices is indicated by drawings and schedules and is specified herein.
- B. Type of overcurrent protective devices in this section include the following:
  - 1. Molded Case Circuit Breakers
  - 2. Electronic Circuit Breakers
  - 3. Ground Fault Protection

## 1.3 QUALITY ASSURANCE:

- A. STANDARDS: Refer to Section 16001 - Electrical General Provisions as applicable.
- B. SUBMITTALS:
  - 1. SHOP DRAWINGS: Submit manufacturer's data on overcurrent protective devices including specifications, time-current trip characteristics curves, mounting requirements, installation instructions, etc. Submit dimensioned drawings of overcurrent protective devices.
  - 2. Equipment Room Layouts: Submit dimensioned drawings of all equipment rooms indicating spatial relationships to other proximate equipment. Insure that all code required clearances are maintained.

## PART 2 – PRODUCTS

## 2.1 GENERAL:

- A. Provide overcurrent protective devices and ancillary components of types, sizes, ratings, and electrical characteristics indicated. Provide enclosures in NEMA ratings as indicated and suitable for applications.

## 2.2 MOLDED CASE CIRCUIT BREAKERS:

## A. MANUFACTURERS:

Subject to compliance with all requirements, provide molded case circuit breakers from one of the following:

- 1. Cutler-Hammer

2. General Electric
3. Siemens
4. Square D

B. MOLDED CASE CIRCUIT BREAKERS:

1. Provide factory-assembled, molded case circuit breakers as integral components of lighting and appliance panelboards, power panelboards, switchboards, and for individual mounting as indicated. Provide thermal magnetic, molded case circuit breakers of amperages, voltages, types, and short circuit current ratings indicated. Provide bolt-on type breakers only. Construct with quick-break, quick-break mechanism with inverse-time delay and instantaneous trip protection for each pole. Provide breakers rated for ambient temperatures to suit respective applications. Provide mechanical screw type removable copper connector lugs of size to accommodate conductors specified.
2. Provide breakers that have interrupting ratings greater than or equal to the specified fault current. Provide fully-rated systems only. Series-rated systems are not acceptable, unless specifically noted otherwise.

2.3 ELECTRONIC CIRCUIT BREAKERS:

A. VENDORS:

Subject to compliance with all requirements, provide electronic circuit breakers from one of the following:

1. Cutler-Hammer
2. General Electric
3. Siemens
4. Square D

B. ELECTRONIC CIRCUIT BREAKERS:

1. Provide factory-assembled, electric circuit breakers as integral components of power panelboards and switchboards. Unless noted otherwise on drawings, provide electronic circuit breakers in accordance with requirements as set forth in "MOLDED CASE CIRCUIT BREAKERS" above and with features as follows:
2. Provide electronic circuit breakers having the following selectable settings:
  - a) Long time pickup and delay.
  - b) Short time pickup and delay with  $I^2T$  In and  $I^2T$  Out features.
  - c) Instantaneous.
  - d) Ground fault pickup and delay with  $I^2T$  In and  $I^2T$  Out features.
3. Provide electronic circuit breakers having the following additional features:
  - a) 80% rated.
  - b) True RMS sensing.
  - c) Interchangeable rating plugs.
  - d) Thermal and magnetic backup protection.
  - e) Long time and ground fault memory.

2.4 GROUND FAULT PROTECTION:

A. GROUND FAULT PROTECTION:

1. Provide ground fault protection systems to operate shunt trip or electric trip of thermal magnetic circuit breakers or bolted pressure switches and/or as integral components of electronic circuit breakers where indicated on drawings and as required to meet all the

requirements as set forth in the NEC. Provide ground fault protection by means of a zero sequence ground fault sensor and ground fault relay. Provide power for ground fault relay through output of current sensor. Provide relay with current settings from 100 through 1200 amperes and time delay of .1 through 1 second. Provide cover that inhibits tampering with settings after installation. Provide means of testing the ground fault system without tripping the breaker or switch to meet the on-site testing requirements of the NEC. Provide visual trip indication for ground fault trip occurrences. Provide all interconnecting wiring as required.

### PART 3 - EXECUTION

#### 3.1 GENERAL:

- A. Install overcurrent protective devices in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

#### 3.2 SIZING FUSES:

- A. Size all fuses in accordance with manufacturer's written recommendations, whether fuse size is indicated on drawings or not. If nuisance tripping occurs, increase fuse size and disconnect if necessary as required to provide nuisance-free tripping. Adjust fuse size for proper ambient temperature, frequent starting and stopping of motor loads, and for loads with long start times.

#### 3.3 IDENTIFICATION:

- A. Provide 1/16" thick black plastic laminate labels with 1/4" high lettering on the exterior of each disconnect indicating name of disconnect or load served. Bolt labels to enclosure. Mark on interior cover the source of power by indicating the panel and circuit number.
- B. Provide red plastic laminate label for disconnects supplied by emergency power.

#### 3.4 MOUNTING:

- A. Mount disconnects as indicated, but in no case higher than 6'-6" from finished floor to top of disconnect. Anchor enclosures firmly to walls and structural surfaces.
- B. Provide 4" high concrete pad under floor-standing disconnects.

#### 3.5 SETTINGS:

- A. Adjust settings of overcurrent protective devices as directed by engineer.

