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SECTION 01 00 00

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# SECTION 01 00 00

# GENERAL REQUIREMENTS

## PART 1 GENERAL

### 1.1 SCOPE

The work to be performed under this contract consists of providing the labor, equipment, and materials to complete the above-titled project in accordance with the required drawings, these specifications, and the contract clauses. This project has been designed completely in English units. The construction is to be in English units with dimensions as shown on the drawings. Materials and products are to be in English units; shop drawings must be submitted with English dimensions. When used in these specifications, the following definitions apply:

a. Furnish: Contractor to supply and deliver complete.

b. Install: Contractor to place, secure and connect as required to make fully operational.

c. Provide: Contractor to furnish and install as defined in item (a) and (b) above.

This work includes:

#### 1.1.1 Base Bid

The base bid comprises the construction of a new substation for N202 and upgrade and/or modification of 3 secondary substations.

##### 1.1.1.1 Base Bid. N202 & N202A New Building Substation

The work consists of providing the outdoor and indoor transformers, medium voltage switchgear, low voltage switchboard, and medium voltage cable per the following itemized list and as indicated on the drawings:

1. Remove (E) incoming cables.

2. Provide new outdoor dual voltage transformer rated 750kVA, 13.8x7.2kV-480Y/277V, new 15kV medium voltage switchgear with vacuum circuit breaker and new outdoor 1200A 480Y/277V switchboard.

3. Provide medium and low voltage cables, conduits, and duct banks.

4. Remove (E) 225kVA 480-208/120V indoor transformer.

5. Provide new indoor transformer rated 225kVA 480-208Y/120V.

6. Provide housekeeping pad for new substation.

7. Reconnect existing equipment to new substation as shown on the drawings.

8. Install the Government furnished devices such as microprocessor-based relays and digital power meters. Connect new relays and metering

devices to the current and voltage transformers as shown on the drawings.

9. Perform testing, commissioning.

10. Provide shrubs.

1.1.1.2 Base Bid. N203 & N204 Building Substation Upgrade

The work consists of replacing the outdoor transformers, medium voltage switchgear, low voltage switchboards and medium voltage cables per the following itemized list and as indicated on the drawings:

1. Provide new outdoor dual voltage transformer rated 750kVA 13.8x7.2kV-480Y/277V, new outdoor transformer rated 500kVA 480-208Y/120V, new medium voltage switchgear with vacuum circuit breaker and new outdoor low voltage switchboards.

2. Provide medium voltage cables in existing conduits.

3. Disconnect existing transformers from all incoming and outgoing conductors and conduits. Demolish existing transformers.

4. Disconnect existing medium voltage switchgear from all incoming and outgoing conductors and conduits. Demolish existing switchgear.

5. Provide housekeeping pad for new substation as shown on structural drawing S3.

6. Install new equipment as shown on electrical drawings. Provide all connections.

7. Install the Government Furnished devices such as microprocessor-based relays and digital power meters. Connect new relays and metering devices to the current and voltage transformers as shown on the drawings.

8. Perform testing and commissioning.

1.1.1.3 Base Bid. N210 Building Substation Upgrade

The work consists of replacing two (2) outdoor transformers with one dual voltage transformer rated 1500kVA, medium voltage switchgear and medium voltage cables (partially) per the following itemized list and as indicated on the drawings:

1. Provide new outdoor dual voltage transformer rated 1500kVA 13.8x7.2kV-480Y/277V, new medium voltage switchgear with vacuum circuit breaker and new outdoor low voltage switchboard rated 2500A.

2. Provide medium voltage cables in new conduits from MH E18 to new medium voltage switchgear.

3. Disconnect existing transformers from all incoming and outgoing conductors and conduits. Demolish existing transformers.

4. Disconnect existing medium voltage switchgear from all incoming and outgoing conductors and conduits. Demolish existing switchgear.

5. Provide new housekeeping pad for substation as shown on structural drawing S4.

6. Install new equipment as shown on electrical drawings. Provide all connections.

7. Install the Government Furnished devices such as microprocessor-based relays and digital power meters. Connect new relays and metering devices to the current and voltage transformers as shown on the drawings.

8. Perform testing and commissioning.

1.1.1.4 Base Bid. N226 Building Substation Upgrade

The work consists of replacing medium voltage switchgear and medium voltage cables between switchgear and transformer T13 per the following itemized list and as indicated on the drawings:

1. Provide new medium voltage switchgear with vacuum circuit breaker.

2. Disconnect existing medium voltage switchgear from all incoming and outgoing conductors and conduits. Demolish existing switchgear.

3. Provide medium voltage cables in existing conduits from new medium voltage switchgear to existing transformer T13.

4. Install the Government Furnished devices such as microprocessor-based relays and digital power meters. Connect new relays and metering devices to the current and voltage transformers as shown on the drawings.

5. Perform testing and commissioning.

1.1.2 Additive #1. Bldg. N221 Building Substation Upgrade

The work consists of replacing the outdoor transformers per the following itemized list and as indicated on the drawings:

1. Provide new outdoor dual voltage transformer T15 rated 1000kVA 13.8x7.2kV-480Y/277V and new outdoor dual voltage transformer T130 rated 500kVA 13.8x7.2kV-208Y/120V.

2. Disconnect existing transformers from all incoming and outgoing conductors and conduits. Demolish existing transformers.

3. Provide new concrete equipment pads with containment area as shown on drawing S5.

4. Install new equipment as shown on electrical drawings. Provide all connections.

5. Perform testing and commissioning.

1.1.3 Additive #2. Bldg. N221B Building Substation Upgrade

The work consists of replacing existing outdoor transformers, medium voltage switchgear, low voltage switchboards and medium voltage cable per the following itemized list and as indicated on the drawings:

1. Provide new outdoor dual voltage transformer T172 rated 1500kVA 13.8x7.2kV-480Y/277V and new outdoor dual voltage transformer T173 rated 300kVA 13.8x7.2kV-208Y/120V.

2. Provide two (2) new medium voltage switchgears with vacuum circuit breaker and two (2) new outdoor low voltage switchboards as shown on the drawings.

3. Provide medium voltage cables in existing conduits from SW 454 to new medium voltage switchgear.

4. Disconnect existing transformers from all incoming and outgoing conductors and conduits. Demolish existing transformers.

5. Disconnect existing medium voltage switchgear from all incoming and outgoing conductors and conduits. Demolish existing switchgear.

6. Install new equipment as shown on electrical drawings. Provide all connections.

7. Install the Government Furnished devices such as microprocessor-based relays and digital power meters. Connect new relays and metering devices to the current and voltage transformers as shown on the drawings.

8. Perform testing, commissioning.

## 1.2 REQUIRED DRAWINGS

The drawings shown on the project drawing list G3 accompany this specification and are part thereof.

Two sets of drawings, and specifications will be furnished to the Contractor without charge. One copy of a NASA or Ames publication will be furnished upon specific request. Other reference publications will not be furnished.

The Contractor shall immediately check furnished drawings and notify the Government of any discrepancies. Commencement of work constitutes acceptance of drawings. Dimensions of existing facilities shall be field checked for accuracy by the Contractor, who shall determine exact dimensions for proper fit. Drawings shall not be construed as being detailed work drawings.

## 1.3 SUBMITTALS

The Contractor shall submit to the Contracting Officer in accordance with Section 01 33 00, "Submittal Procedures":

SD-01, Preconstruction Submittals

List of Key Personnel
List of Subcontractors and Suppliers
Construction Schedule

SD-07, Schedules

Complete Construction Schedule

Submittal Schedule

SD-020, Work Plan

Safety Plan
Complete Construction Phasing Plan

1.4 SECURITY

At all times while on government property, the Contractor, subcontractors, their employees and agents shall wear badges issued by NASA Security, located in Building 26. Each individual will be required to sign personally for the badge. The Contractor will be held accountable for these badges and shall return them to the Contracting Officer immediately after completion of the work; failure to do so may delay final payment.

Workers are to remain at work areas at all times and are not to remain in these buildings unless actively at work. Workers are to vacate the buildings during lunch and break periods.

During times of National Security Alerts, access to the Ames Research Center may be restricted to United States Citizens only.

1.5 HOURS OF WORK

Normal hours for work shall be from 7 a.m. to 5 p.m. Monday thru Friday, excluding federal holidays. Requests for additional work hours require written approval from the Contracting Officer seven (7) days in advance. The Contractor, subcontractors, and their employees shall not remain on-site beyond the approved hours of work.

Work under this contract may require the Contractor to conduct operations outside of normal work hours. The Contractor shall do so, as required by the Contracting Officer, at no additional cost to the Government. Work required to be conducted "Outside of normal work hours" must be completed between 6 p.m. and 6 a.m. Monday through Friday or on a weekend.

1.6 OCCUPANCY OF PREMISES

The Government will occupy and use the facilities within and adjacent to the areas of work during the entire construction period. The Contractor shall provide and coordinate controls for the abatement of dust, noise and inconvenience to Government personnel during the work. Partitions separating work areas from Government-occupied areas and their exit ways shall be of non-combustible, 1-hour, fire resistant construction.

Before work is started, the Contractor shall arrange with the Contracting Officer a sequence of work, means of access, space for material and equipment storage, and use of approaches, corridors and stairways.

PART 2 PRODUCTS

2.1 NEW MATERIALS

All equipment and materials incorporated into the work by the Contractor shall be new, first-class, and delivered in the original unopened containers, except as otherwise specified.

## 2.2 REUSED SALVAGE MATERIALS

Materials and equipment designated in the contract documents to be salvaged or reused shall be carefully removed by the Contractor, so as to minimize damage thereto. The Contractor shall protect, store, and clean them prior to reinstallation or turning over to the Government.

## 2.3 GOVERNMENT-FURNISHED PROPERTY

Refer to Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL, paragraph 1.10, Government-Furnished Equipment (GFE).