#### 3.6 TESTING OF GROUND FAULT PROTECTION:

- A. Have all ground fault protection systems tested by authorized factory representative for proper operation. Replace all malfunctioning units. A complete record of current trip level and time required to trip the disconnecting device shall be submitted to the owner.

END OF SECTION 16180

## SECTION 16181 – DRY-TYPE TRANSFORMERS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B. This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to transformers.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of transformer work is indicated by drawings and schedules and is specified herein.
- B. Type of transformers in this section include the following:
  - 1. Dry-type transformers

## 1.3 QUALITY ASSURANCE:

- A. STANDARDS: Refer to Section 16001 - Electrical General Provisions as applicable.
- B. SUBMITTALS:
  - 1. SHOP DRAWINGS: Submit dimensioned drawings of transformers and enclosures showing accurately scaled layouts of enclosures. Provide product data including certification of transformer performance efficiency, percent regulation at 100 percent and 80 percent power factor, no-load and full load losses in watts, percent impedance at 75 degree C broken down into resistance and reactance, hot-spot and average temperature rise above 40 degree C ambient, sound level in decibels, and standard published data.
  - 2. EQUIPMENT ROOM LAYOUTS: Submit dimensioned drawings of all equipment rooms indicating spatial relationships to other proximate equipment. Insure that all code required clearances are maintained.

## PART 2 – PRODUCTS

## 2.1 MANUFACTURERS:

- A. Subject to compliance with all requirements, provide products from one of the follows:
  - 1. General Electric Co.
  - 2. Siemens Energy & Automation, Inc.
  - 3. Square D Co.
  - 4. Federal Pacific Transformers Co.
  - 5. Cooper Power Systems
  - 6. Powersmiths

## 2.2 GENERAL:

- A. Provide transformers, enclosures, and ancillary components, of types, sizes, and ratings indicated.

### 2.3 DRY-TYPE TRANSFORMERS:

- A. Taps: Provide primary windings with minimum of 4 full capacity taps; each 2-1/2 percent, two above and two below full-rated voltage for de-energized tap-changing operation.
- B. Windings: All windings to be copper.
- C. Insulation: Insulate with Class 220 insulation and rate for continuous operation at KVA.
- D. Temperature Rise: Limit temperature rise to 115
- E. Sound Levels: Sound level rating not to exceed 45 db in accordance with ANSI/NEMA standards.
- F. Efficiency: All transformers 15 KVA and larger shall meet the NEMA TP-1-2002 standard for energy efficiency.
- G. Enclosure: Provide ventilated, heavy-gauge, steel, painted enclosure.
- H. Electrostatic shield: Where indicated on drawings, provide shielded isolation type transformers for attenuation of source line interference.
- I. K-Factor Ratings: Where noted on drawings, provide K-factor rated transformers to serve harmonic loads equivalent to Square D NL (UL K-4 rated) or Square D NLP (UL K-13 rated) as indicated.

## PART 3 - EXECUTION

### 3.1 GENERAL:

- A. Install transformers in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

### 3.2 MOUNTING:

- A. Unless noted otherwise, mount transformers on 4" concrete house-keeping pad. Concrete pad to be furnished and installed under division 16. Anchor transformer enclosures firmly to concrete pad. See Section 16072 – Electrical Support and Seismic Restraints. Maintain adequate clearance from combustible surfaces in accordance with the NEC. Locate transformers a sufficient distance from walls and adjacent equipment to allow for adequate ventilation in accordance with all manufacturer's instructions. Lay-out electrical rooms and spaces prior to rough-in to insure proper ventilation and to maintain code required clearances.

### 3.3 LABELS:

- A. For transformers, provide 1/16" thick black plastic laminate labels with 1/4" high lettering for each load served.
- B. Provide red plastic laminate label for emergency loads.

END OF SECTION 16181

## SECTION 16182 – SWITCHBOARDS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B. This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to switchboards.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of switchboards is indicated by drawings and schedules and is specified herein.

## 1.3 QUALITY ASSURANCE:

- A. STANDARDS: Refer to Section 16001 - Electrical General Provisions as applicable.
- B. SUBMITTALS:
  - 1. Shop Drawings: Submit dimensioned drawings of switchboards and enclosures showing accurately scaled layouts of enclosures. Include schedule of devices, including, but not necessarily limited to, circuit breakers, fusible switches, fuses, and accessories.
  - 2. Equipment Room Layouts: Submit dimensioned drawings of all equipment rooms indicating spatial relationships to other proximate equipment. Insure that all code required clearances are maintained.

## PART 2 – PRODUCTS

## 2.1 VENDORS:

- A. Subject to compliance with all requirements, provide products from one of the follows:
  - 1. Cutler-Hammer
  - 2. General Electric
  - 3. Siemens
  - 4. Square D

## 2.2 GENERAL:

- A. Provide switchboards, enclosures, and ancillary components, of types, sizes, and ratings indicated. Provide overcurrent protective devices, etc. as indicated on drawings for a complete installation. See Section 16180 - Overcurrent Protective Devices.
- B. Rate devices, etc. equal to or greater than the short circuit current rating indicated. Provide fully-rated systems only. Series-rated systems are not acceptable, unless specifically noted otherwise.

## 2.3 AC DEAD-FRONT SWITCHBOARDS:

- A. Provide factory assembled, front accessible, dead-front, floor-standing switchboards in NEMA types to suit respective applications. Construct bus bars of silver-plated copper, braced to withstand RMS symmetrical fault current indicated. Provide ground bus in each section. Provide ANSI-61 painted finish.
- B. Lugs shall be copper only.

### PART 3 - EXECUTION

#### 3.1 GENERAL:

- A. Install switchboards in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

#### 3.2 IDENTIFICATION:

- A. Provide 1/16" thick black plastic laminate labels with 1/4" high lettering on exterior of each enclosure indicating name of switchboard. Bolt labels to enclosure. Mark on enclosure the source of power by indicating the panel and circuit number.
- B. Provide red plastic laminate label for emergency loads.

#### 3.3 MOUNTING:

- A. Provide 4" high concrete pad. Mount switchboard as indicated, but in no case higher than 6'-6" from finished floor to top of switchboard including concrete pad. Bolt switchboard to concrete pad in accordance with Section 16072 – Electrical Support and Seismic Restraints

#### 3.4 CIRCUIT DIRECTORIES:

- A. Provide 1/16" thick black plastic laminate labels with 1/4" high lettering for each load served.
- B. Provide red plastic laminate label for emergency loads.

#### 3.5 WIRING METHODS:

- A. Arrange conductors neatly within enclosure, and secure with suitable nylon ties.

END OF SECTION 16182

## SECTION 16452 – GROUNDING

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B. This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to grounding.

## 1.2 DESCRIPTION OF WORK:

- A. Extent of grounding work is indicated by drawings and schedules and is specified herein.
- B. Ground the complete electrical installation including the system neutral, metallic conduits and raceways, boxes, fittings, devices, cabinets, equipment, and separately derived systems in accordance with the NEC and all other applicable codes to provide a permanent, continuous, low impedance, grounding system.
- C. Provide grounding system such that the resistance from the service entrance ground bus, through the grounding electrode to earth is not greater than 5 ohms.

## 1.3 QUALITY ASSURANCE:

- A. STANDARDS: Refer to Section 16001 - Electrical General Provisions as applicable.
- B. TESTING: Submit results of ground resistance testing as specified in this section. Include name of testing agency with report. Include test results in operation and maintenance manuals.

## PART 2 – PRODUCTS

## 2.1 GENERAL:

- A. Provide grounding equipment and accessories of types, sizes, ratings, and electrical characteristics indicated or as otherwise required to provide a complete system.

## 2.2 GROUNDING CONDUCTORS:

- A. Unless noted otherwise, provide grounding conductors with stranding and insulation types to match phase conductors. Provide conductors with green insulation if possible; otherwise wrap with green tape. Size ground conductors as indicated on drawings. Do not size ground conductors smaller than that allowable by NEC.

## 2.3 GROUND RODS:

- A. Provide copper clad, steel, 3/4" diameter by 10' long, ground rods ( Weaver, Cadweld, or equivalent).
- B. Provide precast concrete box 9-1/2" W. x 16" L. x 18" D. with light duty concrete cover for non-traffic areas or rated steel plate for traffic areas. Provide covers with lifting holes. Engrave

cover with "Ground Rod".

#### 2.4 INSULATED GROUNDING BUSHINGS:

- A. Provide plated malleable iron body with 150 degree Centigrade molded plastic insulating throat, lay-in grounding lug with hardened stainless steel fasteners (OZ Gedney BLG or equivalent).

#### 2.5 CONNECTION TO PIPES:

- A. Provide heavy duty, cast bronze, ground clamp systems with silicon bronze bolts and nuts (OZ Gedney G Series - B or equivalent).

#### 2.6 CONNECTIONS TO STRUCTURAL STEEL, GROUND RODS, OR SPLICES:

- A. Provide exothermic welds. (Cadweld or equivalent)

#### 2.7 BONDING JUMPERS:

- A. Provide bonding jumpers with hot dip galvanized malleable or ductile iron clamps, hot dip galvanized steel U-bolts, and tinned copper braids (OZ Gedney BJ Series or equivalent).

#### 2.8 GROUND BUS:

- A. Provide 1/4" x 4", copper ground bus complete with insulators and brackets in lengths and at mounting heights as indicated on drawings. Furnish complete with drilled holes and lugs to accommodate grounding conductors.

### PART 3 - EXECUTION

#### 3.1 GENERAL:

- A. Install grounding systems in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

#### 3.2 CLEANING:

- A. Thoroughly clean all metal contact surfaces prior to installation of clamp-on connectors.

#### 3.3 SEPARATELY DERIVED SYSTEMS:

- A. Ground each separately derived system in accordance with NEC Section 250.30 unless otherwise indicated on drawings.
  1. Conductor from separately derived systems.
  2. Conductor from insulated ground bushings on service entrance conduits.
  3. Additional ground rods as required to achieve resistance value specified.
  4. Additional items indicated on drawings.

#### 3.4 EQUIPMENT BONDING AND GROUNDING:

- A. Provide an NEC sized conductor, whether indicated or not on the drawings, in raceways as follows:

1. Non-metallic conduits and ducts.
2. Distribution feeders.
3. Motor and equipment branch circuits.
4. Device and lighting branch circuits.
5. Full length of all multi-outlet assemblies and other surface wireways.