## 2.4 SHIPMENTS

Shipments shall be addressed to the Contractor who shall be responsible for their receipt, unloading, handling, and storage at the site. The Government will not accept deliveries on behalf of the Contractor or his subcontractors or assume responsibility for the security of materials, equipment, or supplies delivered to the site.

# PART 3 EXECUTION

## 3.1 TEMPORARY FACILITIES

The Contractor shall install and maintain temporary utilities required for construction, and remove them upon completion of the work. Materials may be new or used, and shall be adequate for their intended usage. They shall not create unsafe conditions, nor violate applicable codes and standards.

The Government will furnish required water and electricity (120v/1Ph) and 480v. Connections, distribution and lighting shall be furnished by the Contractor.

The Contractor shall provide and maintain temporary sanitary facilities, and remove them at the completion of the work. Construction personnel shall not use existing plumbing facilities.

Signs necessary to expedite deliveries, maintain traffic flow, promote safety, and prevent interference with Government operations shall be provided by the Contractor. Advertisement signs shall not be erected.

The Contractor's trailers and sheds shall be placed at least 30 feet from existing structures, unless they are of non-combustible construction.

## 3.2 TRAFFIC PROVISIONS

Work shall be conducted so as to minimize obstruction of traffic and parking. Traffic shall be maintained on at least half of the roadway width at all times. Approval shall be obtained from the Contracting Officer prior to starting any activity that will obstruct traffic.

The Contractor's dust control methods and procedures shall be approved by the Contracting Officer. Dust abatement on access roads shall be treated with applications of calcium chloride, water sprinklers, or similar methods or treatment.

## 3.3 PROTECTION OF EXISTING SYSTEMS

The Contractor shall provide temporary coverings to protect existing

surfaces and equipment when work is being done in adjacent areas. Remove or alter existing work in such a manner as to prevent injury or damage to existing work to remain. Damaged systems, surfaces, and equipment shall be repaired at the Contractor's expense.

Existing utilities and safety systems shall be protected from damage. Utilities and safety systems damaged by the Contractor shall be repaired at the Contractor's expense. Utilities not previously identified to the Contractor, which he encounters in the field, shall be reported to the Contracting Officer immediately. The Contractor shall also record these on the "As-Built" drawings.

Structural members shall not be altered, unless approved by the Contracting Officer.

## 3.4 UTILITY OUTAGES AND CONNECTIONS

Required periods of utility outages and connections during execution of the work which affect existing systems shall be arranged at the convenience of the Government (normally outside of normal work hours). Work shall be scheduled to hold outages to a minimum. Requests for utility outages and connections shall be made in writing to the Contracting Officer at least 3 work days in advance of the time required. Each request shall state the system involved, area involved, approximate duration of outage, and the nature of work involved.

## 3.5 PROGRESS CONTROLS

### 3.5.1 Project Meetings

The Contractor shall attend a pre-construction conference, scheduled by the Contracting Officer. On-site work shall not commence prior to the conference. Discussion shall include the Contractor's list of key personnel, project orientation, list of subcontractors and suppliers, quality control, safety, administration, and temporary utilities and facilities.

The Contractor shall participate in progress meetings on a weekly or other basis, as scheduled by the Contracting Officer. Discussion shall include: submittals; progress; material delivery; potential delays; interfaces; problems; quality control; and safety.

The Contractor shall promptly report to the Contracting Officer construction problems or design deficiencies encountered. Solutions will be determined by the Government.

### 3.5.2 Construction Schedule

The "Practicable Schedule" referred to in the clause, "Schedules for Construction Contracts" and the "Contract Price Breakdown" referred to in the clause, "Payments Under Fixed-Price Construction Contracts" shall take the form of a cost-loaded construction schedule in a bar chart format. Within 30 days of the notice to proceed, and before any progress payment will be considered, the Contractor shall submit this schedule, in two copies, for approval by the Contracting Officer.

The schedule shall be computer generated and plotted on by sheets, showing activity numbers and descriptions, start and finish dates, and total float; as well as the subcontractor responsibility, dollar amounts

associated with each of material, labor, and equipment, and crew size.

The construction schedule shall include separate line items for mobilization and drawing submittal and approval. (These items are to show no associated costs.) A line item showing contract finalization tasks which includes punchlist, clean-up and demobilization, and final as-built drawings.

The construction schedule shall include all significant design, submittal, fabrication, procurement and work activities; plus any constraints, outside of this contract which may impact work on the contract. Work activities longer than 10 working days shall be subdivided into phases/areas of work.

The critical path shall be clearly delineated on the schedule. When milestone dates are included in the Contract, they shall be clearly indicated.

Data shall include verbal activity descriptions with a numerical ordering system cross referenced to the graphic display. Additionally, costs (broken down into separate materials, labor, and equipment costs), duration, early start date, early finish date, late start date, late finish date, and float shall be detailed for each activity. A running total of the percent completion based on completed activity costs versus total contract cost shall be indicated. A system for indicating scheduled dates versus actual activity dates and durations shall be provided.

Schedule shall be of sufficient detail to facilitate the Contractor's control of the job and to allow the Contracting Officer to readily follow progress for portions of the work.

The schedule shall be an accurate representation of the manner in which the Contractor is performing the work. If circumstances indicate that progress is one week or more behind the contract completion, the Contractor shall revise the schedule and his work plan, to eliminate or minimize delays to contract completion.

The Contractor shall provide a single point contact from his on-site organization as his Schedule Specialist. The Schedule Specialist shall have the responsibility of updating and coordinating the schedule with actual job conditions. The Schedule Specialist shall participate in weekly status meetings and present current information on the status of purchase orders, shop drawings, off-site fabrication, materials deliveries, subcontractor activities, anticipated needs for Government furnished equipment, and any problem which may impact the contract performance period.

Update the schedule in three copies at least monthly. Updates shall include the complete revision of the graphic and data displays incorporating changes in scheduled dates and performance periods. Redlined updates shall only be permitted for weekly status reviews.

### 3.5.3 Progress Reports

The Contractor shall submit monthly progress reports to the Contracting Officer, along with the latest updated schedule and any progress payment request. The report shall address: Progress made during the period; Comments on activities which are behind schedule, including reasons, the impact on the overall schedule, and mitigating actions taken or planned; discussion of any current or anticipated problems, technical or scheduling; and other appropriate comments.

3.5.4 Status Report on Materials Orders

Within 15 calendar days after notice to proceed, submit for approval by the Contracting Officer, an initial status report on materials orders. This report shall be updated and re-submitted with each monthly invoice.

Report shall list, in chronological order by need date, materials orders necessary for completion of the contract. The following information will be required for each material order listed:

a. Material name, suppliers, and invoice number.

b. Schedule activity number affected by the order.

c. Delivery date needed to allow directly and indirectly related work to be completed within the contract performance period.

d. Current delivery date agreed on by supplier.

e. When item d exceeds item c, the effect that delayed delivery date will have on the contract completion date.

f. When item d exceeds item c, a summary of efforts made by the Contractor to expedite the delayed delivery date to bring it in line with the needed delivery date, including efforts made to place the order (or subcontract) with other suppliers.

3.5.5 Progress Payments

If requested by the Contractor, the Government may make progress payments, provided that: a cost-loaded schedule is received, approved, and updated by the Contractor; other submittals are received in a timely manner; as-built drawings are being maintained and updated; and logs and marked prints are properly maintained. The amount of any progress payment will be based on the agreed work status and the cost-loaded, updated schedule.

The Contractor shall review the as-built drawings every month with the Contracting Officer's authorized representative. This review will be a part of "the monthly request for payment meeting", and payment -- or a portion of the payment, including final payment -- may be withheld until the as-built drawings have been updated, and accepted by the Contracting Officer.

3.6 PROJECT CLOSEOUT

Prior to the Contract Completion Date, accomplish the following:

3.6.1 Closeout Submittals

Provide Operation & Maintenance Manuals, As-Built Drawings, Certificates and Guarantees, per Section 01 33 00, SUBMITTAL PROCEDURES.

3.6.2 Restoration and Final Cleaning

Restore planted areas disturbed by construction activities to their original conditions by seeding and mulching or sodding. Existing work cut, drilled, altered, or removed by the Contractor shall be reinstalled or repaired to match the surrounding work. Work remaining in place, damaged,

or defaced during construction shall be restored to preconstruction conditions.

Clean interior and exterior exposed surfaces by removing stains, foreign substances, and temporary labels and restraints. Remove construction debris.

3.6.3 Final Acceptance

Upon notification by the Contractor that the work is substantially complete, the Contracting Officer will conduct a pre-final inspection; noting any discrepancies, uncompleted work, etc. on a "Punchlist"; which will be provided to the Contractor. If necessary, revisions to the punchlist may be made before the final inspection. When the Contractor has completed all items on the punchlist, the Contracting Officer will conduct the final inspection. If acceptable, a notice of acceptance will be issued to the Contractor, and release of any retention will be made.

Neither notice of acceptance nor final payment shall constitute waiver of any guarantee or warranty under the contract.

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SECTION 01 10 00

SAFETY PROVISIONS

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# SECTION 01 10 00

# SAFETY PROVISIONS

## PART 1 GENERAL

### 1.1 SCOPE

The provisions of this section apply to all work conducted at Moffett Field, under this contract, including all subcontract work.