### 3.5 ADDITIONAL GROUNDING INSTALLATION REQUIREMENTS:

- A. Provide grounding bushings on all service conduit and conduits installed in concentric/eccentric knock-outs or reducing washer at panelboards, cabinets, and gutters.
- B. Provide bonding jumpers across expansion and deflection couplings in conduit runs, across pipe connections at water meters, and across dielectric couplings in metallic cold water piping system. Connection to water piping system shall be made electrically continuous by connecting to the street side of the water main valve and/or installing additional bonding jumpers across the meter, valves or service unions that might be disconnected.
- C. Provide bonding wire in all flexible conduits.
- D. Isolated Ground Circuits: Circuits used for isolated ground outlets shall be run in separate raceways or shall have a separate green insulated ground conductor installed and tagged for identification at all outlet and junction boxes.

### 3.6 TEST WELLS:

- A. All ground rods shall be driven external to building and shall be located in ground well boxes. Locate in landscaped areas where possible.

### 3.7 TESTING:

- A. Obtain and record ground resistance measurements both from service entrance ground bus to the ground electrode and from the ground electrode to earth. Install additional bonding and grounding electrodes as required to comply with resistance limits specified under this Section. Use independent testing agency for all testing.

END OF SECTION 16452

## SECTION 16610 - EMERGENCY ELECTRICAL SYSTEMS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this section.
- B. This section is a Division 16 General Provisions section, and is part of each Division 16 section making reference to emergency electrical systems.

## 1.2 DESCRIPTION OF WORK:

- A. Types of emergency system components specified in this section include the following:
  - 1. Emergency Diesel Generator Sets
  - 2. Automatic Transfer Switches
  - 3. Exhaust and Fuel Systems
  - 4. Weather Protective Enclosure
  - 5. Remote Annunciator Panel

## 1.3 QUALITY ASSURANCE:

- A. STANDARDS: Refer to Section 16001 - Electrical General Provisions as applicable.
- B. REQUIREMENTS OF REGULATORY AGENCIES:
  - 1. The electric generating system consists of a prime mover, generator, governor, coupling and all controls which must have been tested as a complete unit on a representative engineering model as required by NFPA 110-1985. The tests, being potentially damaging to the equipment tested, must not be performed on the equipment to be sold, but on a separate prototype model.
  - 2. Conform to N.E.C. and applicable inspection authorities.
  - 3. Transfer switches to be labeled under UL 1008.
- C. SHOP DRAWINGS: Submit dimensioned shop drawings of all emergency electrical system components and accessories including but not necessarily limited to emergency generator, protective enclosure, fuel tank, automatic transfer switch, battery charger, all instruments and accessories, and fuel piping requirements. Show accurately scaled layouts of system components. Submittals shall include complete system interconnection wiring diagrams and manufacturer's warranty form indicating compliance with these specifications.
- D. OWNER'S MANUALS: Four (4) sets of owner's manuals specific to the product supplied must accompany delivery of the equipment. General operating instruction, preventive maintenance, wiring diagrams, schematics and parts exploded views specific to this model must be included.

## PART 2 – PRODUCTS

## 2.1 MANUFACTURERS:

- A. Engine Generator Sets: This engine generator sets and equipment from one of the following:
  - 1. Caterpillar

2. Onan
3. Kohler
4. Smith Detroit Diesel
5. Generac

B. Automatic Transfer Switches: Provide automatic transfer switches and accessories from one of the following manufacturers:

1. ASCO
2. Onan
3. Russelectric
4. Zenith
5. Kohler
6. Generac

## 2.2 GENERAL:

A. Provide emergency electrical system components and specified herein and as shown on the drawings. Provide systems and components capable of start and load transfer within 10 seconds of power outages.

B. Please note that the generator is to deliver the specified KW rating as indicated on the drawings. Increase rating of generator as required for altitude and temperature ratings as follows:

1. Altitude: 5500 Feet Above Sea Level
2. Maximum Ambient Temperature: 50 Degrees C.
3. Minimum Ambient Temperature: 0 Degrees C.

## 2.3 ENGINE-GENERATOR SET:

A. Engine: Provide 60 hertz alternating-current standby diesel engine driven generator units of voltage, phase, and capacities indicated. Base rating of electric sets upon operation after deducting power required for output for all necessary operating accessories including radiator fans, fuel pumps, etc. and under environmental conditions specified. Provide electric sets rated and capable of producing KW specified at 0.8 power factor. Certify performance of the electric set series by means of independent testing laboratory tests for full power rating stability, and voltage and frequency regulation. Provide stationary, water-cooled, full diesel, compression ignition, four stroke cycle, multi-cylinder or single cylinder, in-line or V-type engine. Arrange engine for direct connection to an alternator current generator; do not exceed engine speed of 1800 RPM at full rated load.

B. Alternator: Provide direct connected, engine driven, single bearing, synchronous type alternator with electrical characteristics indicated.

1. Instantaneous Voltage Dip: Limit voltage dip of engine generator set to less than 30 percent upon application of full rated power. Accomplish voltage regulation by means of a solid state voltage regulator. Inherently regulated machines are acceptable in sizes under 6 KW.
  - a. Stability: 1 percent of its mean value at any constant load from no load to full load for solid state regulators.
  - b. Regulation: Plus or minus 2 percent maximum so load to full load for solid state regulators.
2. Where more than 40 percent of the load is comprised of rectifiers and/or thyristors, provide power to voltage regulator by means of ceramic type permanent magnet pilot

excitor, capable or 80 percent automatic controlled SCR/Thyristor loading.