### 1.2 REFERENCES

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI A10.7 | 1998 Construction and Demolition, Commercial Explosives and Blasting Agents, Safety Requirements for Transportation, Storage, Handling, and Use |
| ANSI Z359.1 | (1992) Safety Requirements for Personal Fall Arrest Systems |
| ANSI A90.1 | Safety Standard for Manlifts |
| ANSI B30.5 | Safety Code for Crawler, Locomotive, and Truck Cranes |

CODE OF FEDERAL REGULATIONS (CFR)

| | |
|---|---|
| 29 CFR 1926 | Safety and Health Regulations for Construction |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 30 | 2000 Flammable and Combustible Liquids Code |

CALIFORNIA CODE OF REGULATIONS (CCR)

| | |
|---|---|
| CEC | (2007) California Electrical Code |

### 1.3 SUBMITTALS

The Contractor is required to submit the following, in accordance with Section 01 33 00 "Submittals Procedures":

SD-01, Preconstruction Submittals

Safety Clearance Permit Requests, submit at least 24 hours in advance of covered work.

Toolbox Safety Meeting Reports, submit weekly minutes of meetings, copy of attendee sign-in sheet, and list of topics discussed.

Accident Reports and Records, as required.

Crane Inspection Reports, submit daily when operated.

Confined Space Entry Permit, submit completed form daily, including evaluations following space exit.

Crane Compliance Certification, submit for each crane 24 hours prior to bring crane to Ames.

Crane Lift Plans, submit at least 24 hours prior to lifting loads exceeding 75% of rated load capacity.

Confined Space Training Certificates, submit copies of training verification for entrants and attendants at least 48 hours prior to initial entry.

SD-20, Work Plan

The Safety Plan requires Contracting Officer approval before field work may commence.

## 1.4 DEFINITIONS

Competent Person - one who is capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary, hazardous, or dangerous to employees and who has authorization to take prompt corrective measures to eliminate them.

Safety Plan - one distinct part of the work plan. It includes hazard control details required by this section. An IIPP complying with 8 CCR 3202 is an acceptable equivalent, however, the requirements in this section for the job-specific safety plan shall be provided additionally, prior to the start of work.

Job-Specific Safety Plan - describes anticipated potential hazards and planned controls for this particular project. It comprises the bulk of the Safety Plan and its specific contents are described in this section.

## 1.5 GENERAL RESPONSIBILITIES

### 1.5.1 General

The Contractor is required to conform to applicable local, state, and federal laws, regulations, including, ordinances, codes and orders in effect on the date of this contract.

The Contractor is responsible for taking adequate safety and health measures to insure a safe, healthy environment for her employees, those of subcontractors, and for other workers in the area, as well as for bystanders and visitors.

New employees shall be informed of specific site hazards before they begin work. Indoctrination shall be documented in the daily log.

The Contractor shall maintain a file of certificates for all training required by 29 CFR 1925 and 1910 as applicable for each person engaged in hazardous work. The file shall be accessible and, upon request, made available to the Contracting Officer or appointed representative for review and verification for quality control purposes.

The Contractor shall avail the Contracting Officer or appointed representative access to the Contractor's activities to determine adequacy of hazard prevention measures.

The Contractor is responsible for safety requirements compliance by all subcontractors at every tier. All subcontractors, pursuant to this contract, shall include safety requirements of this section.

The Contractor shall notify the COTR and Ames Safety Office immediately upon discovery that OSHA or other regulatory agency is conducting an inspection of the job site.

1.5.2 Visitor Control

The Contractor shall comply with procedures prescribed by the Contracting Officer for control and safety of visitors to the site.

1.5.3 Communication

The Contractor shall familiarize their employees and subcontractors with all safety requirements, shall enforce them; and shall advise the Contracting Officer of any special safety restrictions that they have established so that Government personnel can be made aware of them.

1.5.4 Superintendence by Contractor

The Contractor, or a superintendent appointed by and approved by the Contracting Officer, shall give their personal, on-site superintendence to the Safety Plan, while any work is in progress.

1.6 FIRST AID FACILITIES

Contractor shall post emergency phone numbers at the jobsite.

Report all emergencies and spills or releases of hazardous materials by dialing 911 on Government phones, or (650)604-5555 on other phones. Ambulance, fire, and police services are available through this number 24 hours a day. The AMES HEALTH UNIT is located on the West end of building N215, on Durand Road, across the street from the North side of the cafeteria. It is open Monday thru Friday, between 7:30 a.m. and 4:30 p.m., for emergency care.

1.7 NON-COMPLIANCE

The Contracting Officer may, at any time, notify the Contractor of any non-compliance with the provisions of this section, and may specify corrective actions to be taken. The Contractor shall, upon receipt of such notice, immediately take corrective action. If the Contractor fails or refuses to take prompt corrective action, the Contracting Officer may invoke the "Suspension of Work" provision of the contract, may contact the Contractor's insurance carrier, and/or may invoke whatever other rights are available to the Government under the terms and conditions of this contract to remedy such failure or refusal.

1.8 SAFETY PLAN

The Contractor shall submit a Safety Plan to the Contracting Officer. The Safety Plan must be approved before any field work may proceed. This Safety Plan shall consist of the Contractor's standard "Injury and Illness

Prevention Program", modified and/or supplemented as necessary for specific project requirements. The Safety Plan shall include, as a minimum, the following:

Code of safe practices, complying with 8 CCR 1509. This must be posted at the job site.

Identify detailed contractual and supervisory means for controlling and coordinating safety responsibilities and activities of subcontractors and suppliers in accordance with this section.

Job-specific Safety Plan. Address each of the following:

Designated responsibilities of the Contractor's key personnel. Include names, safety qualifications and assignment details for controlling hazards on job site. Indicate name and professional certifications of the point of contact person responsible for safety on the site. This person must have adequate control of resources to abate hazards or stop work. Other key functions requiring responsible persons include reports and logs, exposure data monitoring, accident investigator and reporting. List training certifications required by 29 CFR 1926 and 1910 as applicable for designated key site personnel.

Demolition plan.

Excavation plan.

Hazardous energy control plan.

Material and personnel lifting plan.

Fall protection plan.

Confined space plan. Identify the qualified person(s), training and experience. Delineate authority to direct work stoppage. Include procedure for rescue.

Asbestos and lead control plan. Incorporate by reference other specialized job specific safety plans required by this contract such as asbestos removal if applicable.

Other potentially hazardous tasks related to scaffolding, machinery, operational equipment, or electrical hazards.

Hazardous materials use. Provision for secondary containment of any hazardous material that will be brought on-site. Inventory or materials to be introduced to the site. Plan for personnel protection during transport, storage and use including MSDS, labeling, and hazard communications plan.

Alcohol and drug control plan.

Unusual conditions. Power outage and weather contingencies.

Safety meetings, inspections, and reports to be conducted or made.

Location/telephone numbers of emergency services and location of their posting on the job site.

Accident reporting procedures.

Procedures for securing an accident site until investigation by the Government is complete.

Procedures for securing work areas and protecting personnel in event of an accident or emergency.

A list of safety clearances that will be required, and a tabulation of anticipated hazards and measures to be used to control the respective risks to acceptable levels.

## 1.9 SAFETY CLEARANCE PERMITS

A specific, written permit is required before conducting operations involving any of the following dangerous operations. The Contractor shall insure that no such work is conducted prior to obtaining the permit, and that all provisions of the permit are met. Contact the Contracting Officer at least 2 working days in advance, to obtain the required permit. The granting of a permit in no way relieves the Contractor of responsibility for any injury or damage which might result from their operation. The granting of these permits may be contingent upon restricted areas or hours of operation or special safety requirements; the Contractor shall comply with these requirements at no additional cost to the Government.

OPEN FLAME HEATING DEVICES or OPEN FIRES. Use of these devices requires a permit. Burning of trash, brush, or wood is prohibited.

EXCAVATION. Excavation 6" or more beneath the surface requires a permit.

CONFINED SPACE ENTRY. Entry or work in confined spaces, including but not limited to manholes and vaults, requires a permit.

FACILITY CLOSURE OR OBSTRUCTION. Obstruction of streets, walks, and parking areas, and other facilities occupied and used by the government requires a permit.

ELECTRICAL WORK. Work on electrical circuits or equipment of greater than 480 volts requires a permit, and compliance with Section 01100.

WELDING, FLAME CUTTING, AND MELTING. These operations require a permit.

RADIATION. Required before any radioactive materials, radiation producing machines, or particle accelerators are brought onto Ames Research Center.

EXPLOSIVES. Required before explosives are transported to the site or used on-site.

## 1.10 HOLD OFF AND SPECIAL CONDITIONS TAGS

HOLD OFF and SPECIAL CONDITIONS tags are in general use on the site. They are used whenever equipment lockout or use only under specific, limited conditions is required to insure a safe working environment. The Contractor is required to ALWAYS HONOR THESE TAGS. The lives of workers may depend on it. If the Contractor needs to have a tag removed or believes that one should be applied, he shall contact the Contracting Officer's Technical Representative (COTR).

A HOLD OFF tag constitutes an order not to operate a piece of equipment.

A SPECIAL CONDITIONS tag specifies the conditions or circumstances under which the equipment may be operated. It constitutes an order not to operate the equipment except under the conditions or circumstances specified.

## 1.11 REPORTS AND RECORDS

### 1.11.1 Toolbox Meeting Reports

The Contractor's superintendent shall conduct weekly toolbox safety meetings with all employees and subcontractors and shall provide a copy of the minutes of these meetings to the Contracting Officer.

### 1.11.2 Accident Reports

The Contractor shall immediately make an oral report to the Contracting Officer of any accident which results in one of the following: fatality; disabling or lost-time injury; injury requiring medical treatment; property contamination; or property loss of $10,000 or more. A written report shall be submitted to the Contracting Officer within 5 days of each incident. The report shall include investigative findings (but is not required to include an expression of opinion as to the negligence or fault of any employee); and proposed or completed corrective actions.

## 1.12 SAFETY INSPECTION

The Contractor's operations are always subject to inspection by the Government's construction safety engineer and by the site superintendent. The Contractor shall comply with reasonable requests of these individuals, as relates to safety. If the Contractor believes any request of these individuals to be outside the scope of the contract, he shall immediately notify the Contracting Officer of this fact. The Contracting Officer will make a determination on the issue, and give appropriate direction to the Contractor.

## 1.13 FALL PROTECTION ANCHORAGE

Personal fall arrest anchorages shall be installed in accordance with ANSI Z359.1 requirements. Permanent anchorages installed under this contract shall remain in place for continued Government use. Provide standard primer sealer and finish paint if not galvanized, for corrosion protection purposes.

## 1.14 PERMANENT SIGNAGE

Provide permanent warning and identification signs in accordance with 29 CFR 1910 and CEC requirements for potential hazards installed under this contract. These shall include, but not be limited to, circuit breaker identification, high voltage electrical warning, pipe labeling and confined space warnings. On new permit required confined spaces, labeling signs shall be integral to or securely attached weather resistant signs on access covers. Coordinate with Contracting Officer for approval of signs differing from similar existing signs installed throughout Ames.

## 1.15 CHEMICALS AND HAZARDOUS MATERIALS

Chemicals and hazardous materials as defined in 29 CFR 1910.1200 that are integral to new work and remain part and parcel to completed work installed, shall be identified by the Contractor. Products containing carcinogens as defined in 29 CFR 1910 Subpart Z or by the State of California shall be approved by the Contracting Officer. Sheet rock and gypsum wallboard products shall be asbestos free.

## 1.16 GENERAL SAFETY RULES

The Contractor is required to adhere to the following safety rules, in addition to all other applicable requirements.

Ladders shall be tied off and/or braced, to prevent movement. Workers shall not stand on any of the top three rungs of a ladder.

The Contractor shall insure that all employees wear an approved hard hat at all times in designated hard hat areas.

Tools, equipment, etc. shall be raised or lowered by means of a bucket and/or rope. Employees shall not throw or drop items from one level to another.

The Contractor shall, at all times, provide a clean work area, and free and clear emergency egress ways. Debris shall be removed from the work areas, and the area swept daily.

All employees shall be provided with, and shall use safety clothing and equipment appropriate to the work they are performing, including, but not limited to: goggles or face shields, protective garments, ear protection, safety shoes, and safety belts. Train all employees in the proper use of these items. Insure that persons employed in cutting, chipping, burning, and similar operations use proper eye protection.

## 1.17 FIRE PREVENTION AND PROTECTION

The Contractor shall provide, maintain, and keep available on-site at least two fully charged fire extinguishers. During welding and torch cutting work, the extinguishers shall be in the immediate vicinity of the work.

Flammable liquids shall be stored and handled in accordance with the Flammable and Combustible Liquids Code, NFPA 30.

Open fires or salamanders shall not be permitted in construction areas.

Smoking shall not be permitted in dangerous areas, such as paint storage, fuel storage, confined space, and posted "No Smoking" areas. Smoking is also prohibited in all trailers and buildings located on Government property.

Obstruction-free routing shall be provided for persons carrying hot substances. Hot substances shall not be carried up or down ladders.

Gas bottles shall be stored upright, and shall be secured top and bottom to prevent accidental tipping.

## 1.18 EXCAVATION

Prior to excavation, the Contractor shall obtain from the Contracting Officer the locations of the underground utilities in the area and shall mark these locations on the ground surface. The elevations and exact locations of all utilities are not known; therefore, the Contractor shall exercise caution in all excavation work to avoid damaging existing utilities.

Conduct all excavation under the direct, on-site supervision of a qualified person with experience in earthwork and knowledgeable of the requirements of Article 6 of the California Construction Safety Orders. This person shall be named on the Excavation Permit Request. The competent person shall inspect the excavation daily and after every rainstorm or other hazard-increasing occurrence, before any person is allowed to enter the excavation. If inspection reveals a potential hazard, it shall be mitigated before any person is allowed to enter the excavation. Keep a log of these inspections and submit a copy to the COTR with each weekly tool-box meeting minutes.

If an existing utility line is broken, the Contractor shall immediately notify the Contracting Officer. The Contractor shall berm the area to prevent run off to storm drain and immediately block off adjacent storm drain catch basins.

If, during the soil work/excavation, the soil appears discolored, has an odor, or if debris is observed, the Contractor shall notify the Contracting Officer immediately. The soil will be tested by the government. The Contractor shall place contaminated spoils on plastic sheeting and cover with a plastic tarpaulin.

Excavations and trenches deeper than 5 feet shall be shored to the requirements of OSHA 29 CFR 1926 in areas where personnel are working.

Excavations and trenches deeper than 12 feet shall have shoring designed (and design stamped) by a California registered Civil Engineer and approved by the Contracting Officer.

When work is being done in trenches deeper than 4 feet, ladders or other safe means of egress shall be located in the trench, so as to require no more than 25 feet of lateral travel for employees; and at least one Contractor employee shall stand by above ground, ready to give assistance in an emergency.

Open trenches and excavations shall be barricaded to the satisfaction of the Contracting Officer. Warning lights (at night) and signs, safety cones, and flags shall be provided and maintained by the Contractor to direct vehicular and pedestrian traffic around such openings.

## 1.19 CONFINED SPACE WORK

If entry into a confined space(s) is required, implement a confined space entry program compliant with applicable regulations (the federal OSHA confined spaces standard applies in areas of federal jurisdiction, which is most of the Center, the CAL-OSHA confined spaces standard applies for spaces north of Hunsaker Road and west of Lindbergh Road).

Comply with the requirements of 29 CFR 1910.146 and NHS/IHS 1845.2.

Confined spaces are those which have extremely limited provisions for entry and exit, have poor natural ventilation, or may contain hazardous atmosphere. No work shall be conducted in a confined space without required training and a Confined Space Entry permit, issued by the Contractor, in addition to the Government permit specified above.

All pipelines which may contain flammable or hazardous substances, and which enter a confined space, shall be blinded, blocked, or disconnected before entry.

If tests determine that hazardous conditions exist, remove all hazardous substances, and/or provide adequate ventilation prior to entry.

The Contractor shall provide a qualified person, forced air ventilation, and adequate testing devices to monitor air quality during the entire work period, at no additional cost to the Government. If tests determine that hazardous conditions exist, all hazardous substances shall be removed by the Contractor to the satisfaction of the Contracting Officer, prior to entry.

When oxygen consuming or hazardous substance producing procedures are to be employed in the confined space, or when the Contracting Officer determines that a hazardous atmosphere may develop during work, the Contractor shall provide a qualified person and adequate testing devices, to monitor air quality during the entire work period, at no additional cost to the Government.

At least one Contractor employee shall stand by outside of the confined space, ready to give assistance in an emergency.

The Contractor shall provide appropriate protective clothing and/or equipment to their employees and it shall be used.

When open, manholes or vaults shall be barricaded by the Contractor, and warning lights (at night) and signs shall be provided by him.

Whenever it is necessary to work in an area equipped with an automatic CO2 discharge system, the CO2 isolation valve shall be locked closed and tagged before entering the area. An audible alarm shall precede the activation of the CO2 discharge system. When the alarm sounds, all personnel shall leave the area immediately. The area shall not be re-entered without proper breathing apparatus unless gas detection tests have been made and the area declared safe.

Other specific requirements for confined space work include: Manhole cover hooks, cover lifters, or recessed handles shall be used for removing or replacing manhole covers. Manholes shall be entered or exited by means of a ladder whenever possible. Manhole covers and gratings shall be properly seated when replaced. Employees shall use only CEC approved lighting units for illumination when working in confined spaces. No matches or smoking are allowed in confined spaces. Air-driven tools used around energized cables shall be grounded.

## 1.20 FACILITY CLOSURE OR OBSTRUCTION

The Contractor shall take steps to insure that any closure or obstruction of streets, walks or other facilities is adequately barricaded, that warning signs and lights (at night) are provided, and that the closure or obstruction is of the minimum practical duration.

## 1.21 ELECTRICAL SAFETY

When working on equipment or circuits designed to carry more than 480 volts, the provisions of Section 01 12 00, "Electrical Systems Safety," apply in addition to those of this section.

Before working on any electrical equipment or circuit, it shall be properly grounded, and unless prior written approval has been given otherwise, it shall be disconnected from the power source, and tagged/locked out.

Portable electric tools shall be protected with standard 3-prong grounding plugs or be double-insulated, and shall be unplugged when not in use.

Ground fault interrupters shall be used on all temporary electrical lines and cables, including extension cords; temporary wiring and cables shall be routed to prevent tripping hazards.

When permanently removing equipment or circuits, the wiring, conduit, and boxes shall be removed back to the source, unless otherwise specified. The main panel shall also be annotated to the effect that the circuit is no longer in use.

## 1.22 WELDING, FLAME CUTTING, AND MELTING

During flame cutting and welding, the Contractor shall take care and provide protection to prevent splatter from damaging facilities or causing fire. When these operations are performed above or below ground level, at least one Contractor employee shall stand by at the ground, with firefighting equipment, ready to give assistance in an emergency.

The Contractor shall discontinue burning, welding, or cutting operations 1 hour prior to the end of the normal work day. A workman shall remain at the site for 1 hour after discontinuing these operations to make thorough inspection of the area for possible sources of latent combustion. He shall be equipped with two full 15-pound carbon dioxide fire extinguishers.

The Contractor shall provide shields, fire blankets, and other protection devices to protect persons and property adjacent to the area of work.

## 1.23 RADIATION

No use of radioactive materials, radiation producing machines, or particle accelerator equipment shall be allowed on-site, UNLESS a Radiation Safety Clearance Permit has been obtained from the Contracting Officer, and all provisions of the permit and this section have been met.

Workers shall be protected from radiation exposure in accordance with 10 CFR 20, Standards for Protection Against Radiation.