- C. Lubrication System: Equip engine with a pressure lubricated system. Provide spin-on type full flow lubricating oil filter. Equip filters with bypass valve to insure oil circulation if filters are clogged. Include dipstick oil level indicator.
- D. Air Cleaner: Provide reusable element air cleaner of size and type recommended by the engine manufacturer.
- E. Starting: Equip engine with a 12 volt electric starting motor of sufficient capacity to crank the engine at a speed which will allow full diesel starting of the engine. Disengage starter automatically when engine starts.
- F. Batteries: Provide rack-mounted, heavy duty, lead acid battery set of adequate voltage and amperage capacity to start and operate the engine. Provide sufficient capacity for cranking the engine for at least 30 seconds at firing speed with capacity for starting the diesel engine a minimum of four times. Provide capacity and voltage recommended by engine manufacturer. Provide all intercell and connecting battery cables as required.
- G. Battery Charger: Provide an automatic dual rate battery charger manufactured by the engine-generator set supplier. The automatic equalizer system shall monitor and limit the charge current to 10 amps. The output voltage is to be determined by the charge current rate. The charger must have a maximum open circuit voltage of 35 volts and be protected against a reverse polarity connection. The battery charger is to be factory installed on the generator set. Due to line voltage drop concerns, a battery charger mounted in the transfer switch will be unacceptable.
- H. Water Jacket Heater: Equip engine with thermostatically controlled water jacket heater. The heater voltage shall be 120 volt single phase for smaller units or 480 volt single-phase for larger units in KW rating as recommended by the manufacturer. Make all connections to water jacket heaters.
- I. Engine Instruments: Provide a unit mounted console with the following gauges:
  - 1. Run-stop-remote switch
  - 2. Remote starting, 12-volt, 2 wire
  - 3. Coolant temperature gauge
  - 4. Field circuit breaker
  - 5. DC voltmeter
  - 6. Running time meter
  - 7. Lamp test switch
  - 8. Engine preheat switch
  - 9. Oil pressure gauge
  - 10. Fault reset switch
  - 11. Cycle cranking
  - 12. Time delay start/stop
  - 13. 7-Light engine monitor with individual 1/2 amp relay signals and a common alarm contact for each of the following conditions:
    - a. Run
    - b. Pre-warning for low oil pressure
    - c. Pre-warning for high coolant temp
    - d. Low oil pressure shutdown
    - e. High coolant temperature shutdown
    - f. Overcrank shutdown
    - g. Overspeed shutdown

- J. Exhaust System: An exhaust silencer shall be provided of the size as recommended by the manufacturer and shall be of critical grade. Wrap the entire exhaust system, from manifold to roof or wall penetration with exhaust insulation. The silencer(s) shall be mounted on the weather protective enclosure with the use of a flexible, seamless, stainless steel exhaust connection and rain cap. All components must be properly sized to assure operation without excessive back pressure when installed.
- K. Engine Protection Devices: Provide the following engine protection devices with indicating light annunciation for each device:
1. Low-Oil pressure cut-out
  2. High air temperature cut-out
  3. Overspeed Cut-out
- L. Mounting: Equip electric set with a suitable base for mounting on a level surface.
- M. Isolators: Provide spring isolators between the electric set and base. Spring isolators between the engine and the base are acceptable if in accordance with manufacturer's recommendations.
- N. Fuel: Provide engine capable of satisfactory performance on commercial grade diesel fuel as recommended by the manufacturer.
- O. Governor: Equip engine with an electronic governor to maintain frequency within the limits as required to properly serve computer and electronic equipment.
- P. Fuel System:
1. Equip engine with primary and secondary fuel filters with replaceable elements, and an engine driven fuel pump, all mounted on the engine. Provide fuel system piping of size and type recommended by the engine manufacturer.
  2. The fuel system shall include a base-mounted fuel tank sized for 48 hours of run time at full load. It shall have the structural integrity to support the engine-generator set. Minimum features shall include all welded double-wall construction, a lockable fuel filler cap, fuel gauge, fuel line check valve and fittings for fuel supply, return, fill and vent. This tank must be supplied and warranted by the engine-generator set manufacturer and be factory installed. The tank shall be provided with a complete leak detection system and control panel.
- Q. Weather Protective Enclosure: The engine-generator set shall be factory enclosed in a Level 2 sound rated, heavy gauge steel enclosure constructed with corner posts, coated with electro statically applied zinc and finished with baked enamel paint. The enclosure is to have large, hinged doors to allow access to the engine, alternator and control panel. Each door is to be fitted with stainless steel, lockable hardware with identical keys. Padlocks do not meet this specification.
- R. Main Line Circuit Breaker: Provide a main line circuit breaker in rating as indicated on the drawings, but in no case greater than that recommended by the generator manufacturer. Provide a breaker with AIC rating as required to safely interrupt and clear the maximum available fault current of the alternator to meet all NEC requirements.

## 2.4 AUTOMATIC TRANSFER SWITCHES

- A. General: Automatic transfer switches shall be furnished by the manufacturer of the engine-generator set so as to maintain system compatibility and local service responsibility for the complete emergency power system. It shall be listed by Underwriter's Laboratory, Standard

1008 with circuit breaker protection. Representative production samples of the transfer switch supplied shall have demonstrated through tests the ability to withstand at least 10,000 mechanical operation cycles. One operation cycle is the electrically operated transfer from normal to emergency and back to normal. Wiring must comply with NEC table 373-6(b).