Ames Research Center is a federal site, under the jurisdiction of the Nuclear Regulatory Commission (NRC). All non-NRC licensed radiographers must obtain a reciprocity agreement with the NRC prior to bringing sources on site. A copy of the radiography contractor's license to conduct radiography and its company safety manual shall be kept on file with the NASA Radiation Safety Officer.

The Contractor shall conduct radiation operations only under the surveillance of the Contracting Officer. The Contractor shall

conspicuously post the area, and erect barriers, as required by Title 10 CFR PART 34. During hours of darkness the signs shall be conspicuously illuminated with an amber or white light. The Contractor shall maintain direct surveillance of the area to protect against unauthorized entry and shall maintain a properly calibrated survey meter on site and conduct periodic monitoring.

The Contractor shall immediately report to the Contracting Officer any radiological health hazard, emergency, or loss of radioactive material at the center or site.

Upon completion of radiological operations, the Contractor shall notify the Contracting Officer and shall remove warning signs and ropes.

Radiographs shall be performed in a manner consistent with Title 10 CFR PART 34 and approved by the Contracting Officer, and in the presence of an approved radiographer. Radiography shall be performed after 5:00 p.m. on weekdays or on weekend days.

Conduct any photoprocessing of radiographic film per the requirements of the City of Mountain View or the City of Sunnyvale. The Radiation Safety Permit Request shall contain an annotation of the volume of waste water anticipated to be discharged and the location of proposed discharge. If the permit request is not so annotated, the Contractor shall NOT perform on-site photoprocessing.

## 1.24 HIGH NOISE LEVEL PROTECTION

Operations performed by the Contractor that involve the use of equipment with output of high noise levels (jackhammers, air compressors, and explosive device activated tools) shall be scheduled for during the hours approved by the Contracting Officer.

## 1.25 ASBESTOS

### 1.25.1 New Materials

Unless otherwise specified, no asbestos-containing materials are to be used by the Contractor.

### 1.25.2 Encountering Asbestos

Except as specified, no asbestos-containing material is expected to be encountered on the site. If the Contractor encounters asbestos material that is not specified, immediately inform the Contracting Officer. Unless otherwise instructed, the Contractor shall not break, burn, or tear materials suspected of containing asbestos. If the Contracting Officer determines it necessary, she shall arrange for removal, disposal, and/or isolation of the material.

### 1.25.3 Handling Asbestos

If the Contractor is to handle-asbestos containing materials, this work shall be done in accordance with Section 02 08 00, "Asbestos Abatement".

## 1.26 LEAD

All existing painted structural and miscellaneous steel and steel pipe shall be assumed to be coated with lead-based material, unless otherwise

specified. All requirements for lead-containing materials and lead-producing operations contained in the referenced regulations shall be met by the Contractor.

If the Contractor is to remove lead containing paint, this work shall be done in accordance with Section 02090, "Lead Paint Abatement/Demolition".

1.27 LIFTING

Crane Compliance Certification. Provide for each crane entering Ames under this contract. Provide statement on company letterhead indicating that the crane and rigging gear meet 29 CFR 1926.555, 952(c), and 406(a) requirements as applicable. Include operator training and qualification data.

Personnel Lifts. Occupied scissor lifts shall be lowered prior to horizontal relocation. Hard hats shall be worn while in lifts. Personal fall restraint devices shall be utilized. Personnel lifting shall comply with ANSI A90.1 and A92.2.

Materials Lifting. Comply with rigging requirements of ANSI B30.5 and AHB 1700.1, Sections 17.4.5 to 17.8. Tandem lifting is prohibited. Each load shall be rigged and attached independently to the hook or master-link in such a fashion that the load cannot slide or otherwise become detached. Lifting of multiple rigged materials on a single hook or master-link, also known as Christmas-tree lifting or tandem lifting is prohibited.

1.28 DEMOLITION

Avoid production of dust during concrete demolition. Wet concrete before demolition. If dust is visible from concrete demolition, provide additional wetting of concrete.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

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# SECTION 01 12 00

# ELECTRICAL SYSTEMS SAFETY

## PART 1 GENERAL

### 1.1 SUMMARY

Provisions of this section apply to work on all electrical systems, designed for greater than 480 volts (nominal).

These provisions are in addition to those required by Section 01100 (Safety Provisions) to this specification, and to those referenced below.

### 1.2 REFERENCES

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C2 | (1993) National Electrical Safety Code |

CALIFORNIA CODE OF REGULATIONS (CCR)

| | |
|---|---|
| CEC | (2007) California Electrical Code |

HEALTH AND SAFETY MANUAL

| | |
|---|---|
| AHB1700-1 | (1997) NASA - Ames Research Center Health and Safety Manual |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (1995) Acceptance Testing Specifications for Electrical Power Distribution Equipment Systems |

### 1.3 SUBMITTALS

The following shall be submitted in accordance with the provisions noted in Part 2, below and Section 01 33 00, SUBMITTAL PROCEDURES.

SD-20, Work Plan

For approval by the Contracting Officer

Work Clearance Request, for connections to existing utilities.

## PART 2 PRODUCTS

### 2.1 GROUNDING

Before starting work on any equipment or system having electrical connections, such equipment shall be properly grounded (See paragraph entitled, "Grounding of Equipment").

## 2.2 HAZARDOUS FLUIDS

Any system containing poisonous, combustible or other dangerous gases or fluids shall be safe in accordance with all safety regulations concerning these materials prior to the commencement of work (See Section 01 10 00, "Safety Provisions").

## 2.3 EARTH RETURN

Earth return shall not be used in the wiring of any power circuit.

## 2.4 CONNECTION/DISCONNECTION TO GOVERNMENT ELECTRICAL POWER

At least twenty one (21) days prior to connecting or disconnecting to any part of the Government's electrical power distribution system, the Contractor shall submit a written application to the Contracting Officer stating the date, time, location, the service involved, and when such connection/disconnection is desired to be made.

Initial energizing of new electrical equipment shall be done only in the presence of the Contracting Officer or a designated representative.

# PART 3 EXECUTION

## 3.1 GENERAL SAFETY RULES

Welding or burning shall not be permitted in the immediate vicinity of electrical equipment unless authorized by the Contracting Officer or a designated representative.

The "buddy system" shall be used whenever working on power systems, whether energized or not.

Before maintaining or repairing any electrical equipment, it shall be disconnected from the power source.

Ground wires or connections to frames or cases shall not be removed from any energized equipment.

Do not use metal ladders when working on electrical equipment.

Do not wear rings or other jewelry when working on electrical equipment since this presents a shock and burn hazard.

In fishing a tape or wire through a conduit, people shall be stationed so as to prevent the free ends of the tape or wire from contacting live equipment.

## 3.2 PROTECTIVE CLOTHING/EQUIPMENT

### 3.2.1 Gloves

Lineman's type high voltage rubber gloves shall be used with leather protectors and shall be tested at least every 90 days. In addition, standard air test shall be made immediately before use. All testing shall be in accordance with industry standards for the circuit voltages involved, and shall parallel the test procedures employed by electrical utility firms. Rubber gloves shall not be relied upon for protection on live circuits of more than 3,500 volts to ground.

### 3.2.2 Replacing Fuses

When removing or replacing fuses, except where equipment has been de-energized, grounded, tagged out, and tested; fuse tongs or insulated fuse extractors shall be used on circuits of 50 to 499 volts. On circuits above 500 volts, rubber gloves and high-voltage sticks or tongs shall be used. Above 23,000 volts, fuses shall not be removed or replaced until the circuit or equipment is de-energized, tagged, grounded, and tested for voltage.

### 3.2.3 Eye Protections

Safety glasses or goggles shall be used when making electrical measurements on energized circuits.

## 3.3 WORK ON LIVE CIRCUITS

No work shall be performed on energized circuits without prior approval. When such work is necessary, a standard detailed procedure shall be established, approved by the Contracting Officer, and shall be followed when conducting and performing such work. Test measurements of up to 500 volts are allowed.

## 3.4 GROUNDING OF EQUIPMENT

### 3.4.1 Testing for Voltages

Before protective grounds are attached, a test for voltage shall be made. The test device shall be checked to insure that it is the correct device for use at the voltage of the circuit or equipment to be tested.

### 3.4.2 Protective Grounding and Short Circuiting

Circuits or equipment shall be de-energized, tagged, and tested for presence of voltage by "buzzing the line" before the protective grounds are attached. Circuit or equipment conductors, including the neutral, when present, shall be effectively grounded to both ground and short circuit conductors before the work is started. Protective grounds shall not be removed until the work is finished and workers are clear of the circuit or equipment.

It shall be the responsibility of the electrical foreman person directly in charge of work to witness that adequate grounds are placed for the protection of all personnel, even though the tags may be placed in the name of another person. Protective grounds shall be placed on all sides of the work where there is a possible source of power (including wire crossings and parallel lines) and as close to the point of work as possible. Additional grounds shall be placed where necessary to reduce static charges or induced voltages from adjacent lines.

Only OSHA approved grounding devices shall be use, and in no case shall the grounding cable be smaller than 2/0 copper or equivalent.

## 3.5 SUBSTATIONS AND BUILDINGS

### 3.5.1 Work/Test/Energization Plans

The Contractor shall submit a work plan to the Contracting Officer at least

twenty one (21) days prior to initiating work in manholes which outlines the work to be done and identifies the circuits required to be de-energized to safely conduct the operation. Changes to this work plan shall be reviewed with the Contracting Officer prior to initiation.

Test Plan shall include the parameters of all the Government-Furnished Equipment (GFE) and Contractor provided equipment to be tested, test value and the acceptance tolerances shall be in accordance with NETA ATS and other sections of this specification. All equipment shall be tested by a certified testing firm.

Energization Plan shall include the step-by-step switching procedure. Also field verification of wiring, phase rotations, voltage and currents, etc., shall be written in this plan. The Contractor shall submit a test plan and energization plan twenty-one (21) calendar days prior to request for power outage, to the Contracting Officer for review and approval. The testing and energization plans shall include, but not to be limited to the following:

Test Plan:

a. Name of the certified testing firm.
b. The dates on which equipment will be tested.
c. Description of equipment to be tested.
d. Date of test instrument calibration.
e. Test equipment to be used.
f. Safety Operating Procedures.
g. Complete description of visual and mechanical/electrical inspection and test procedures.

Energizing Plan:

a. Step-by-step procedure of the equipment to be disconnect/re-connected or energized of the new/existing devices.
b. Pre-energize and pre-inspection requirements.
c. Procedure of visual and mechanical inspection.
d. Description of equipment to be energized.
e. Monitoring equipment on hand such as recorders, rotation meters, test instruments, etc.
f. Safety procedures.
g. Coordination with NASA-Ames facilities personnel.

3.5.2 Feedback

In performing work on substation equipment, extreme caution shall be exercised to eliminate the danger of feedback from other sources by testing, disconnection, grounding or short circuiting transformer, potential devices, coupling capacitors etc.

3.5.3 Installing Ground

First, attach protective grounding cable or cables to the station grounding system. Then attach a grounded cable to each conductor of the circuit or bus or to the conductor to be worked on. Be sure that all workers keep clear of the grounded cables and clamps until the grounding is completed. Grounding conductors shall be furnished and provided by the Contractor(s).

### 3.5.4 Removing Ground

To remove the protective ground, detach the grounded cable from each conductor, keeping as far away as possible, and being sure that all workers keep clear of the grounded cables and clamps until all conductor clamps have been removed. Then remove ground clamp or clamps from the station grounding system.

### 3.5.5 Inspection

A NASA representative shall make periodic inspections of all work in energized substations and make certain that adequate caution is exercised by personnel.

## 3.6 UNDERGROUND CABLES

Cables shall not be spliced while energized.

In cases where protective grounding of conductors making up underground cables cannot be done at the point of work, the grounds shall be attached at the nearest location where the conductors can be reached, in accordance with protective grounding instructions for stations or overhead lines.

Identify cables by tags, ducts or duct records. Tags and ducts occupied by the cables shall be checked against records, and, if possible, checked physically in manholes on either side of the location where the work is to be performed.

High voltage rubber gloves shall be used when removing sheathing or shielding tape, when testing for voltage, and when cutting or sawing into cables.

Before removing a section of metallic sheathing or shielding tape from cables employed in circuits above 480 volts, both sides shall be bonded together with a metallic jumper.

At least 10 inches of sheathing or shielding tape shall be removed for the full circumference of the cable at the point where the cut is to be made.

After sheathing or shielding tape has been removed and before any insulation is disturbed, the cable shall be tested for voltage with a voltage detector.

If no voltage is detected, one-half of the insulation shall be removed, tested again, and if no voltage is detected, the cable may then be cut or pierced.

## 3.7 SWITCHING

Electrical switching required for clearance to work on equipment operating from electrical circuits shall be performed only by Government personnel authorized as safety operators for the specific equipment.

High voltage rubber gloves shall be worn when using hook sticks to operate any fused cutouts when the voltage exceeds 480 volts.

Work shall not be done on circuits or equipment disconnected from sources of power by oil and SF6 breakers alone. The disconnect switch ahead of the breaker shall be opened prior to work being done.

Before operating any switch used for maintenance or for isolating circuits above 480 volts, the switchman must be accompanied by properly instructed person who shall stand at a safe distance and be prepared to take such steps as may be necessary in the event of an emergency.

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# SECTION 01 33 00

# SUBMITTAL PROCEDURES

## PART 1 GENERAL

The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections.

Units of weights and measures used on all submittals are to be the same as those used in the contract drawings.

Each submittal is to be complete and in sufficient detail to allow ready determination of compliance with contract requirements.

Contractor's Quality Control (CQC) System Manager and the Designer of Record, if applicable, to check and approve all items prior to submittal and stamp, sign, and date indicating action taken. Proposed deviations from the contract requirements are to be clearly identified. Include within submittals items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required submittals.

Submittals requiring Government approval are to be scheduled and made prior to the acquisition of the material or equipment covered thereby. Picked up and disposed of in accordance with manufacturer's Material Safety Data Sheets (MSDS) and in compliance with existing laws and regulations samples remaining upon completion of the work.

### 1.1 DEFINITIONS

Requirements of this section apply to, and are component parts of, each section of this specification.

#### 1.1.1 Submittal Descriptions (SD)

Submittals requirements are specified in the technical sections. Submittals are identified by Submittal Description (SD) numbers and titles as follows:

SD-01 Preconstruction Submittals

Submittals which are required prior to a notice to proceed commencing work on site. Submittals required prior to the start of the next major phase of the construction on a multi-phase contract. Schedules or tabular list of data or tabular list including location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work, submitted prior to contract notice to proceed or next major phase of construction.

Certificates of insurance
Surety bonds
List of proposed subcontractors

List of proposed products
Construction Progress Schedule
Schedule of prices
Health and safety plan
Work plan
Quality control(QC) plan
Environmental protection plan

SD-02 Shop Drawings

Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work.

Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project.

Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

SD-03 Product Data

Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems or equipment for some portion of the work.

Spare parts data shall indicate manufacturer's name, part number, nomenclature, and stock level required for maintenance and repair. List those items that may be standard to the normal maintenance of the system.

Samples of warranty language when the contract requires extended product warranties.

SD-04 Samples

Fabricated or unfabricated physical examples of materials, equipment or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged.

Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project.

Field samples and mock-ups constructed on the project site establish standards by which the ensuring work can be judged. Includes assemblies or portions of assemblies which are to be incorporated into the project and those which will be removed at conclusion of the work.

SD-05 Design Data

Design calculations, mix designs, analyses or other data pertaining to a part of work.

Design submittals, design substantiation submittals and extensions of design submittals.

## SD-06 Test Reports

Report signed by authorized official of testing laboratory that a material, product or system identical to the material, product or system to be provided has been tested in accord with specified requirements. (Testing must have been within three years of date of contract award for the project.)

Report which includes findings of a test required to be performed by the Contractor on an actual portion of the work or prototype prepared for the project before shipment to job site.

Report which includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.

Investigation reports.

Daily logs and checklists.

Final acceptance test and operational test procedure.

## SD-07 Certificates

Statements printed on the manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements. Must be dated after award of project contract and clearly name the project.

Document required of Contractor, or of a manufacturer, supplier, installer or subcontractor through Contractor, the purpose of which is to further quality of orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel qualifications.

Confined space entry permits.

Text of posted operating instructions.

## SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system or material, including special notices and Material Safety Data sheets concerning impedances, hazards and safety precautions.

## SD-09 Manufacturer's Field Reports

Documentation of the testing and verification actions taken by manufacturer's representative at the job site, in the vicinity of the job site, or on a sample taken from the job site, on a portion of the work, during or after installation, to confirm compliance with manufacturer's standards or instructions. The documentation must be signed by an authorized official of a testing laboratory or agency and must state the test results; and indicate whether the material, product, or system has passed or failed the test.

Factory test reports.

## SD-10 Operation and Maintenance Data

Data is furnished by the manufacturer, or the system provider, to the equipment operating and maintenance personnel. This data is needed by operating and maintenance personnel for the safe and efficient operation, maintenance and repair of the item.

This data is intended to be incorporated in an operations and maintenance manual or control system.

The Contractor shall submit 3 copies of the project operation and maintenance manuals 30 days prior to testing the system involved. Data shall be updated and resubmitted for final approval no later than 30 days prior to contract completion.

Operation and Maintenance Manuals shall be consistent with the manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Information shall be bound in manual format and grouped by technical sections. Test data shall be legible and of good quality. Pages for vendor data and manuals shall be bound in 3-ring, loose-leaf binders. Data shall be organized by separate index and tabbed sheets, in a loose-leaf binder. The binder shall lie flat with printed sheets that are easy to read. Caution and warning indications shall be clearly labeled.

## SD-11 Work Plan

Work Plan: Detailed procedures defining the Contractor's provisions for construction activity, including equipment techniques used and protection controls.

Demolition Plan: Detailed procedures defining the Contractor's provisions for construction activity.

Safety Plan: Detailed procedures defining the Contractor's provisions for accident prevention and health protection of their workers, subcontractors, and government workers and describing action taken in emergency spill response procedure.

Quality Assurance Plan.

## SD-12 Closeout Submittals

Documentation to record compliance with technical or administrative requirements or to establish an administrative mechanism.

As-Built Drawings shall be submitted under the following criteria: In order to minimize the time for final payment at the completion of the project, the Contractor shall update the as-built drawings every month with the Contracting Officer's authorized representative. This update will be a part of "the monthly request for payment meeting," and payment -- or a portion of the payment, including final payment -- may be withheld until the as-built drawings have been updated, and accepted by the Contracting Officer.

After completion of all construction, and before final payment is made under this contract, the Contractor shall provide the Contracting Officer with one complete set of full size blueline contract drawings with alternations shown in red pencil.

Special requirements necessary to properly close out a construction contract. For example, Record Drawings, manufacturer's help and product lines necessary to maintain and install equipment. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

1.1.2 Approving Authority

Office or designated person authorized to approve submittal.

1.1.3 Work

As used in this section, on- and off-site construction required by contract documents, including labor necessary to produce submittals, construction, materials, products, equipment, and systems incorporated or to be incorporated in such construction.

1.2 SUBMITTAL CLASSIFICATION

Submittals are classified as follows:

1.2.1 Government Approved

Government approval is required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Contracting Officer. Government approval is required for any deviations from the Solicitation or Accepted Proposal and other items as designated by the Contracting Officer. Within the terms of the Contract Clause entitled "Specifications and Drawings for Construction," they are considered to be "shop drawings."