- B. Ratings & Performance: Refer to electrical drawings for switch rating requirements. Where transfer switch is fed from an upstream overcurrent protection device having ground fault protection, provide a four pole unit with switched neutral.
- C. Construction:
1. The transfer switch shall be double throw construction, positively electrically and mechanically interlocked to prevent simultaneous closing and mechanically held in both normal and emergency positions. Independent break before make action shall be used to positively prevent dangerous source to source connections. When switching the neutral, this action prevents the objectionable ground currents and nuisance ground fault tripping that can result from overlapping designs. The transfer switch shall be approved for manual operation. The electrical operating means shall be by electric solenoid. Every portion of the contactor is to be positively mechanically connected. No clutch or friction drive mechanism is allowed, and parts are to be kept to a minimum. This transfer switch shall not contain integral overcurrent devices in the main power circuit, including molded case circuit breakers or fuses.
  2. The transfer switch electrical actuator shall have an independent disconnect means to disable the electrical operation during manual switching. Maximum electrical transfer time in either direction shall be 160 milliseconds, exclusive of time delays. Main switch contacts shall be high pressure silver alloy contacts to resist burning and pitting for long life operation.
  3. There shall be one SPDT, 10 ampere, 250 volt auxiliary switch on both normal and emergency sides, operated by the transfer switch. Full rated neutral bar with lugs for normal, emergency and load conductors shall be provided inside the cabinet.
- D. Controls:
1. All control equipment shall be mounted on the inside of the cabinet door in a metal lockable enclosure with transparent safety shield to protect all solid state circuit boards. This will allow for ease of service access when main cabinet lockable door is open, but to prevent access by unauthorized personnel. Control boards shall have installed cover plates to avoid shock hazard while making control adjustments. The solid state voltage sensors and time delay modules shall be plug-in circuit boards with silver or gold contacts for ease of service.
  2. A solid state undervoltage sensor shall monitor all phases of the normal source and provide adjustable ranges for field adjustments for specific applications needs. Pick-up and drop-out settings shall be adjustable from a minimum of 70% to a maximum of 95% of nominal voltage. A utility sensing interface shall be used, stepping down line voltage to 24VAC, helping to protecting the printed circuit board from voltage spikes and increasing personnel safety when troubleshooting.
  3. Signal the engine-generator set to start in the event of a power interruption. A set of contacts shall close to start the engine and open for engine shutdown. A solid state time delay start (adjustable, .1 to 10 seconds) shall delay this signal to avoid nuisance start-ups on momentary voltage dips or power outages.
  4. Transfer the load to the engine-generator set after it reached proper voltage (adjustable, 70% to 90%) and frequency (adjustable, 80% to 90%). A solid state time delay (adjustable, 5 seconds to 3 minutes) shall delay this transfer to allow the engine-generator to warm-up before application of load. There shall be a switch to bypass this warm-up timer when immediate transfer is required.
  5. Retransfer the load to the line after normal power restoration. A return to utility timer (adjustable, 1 to 30 minutes) shall delay this transfer to avoid short term normal power

- restoration.
6. The operating power for transfer and retransfer shall be obtained from the source to which the load is being transferred. Controls shall provide an automatic retransfer of the load from emergency to normal if the emergency source fails with the normal source available.
  7. Signal the engine-generator to stop after the load retransfers to normal. A solid state engine cool down timer (adjustable, 1 to 30 minutes) shall permit the engine to run unloaded to cool down before shutdown.
  8. Provide an engine minimum run timer (adjustable, 5 to 30 minutes) to ensure an adequate engine run period.
  9. Provide a solid state plant exercise clock to set the day and time of generator set exercise period. Actual time of day and exercise time shall be displayed. The clock shall have a one week cycle and be powered by the load side of the transfer switch. A battery must be supplied to maintain the circuit board energized when the load side of the transfer switch is de-energized. Include a switch to select if the load will transfer to the engine-generator set during the exercise period.
  10. The transfer switch shall have a time delay neutral feature to provide a time delay (adjustable, .1 to 10 seconds) during the transfer in either direction, during which time the load is isolated from both power sources. This allows residual voltage components of motors or other inductive loads (such as transformers) to decay before completing the switching cycle. A switch will be provided to bypass this feature when immediate transfer is required.
  11. Front mounted controls shall include a selector switch to provide for a NORMAL TEST mode with full use of time delays, FAST TEST mode which bypasses all time delays to allow for testing the entire system in less than one minute, or AUTOMATIC mode to set the system for normal operation.
  12. Provide bright lamps to indicate the transfer switch position in either UTILITY (white) or EMERGENCY (red). A third lamp is needed to indicate STANDBY OPERATING (amber). These lights must be energized from utility or the engine-generator set.
  13. Provide manual operating handle to allow for manual transfer. This handle must be mounted inside the lockable enclosure so accessible only by authorized personnel.
  14. Provide a safety disconnect switch to prevent load transfer and automatic engine start while performing maintenance. This switch will also be used for manual transfer switch operation.
  15. Provide LED status lights to give a visual readout of the operating sequence. This shall include utility on, engine warm-up, engine warm-up bypass, standby voltage "ready", standby frequency "ready", standby on, transfer to standby, return to utility, engine cool down, engine minimum run and fast test mode.