1.2.1.1 Substitutions

Unless prohibited or provided for otherwise elsewhere in the Contract, where the accepted contract proposal named products, systems, materials or equipment by manufacturer, brand name and/or by model number or other specific identification, and the Contractor desires to substitute manufacturer or model after award, submit a requested substitution for Government concurrence. Include substantiation, and identifying information, as meeting the contract requirements and that it is equal in function, performance, quality and salient features to that in the accepted contract proposal.

1.2.2 Information Only

Submittals not requiring Government approval will be for information only. For Design-build construction all submittals not requiring Designer of Record or Government approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract Clause referred to above.

1.3 PREPARATION

1.3.1 Identifying Submittals

When submittals are provided by a lower tier contractor the Prime Contractor is to prepare, review and stamp with Contractor's approval all specified submittals prior to submitting for Government approval.

Identify submittals, except sample installations and sample panels, with the following information permanently adhered to or noted on each separate component of each submittal and noted on transmittal form. Mark each copy of each submittal identically, with the following:

a. Project title and location.

b. Construction contract number.

c. Date of the drawings and revisions.

d. Name, address, and telephone number of subcontractor, supplier, manufacturer and any other second tier Contractor associated with submittal.

e. Section number of the specification section by which submittal is required.

f. Submittal description (SD) number of each component of submittal.

g. When a resubmission, add alphabetic suffix on submittal description, for example, submittal 18 would become 18A, to indicate resubmission.

h. Product identification and location in project.

Submittal identification shall include space to receive the review action by the Contracting Officer.

1.3.2 Format for SD-02 Shop Drawings

a. Shop drawings are not to be less than 8 1/2 by 11 inches nor more than 30 by 42 inches, except for full size patterns or templates. Preferred drawing size is 24 by 36 inches. Prepare drawings to accurate size, with scale indicated, unless other form is required. Drawings are to be suitable for reproduction and be of a quality to produce clear, distinct lines and letters with dark lines on a white background.

b. Present A4 8 1/2 by 11 inches sized shop drawings as part of the bound volume for submittals required by section. Present larger drawings in sets.

c. Include on each drawing the drawing title, number, date, and revision numbers and dates, in addition to information required in paragraph entitled "Identifying Submittals."

d. Number drawings in a logical sequence. Contractors may use their own number system. Each drawing is to bear the number of the submittal in a uniform location adjacent to the title block. Place the Government contract number in the margin, immediately below the title block, for each drawing.

e. Dimension drawings, except diagrams and schematic drawings; prepare drawings demonstrating interface with other trades to scale. Use the same unit of measure for shop drawings as indicated on the contract drawings. Identify materials and products for work shown.

f. Include the nameplate data, size and capacity on drawings. Also include applicable federal, military, industry and technical society publication references.

1.3.3 Format of SD-03 Product Data and SD-08 Manufacturer's Instructions

a. Present product data submittals for each section as a complete, bound volume. Include table of contents, listing page and catalog item numbers for product data.

b. Indicate, by prominent notation, each product which is being submitted; indicate specification section number and paragraph number to which it pertains.

c. Supplement product data with material prepared for project to satisfy submittal requirements for which product data does not exist. Identify this material as developed specifically for project, with information and format as required for submission of SD-07 Certificates.

d. Provide product data in English units.

e. Include the manufacturer's name, trade name, place of manufacture, and catalog model or number on product data. Also include applicable federal, military, industry and technical society publication references. Should manufacturer's data require supplemental information for clarification, submit as specified for SD-07 Certificates.

f. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), ASTM International (ASTM), National Electrical Manufacturer's Association (NEMA), Underwriters Laboratories (UL), and Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. State on the certificate that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

g. Collect required data submittals for each specific material, product, unit of work, or system into a single submittal and marked for choices, options, and portions applicable to the submittal. Mark each copy of the product data identically. Partial submittals will be accepted for expedition of construction effort.

h. Submit manufacturer's instructions prior to installation.

1.3.4 Format of SD-04 Samples

Samples shall be physically identical with the proposed material or product to be incorporated in the work, fully fabricated and finished in the specified manner, and full scale. Where variations in color, finish,

pattern, or texture are inherent in the material or product represented by the sample, multiple units of the sample, showing the near-limits of the variations and the "average" of the whole range (not less than 3 units), shall be submitted. Each unit shall be marked to describe its relation to the range of the variation. Where samples are specified for selection of color, finish, pattern, or texture, the full set of available choices shall be submitted for the material or product specified. Sizes and quantities of samples shall represent their respective standard unit.

1.3.5 Format of SD-05 Design Data and SD-07 Certificates

Provide design data and certificates on 8 1/2 by 11 inches paper. Provide a bound volume for submittals containing numerous pages.

1.3.6 Format of SD-06 Test Reports and SD-09 Manufacturer's Field Reports

a. Provide reports on 8 1/2 by 11 inches paper in a complete bound volume.

b. Indicate by prominent notation, each report in the submittal. Indicate specification number and paragraph number to which it pertains.

1.3.7 Format of SD-01 Preconstruction Submittals and SD-11 Closeout Submittals

a. When submittal includes a document which is to be used in project or become part of project record, other than as a submittal, do not apply Contractor's approval stamp to document, but to a separate sheet accompanying document.

b. Provide all dimensions in administrative submittals in English units.

1.4 VARIATIONS / SUBSTITUTION REQUESTS

Variations from contract requirements require Government approval pursuant to contract Clause FAR 52.236-21 and will be considered where advantageous to Government.

1.4.1 Considering Variations

Discussion with Contracting Officer prior to submission, will help ensure functional and quality requirements are met and minimize rejections and re-submittals. When contemplating a variation which results in lower cost, consider submission of the variation as a Value Engineering Change Proposal (VECP).

Specifically point out variations from contract requirements in transmittal letters. Failure to point out deviations may result in the Government requiring rejection and removal of such work at no additional cost to the Government.

1.4.2 Proposing Variations

When proposing variation, deliver written request to the Contracting Officer, with documentation of the nature and features of the variation and why the variation is desirable and beneficial to Government. If lower cost is a benefit, also include an estimate of the cost savings. In addition to documentation required for variation, include the submittals required for the item. Clearly mark the proposed variation in all documentation.

### 1.4.3 Warranting That Variations Are Compatible

When delivering a variation for approval, Contractor warrants that this contract has been reviewed to establish that the variation, if incorporated, will be compatible with other elements of work.

## 1.5 SUBMISSION REQUIREMENTS

### 1.5.1 Schedules

Within 15 calendar days of notice to proceed, provide, for approval by the Contracting Officer, the following schedule of submittals:

a. A schedule of shop drawings and technical submittals required by the specifications and drawings. Indicate the specification or drawing reference requiring the submittal; the material, item, or process for which the submittal is required; the "SD" number and identifying title of the submittal; the contractor's anticipated submission date and the approval need date.

b. A separate schedule of other submittals required under the contract but not listed in the specifications or drawings. Schedule will indicate the contract requirement reference; the type or title of the submittal; the Contractor's anticipated submission date and the approval need date (if approval is required).

c. Submittals called for by the contract documents will be listed on one of the above schedules. If a submittal is called for but does not pertain to the contract work, the Contractor shall include the submittal in the applicable schedule and annotate it "N/A" with a brief explanation. Approval of the schedules by the Contracting Officer does not relieve the Contractor of supplying submittals required by the contract documents but which have been omitted from the schedules or marked "N/A".

d. Re-submit copies of both schedules and annotate monthly by the Contractor with actual submission and approval dates. When all items on a schedule have been fully approved, no further re-submittal of the schedule is required.

### 1.5.2 Drawing Submittals

Submit six (6) blackline or blueline opaque print(s) of each drawing. Two prints, marked with review notations by the Contracting Officer, will be returned to the Contractor. All required installation, fabrication and connection drawings shall be submitted and approved prior to the start of work detailed on these drawings.

### 1.5.3 Data Submittals

Submit six (6) complete sets of indexed and bound product data. Two sets, marked with review notations by the Contracting Officer, will be returned to the Contractor.

### 1.5.4 Samples

Submit one (1) set of identified samples. A copy of the transmittal form, marked with review notations including selections by the Contracting Officer, will be returned to the Contractor.

Samples that are intended or permitted to be returned and actually incorporated in the work are so indicated in the individual technical sections. These samples will be returned to the Contractor, at his expense, to be clearly labeled, with installation location recorded. Samples shall be in undamaged condition at the time of installation.

Where mockups and similar large samples are required by individual technical sections, it is recognized that these are a special type of sample which cannot be readily "transmitted" as specified for submittal of samples. Otherwise, and except as indicated in the individual technical sections, the requirements for samples shall be complied with and a transmittal form shall be processed for each mockup, to provide a record of the activity.

## 1.6 GOVERNMENT'S REVIEW

### 1.6.1 Review Notations

The Contracting Officer will review submittals and provide pertinent notation within ten (10) working days after date of submission. Submittals will be returned to the Contractor with the following notations:

a. Submittals marked "approved" authorize the Contractor to proceed with the work covered.

b. Submittals marked "approved as noted" authorize the Contractor to proceed with the work covered provided he takes no exception to the corrections. Notes shall be incorporated prior to submission of the final submittal.

c. Submittals marked "return for correction" require the Contractor to make the necessary corrections and revisions and to re-submit them for approval in the same routine as before, prior to proceeding with any of the work depicted by the submittal.

d. Submittals marked "not approved" or "disapproved" indicate noncompliance with the contract requirements and shall be re-submitted with appropriate changes. No item of requiring a submittal shall be accomplished until the submittals are approved or approved as noted.

e. The Contractor shall make corrections required by the Contracting Officer. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or specifications; notice as required under the clause entitled, "Changes" shall be given to the Contracting Officer. Approval of the submittals by the Contracting Officer shall not be construed as a complete check, but will indicate only that the general method of construction and detailing is satisfactory. The Contractor shall be responsible for the dimensions and design of connection details and construction of work. Failure to point out deviations may result in the Government requiring rejection and removal of such work at the Contractor's expense.

f. If changes are necessary to approved submittals, the Contractor shall make sure revisions and submission of the submittals are in accordance with the procedures above. No item of work requiring a submittal change shall be accomplished until the changed submittals are approved.