## 2.5 REMOTE ANNUNCIATOR PANEL:

- A. General: Provide remote annunciator panel with the following features:
  1. Provide visual indication of 20 separate alarm conditions. The panels shall monitor and be labeled as follows:
    - a. GENSET RUNNING (Green)
    - b. HIGH TEMP (Amber)
    - c. LOW OIL PRESS (Amber)
    - d. LOW TEMP (Amber)
    - e. LOW FUEL (Amber)
    - f. HIGH TEMP (Red)
    - g. LOW OIL PRESS (Red)
    - h. OVERCRANK (Red)
    - i. OVERSPEED (Red)
    - j. NOT IN AUTO (Red-flashing)
    - k. BLANK (Red)

- I. BLANK (Red)
2. Switchable lenses and alarm horn function.
3. Removable legend plates for engraving alarm or status labels.
4. Alarm silence button on annunciator resets circuit for any subsequent fault condition whether or not initial fault has been cleared.
5. Designed for operation at 24 VDC, with negative ground signals.
6. Stainless steel front panel for flush or surface mounting. Refer to drawings for mounting requirements.
7. Knockouts for conduit connections.
8. Replaceable 25,000 hour high intensity lamps for easy readability, high reliability, and low power consumption.
9. Lamp Test/Alarm silence switch.

### PART 3 - EXECUTION

#### 3.1 GENERAL:

- A. Install emergency electrical systems in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

#### 3.2 MOUNTING:

##### A. Generator Sets:

1. Housekeeping Pads: Unless noted otherwise, provide 6" high steel reinforced concrete pad for generator sets. Adjust height of pad and steel reinforce in accordance with all manufacturer's recommendations - verify prior to installation. Refer to "Concrete Bases" under Section 16001 - Electrical General Provisions.

##### B. Transfer Switches:

1. Anchor switches firmly to walls and structural surfaces.
2. Housekeeping Pads: Provide housekeeping pads in accordance with "Concrete Bases" under Section 16001 - Electrical General Provisions.

#### 3.3 FACTORY TESTING:

- A. Before shipment of the equipment, the engine-generator set shall be tested under rated load and power factor for performance and proper functioning of control and interfacing circuits. Tests shall include:
  1. Verifying all safety shutdowns are functioning properly.
  2. Single step load pick-up per NFPA 110-1985, Paragraph 5-13.2.6.
  3. Transient and voltage dip responses and steady state voltage and speed (frequency) checks.

#### 3.4 SERVICE:

- A. Supplier of the electric set and associated items shall have permanent service facilities in this trade area. These facilities shall comprise a permanent force of factory trained service personnel on 24 hour call, experienced in servicing this type of equipment, providing warranty and routine maintenance service to afford the owner maximum protection. Delegation of this service responsibility for any of the equipment listed herein will not be considered fulfillment of

these specifications. Service contracts shall also be available.

3.5 WARRANTY:

- A. The standby electric generating system components, complete engine-generator, instrumentation panel, and automatic transfer switch shall be warranted by the manufacturer against defective materials and factory workmanship for a period of one year. Such defective parts shall be repaired or replaced at the manufacturer's option, free of charge for travel and labor. The warranty period shall commence when the standby power system is first placed into service. Multiple warranties for individual components (engine, alternator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided. Also, in the judgment of the specifying authority, the manufacturer supplying the warranty for the complete system must have the financial strength and technical expertise with all components supplied to provide adequate warranty support.

3.6 CHECKOUT & STARTUP:

- A. The supplier of the electric generating plant and associated items covered herein shall provide factory trained technicians to checkout the completed installation and to perform an initial startup inspection to include:
  - 1. Ensuring the engine starts (both hot and cold) within the specified time.
  - 2. Verification of engine parameters within specification.
  - 3. Set no load frequency and voltage.
  - 4. Test all automatic shutdowns of the engine-generator.

3.7 LOAD BANK TEST:

- A. Conduct a load bank test to the rated KW of the generator for a minimum of four hours.

3.8 MISCELLANEOUS:

- A. Provide engine lubricating oil, fuel, engine coolant, filters, etc. for system testing. After testing, refill all fluids to capacity for final acceptance.
- B. Provide line voltage wiring for battery chargers, heaters, and leak detection system.
- C. Provide low voltage control and monitoring wiring for all transfer switches and remote annunciators as may be specified.

END OF SECTION 16610

SECTION F-162CHAIN-LINK FENCES

## Description

F-162-1.1 This item shall consist of furnishing and erecting a chain-link fence in accordance with these specifications and the details shown on the plans and in conformity with the lines and grades shown on the plans or established by the Engineer.

## Materials

F-162-2.1 Fabric. The chain-link fence fabric shall be a woven 9-gauge galvanized steel wire in a 2-inch (50 mm) mesh and shall meet the requirements of ASTM A 392, Class 2.

F-162-2.3 Posts, Rails and Braces. Posts, rails, and braces shall conform to the requirements of ASTM F 1043 or ASTM F 1083 as follows:

Galvanized tubular steel pipe shall conform to the requirements of Group IA, (Schedule 40) coatings conforming to Type A, or Group IC (High Strength Pipe), External coating Type B, and internal coating Type B or D.

Composite posts shall conform to the strength requirements of ASTM 1043 or ASTM F 1083. The strength loss of composite posts shall not exceed 10 percent when subjected to 3,600 hours of exposure to light and water in accordance with ASTM G 23, ASTM G 26, and ASTM G 53.

Posts, rails, and braces, with the exception of galvanized steel conforming to ASTM F 1043 or ASTM F 1083, Group IA, type A, or aluminum alloy, shall demonstrate the ability to withstand testing in salt spray in accordance with ASTM B 117 as follows:

External:	1,000 hours with a maximum of 5 percent red rust
Internal:	650 hours with a maximum of 5 percent red rust

The dimensions of the posts, rails, and braces shall be in accordance with Tables I through VI of Federal Specification RR-F-191/3D.

F-162-2.4 Gates. Gate frames shall consist of the posts shall consist of galvanized steel pipe and shall conform to the specifications for the same material under paragraph F- 162-2.3. The fabric shall be of the same type material as used in the fence.

Structural members of gates shall be fully welded by a method that will provide a continuous weld on all sides and faces of joints at exposed edges. Surplus welding material shall be removed.

F-162-2.5 Wire Ties and Tension Wires. Wire ties for use in conjunction with a given type of fabric shall be of the same material and coating weight identified with the fabric type. Tension wire shall be 7-gauge marcelled steel wire with the same coating as the fabric type and shall conform to ASTM A 824.

All material shall conform to Federal Specification RR-F-191/4D.

F-162-2.6 Miscellaneous Fittings and Hardware. Miscellaneous steel fittings and hardware for use with zinc-coated steel fabric shall be of commercial grade steel or better quality, wrought or cast as appropriate to the article, and sufficient in strength to provide a balanced design when used in conjunction with fabric posts, and wires of the quality specified herein. All steel fittings and hardware shall be protected with a zinc coating applied in conformance with ASTM A 153. Barbed wire support arms shall withstand a load of 250 pounds (113 kg) applied vertically to the outermost end of the arm.

F-162-2.7 Concrete. Concrete shall be of a commercial grade with a minimum 28-day compressive strength of 3000 psi (17.2 MPa).

F-162-2.8 Marking. Each roll of fabric shall carry a tag showing the kind of base metal (steel, aluminum, or aluminum alloy number), kind of coating, the gauge of the wire, the length of fencing in the roll, and the name of the manufacturer. Posts, wire, and other fittings shall be identified as to manufacturer, kind of base metal (steel, aluminum, or aluminum alloy number), and kind of coating.

F-162-2.9 Submittals. Prior to purchasing fence materials, the Contractor shall submit information to the Engineer for those materials proposed for use during construction. The submittal shall show the appropriate ASTM or Federal Specification and a statement that the material does or does not comply with the applicable specification. The submittal shall include the following items:

- a. chain-link fabric
- b. pipe for posts, rails and braces
- c. wire ties
- d. tension wires
- e. fittings and hardware
- f. concrete
- g. gate shop drawings

Submittals shall comply with procedures set forth in the "Shop Drawing and Sample Submittals" section of the General Conditions. Allow ten days for review by the Engineer, excluding delivery time to and from the Contractor.

No material shall be delivered until the submittal has been accepted by the Engineer and returned to the Contractor.

#### Construction Methods

F-162-3.1 Installing Posts. All posts shall be set in concrete at the required dimensions, depths, and spacing shown on the plans and details. The post holes shall be in proper alignment so that there is a minimum of 3 inches (75 mm) of concrete on all sides of the posts. The concrete shall be thoroughly compacted around the posts by tamping or vibrating and shall have a smooth finish slightly higher than the ground and sloped to drain away from the posts. All posts shall be set plumb and to the required grade and alignment. No materials shall be installed on the posts, nor shall the posts be disturbed in any manner within 7 days after the individual post footing is completed.

Should rock or pavement be encountered at a depth less than the planned footing depth, a hole 2 inches (50 mm) larger than the greatest dimension of the posts shall be drilled to a depth of 12 inches (300 mm). After the posts are set, the remainder of the drilled hole shall be filled with grout, composed of one part portland cement and two parts mortar sand. Any remaining space above the rock or pavement shall be filled with concrete in the manner described above.

In lieu of drilling through the rock, the rock may be excavated to the required footing depth. No extra compensation shall be made for drilling or rock excavation.

F-162-3.2 Installing Top Rails. The top rail shall be continuous and shall pass through the post tops. The coupling used to join the top rail lengths shall allow for expansion.

F-162-3.3 Installing Braces. Horizontal brace rails, with diagonal truss rods and turnbuckles, shall be installed at all terminal posts.

F-162-3.4 Installing Fabric. The wire fabric shall be firmly attached to the posts and braced in the manner shown on the plans. All wire shall be stretched taut and shall be installed to the required elevations. The fence shall generally follow the finished concert/ asphalt, with the bottom of the fence fabric no less than 1 inch (25 mm) or more than 2 inches (50 mm) from the surface.

F-162-3.5 Clean Up. The Contractor shall remove from the vicinity of the completed work all tools, equipment, extra fence parts, etc. used during construction.

#### Material Requirements

ASTM A 121	Specification for Zinc-Coated (Galvanized) Steel Barbed Wire
ASTM A 153	Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 392	Specification for Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A 446	Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
ASTM A 824	Specification for Metallic-Coated Steel Marcellled tension Wire for Use with Chain Link Fence
ASTM A 1011	Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength, Low-Alloy and High-Strength Low-Alloy with Improved Formability
ASTM B 117	Practice for Operating Salt Spray (Fog) Apparatus
ASTM F 1043	Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework
ASTM F 1083	Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
Fed. Spec.	Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails RR-F-191/3 and Braces)
Fed. Spec. RR-F-191/4	Fencing, Wire and Post, Metal (Chain-Link Fence Accessories)

\*\* End of Section F-162 \*\*