1.6.2 Sample Approval

Furnish, for the approval of the Contracting Officer, samples required by the specifications or by the Contracting Officer. Shipping charges shall be paid by the Contractor. Materials or equipment requiring sample approval shall not be delivered to the site or used in the work until approved in writing by the Contracting Officer.

Each sample shall have a label indicating:

a. Name of project

b. Name of Contractor

c. Material or equipment

d. Place of origin

e. Name of producer and brand

f. Specification section to which samples apply

g. Samples of furnished material shall have additional markings that will identify them under the finished schedules.

The Contractor shall submit to the Contracting Officer two samples of materials where samples are requested. Transmit to the Contracting Officer with each sample a letter, original and two (2) copies, containing the above information.

Approval of a sample shall be only for the characteristics or use named in such approval and shall not be construed to change or modify any contract requirements. Before submitting samples, the Contractor shall assure that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approve.

Materials and equipment incorporated in the work shall match the approved samples. If requested approved samples, including those which may be damaged in testing, will be returned to the Contractor, at his expense, upon completion of the contract. Samples not approved will also be returned to the Contractor at its expense, if so requested.

Failure of any materials to pass the specified tests will be sufficient cause for refusal t consider, under this contract, any further samples of the same brand or make of that material. The Government reserves the right to disapprove any material or equipment which previously has proved unsatisfactory in service.

Variations from contract requirements shall be specifically pointed out in transmittal letters. Failure to point out deviations may result in the Government requiring rejection and removal of such work at no additional cost to the Government.

Samples of various materials or equipment delivered on the site or in place may be taken by the Contracting Officer for testing. Samples failing to meet contract requirements will automatically void previous approvals. The Contractor shall replace such materials or equipment to meet contract requirements.

Approval of the Contractor's samples by the Contracting Officer shall not relieve the Contractor of his responsibilities under the contract.

## 1.7 PROGRESS SCHEDULE

### 1.7.1 Project Network Analysis

Submit the initial progress schedule within 21 calendar days of notice to proceed. Schedule shall be updated and resubmitted monthly beginning 7 calendar days after return of the approved initial schedule. Updating shall entail complete revision of the graphic and data displays incorporating changes in scheduled dates and performance periods. Redlined updates will only be acceptable for use as weekly status reviews.

The Contractor shall provide a single point of contact from his on-site organization as his Schedule Specialist. The Schedule Specialist shall have the responsibility of updating and coordinating the schedule with actual job conditions. The Schedule Specialist shall participate in weekly status meetings and present current information on the status of purchase orders, shop drawings, off-site fabrication, material deliveries, Subcontractor activities, anticipated needs for Government furnished equipment, and any problem which may impact the contract performance period.

Include the following in the project network analysis:

a. Graphic display shall be a standard network or arrow diagram capable of illustrating the required data. Drafting shall be computer generated on standard 24 by 36 inch (nominal size) drafting sheets or on small ( 11 by 17 inch minimum) sheets with separate overview and detail breakouts. Provide a project network analysis that is legible with a clear, consistent method for continuations and detail referencing. Clearly delineate the critical path on the display. Clearly indicate the contract milestone date on the project network analysis graphic display.

b. Data shall be presented as a separate printout on paper or, where feasible, may be printed on the same sheet as the graphic display. Data shall be organized in a logical coherent display capable of periodic updating.

c. Data shall include verbal activity descriptions with a numerical ordering system cross referenced to the graphic display. Additionally, costs (broken down into separate materials and labor costs), duration, early start date, early finish date, late start date, late finish date, and float shall be detailed for each activity. A running total of the percent completion based on completed activity costs versus total contract cost shall be indicated. A system for indicating scheduled dates versus actual activity dates and durations shall be provided.

d. Schedule shall be of sufficient detail to facilitate the Contractors' control of the job and to allow the Contracting Officer to readily follow progress for portions of the work.

## 1.8 STATUS REPORT ON MATERIAL ORDERS

Within 15 calendar days after notice to proceed, submit for approval by the Contracting Officer, an initial material status report on all material orders. This report will be updated and re-submitted every 30 calendar

days as the status on material orders changes.

Report shall list, in chronological order by need date, material orders necessary for completion of the contract. The following information will be required for each material order listed:

a. Material name, supplier, and invoice number.

b. Bar chart line item or CPM activity number affected by the order.

c. Delivery date needed to allow directly and indirectly related work to be completed within the contract performance period.

d. Current delivery date agreed on by supplier.

e. When item d exceeds item c, the effect that delayed delivery date will have on contract completion date.

f. When item d exceeds item c, a summary of efforts made by the Contractor to expedite the delayed delivery date to bring it in line with the needed delivery date, including efforts made to place the order (or subcontract) with other suppliers.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

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SECTION 01 45 00

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# SECTION 01 45 00

# QUALITY CONTROL

## PART 1 GENERAL

### 1.1 SUMMARY

The requirements of this Section apply to all work done under this contract. All work shall be accomplished in accordance with professionally recognized standards for building construction.

### 1.2 REFERENCES

The following publications form a part of these specifications, except where more stringent requirements are specified herein. The Contractor shall perform his work in the manner prescribed by these references. Refer to individual sections for the other appropriate references.

CALIFORNIA CODE OF REGULATIONS (CCR)

| | |
|---|---|
| CBC | (2007) California Building Code |
| CFC | (2007) California Fire Code |
| CPC | (2007) California Plumbing Code |
| CMC | (2007) California Mechanical Code |
| CEC | (2007) California Electrical Code |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 101 | (2006) Life Safety Code |

### 1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00, "Submittal Procedures":

SD-01, Preconstruction Submittals

Quality Control Plan Submitted within 30 days of the Notice to Proceed, and before any off-site or on-site fabrication or installation is begun. This plan shall detail means for complying with the provisions of Part 3, below.

SD-06, Test Reports

SD-07, Certificates

Certificates of Compliance

## 1.4 PRIMARY UNITS

This project has been designed completely in English units. The construction is to be in English units with dimensions as shown on the drawings. Materials and products are to be in English units; shop drawings must be submitted with English dimensions.

# PART 2 PRODUCTS

## 2.1 GENERAL

Materials and equipment to be provided under this contract shall be new, first-class, standard catalogue products of manufacturers regularly engaged in the manufacture of these products. Where two or more units of the same equipment class are furnished, the equipment shall be from the same manufacturer and shall be interchangeable.

## 2.2 TRANSPORTATION, HANDLING AND STORAGE

The manufacturer shall package material requiring protection in sturdy containers. Protection shall include vapor sealants for products sensitive to moisture or exposure. Material handling equipment shall be selected with the express purpose of minimal damage to existing work and new material.

The Contractor shall store supplies, material, and equipment so as to properly protect and preserve these items. If the Contracting Officer determines that property is not adequately protected by the Contractor, such property may be protected by the Government and the cost thereof may be charged to the Contractor.

# PART 3 EXECUTION

## 3.1 GENERAL

Quality Control, including inspections and tests required by these specifications during off-site fabrication shall be entirely the Contractor's responsibility. The Contractor shall submit the records of such tests and inspections to the Contracting Officer, at least 24 hours in advance of incorporation of the materials and/or equipment in the project.

The Contractor shall be responsible for all field inspection and tests required by these specifications, unless noted otherwise.

Government inspection shall in no way replace Contractor inspection or otherwise relieve the Contractor of his responsibility to furnish an acceptable end item. Government inspection shall not be used by the Contractor as evidence of effective inspection by himself or subcontractors.

## 3.2 CONTRACTOR QUALITY CONTROL PLAN

The Contractor shall maintain an approved quality control system. This shall include the following:

### 3.2.1 Quality Control Manager

A qualified individual whose responsibility is the day-to-day direction of the quality control system. This individual shall report directly to management, and shall have the necessary authority to control the quality

of the Contractor's work.

3.2.2 Purchase Control and Receiving Inspection

A system documenting procurement to drawings, specifications and approved submittals; certified testing by suppliers; and inspection by the Contractor to procurement records and contract requirements. A receiving inspection record shall accompany each delivery to the construction site.

3.2.3 Non-Conformance Control

A system documenting the handling, recording, identification, disposition, and reporting of non-conforming components and materials. A non-conformance report shall be submitted to the Government for each item found to be not in conformance with requirements--irrespective of the disposition of the non-conforming article.

3.2.4 Inspection and Test Plan

A plan, identifying tests required for each specific material, component, or item of work, and the records and reports to be made.

3.2.5 Inspection and Test Procedures

Procedures for each inspection/test, giving methods, records, reports, and identifying the organization conducting each.

3.2.6 Training and Certification

Procedures, records, and control for all inspectors and workers for which certification, licensing, or other formal qualification is required.

3.2.7 Calibration Program

A system for identifying calibration requirements, including methods for scheduling, conducting, and documenting required calibrations.

3.2.8 Qualification of Procedures

A means for identifying, conducting, testing, and recording the qualification of test and work procedures (including welding).

3.2.9 Drawing and Change Control

A means for insuring that all affected persons and organizations receive changes in a timely manner, and that only the latest version of drawings and specifications is used.

3.3 INSPECTIONS/TESTS

Inspections and tests conducted by the Contractor will be witnessed by the Government. At least 24 hours notice shall be given the Government, and at least 2 hours shall be allowed for Government inspection, prior to any test, on site.

The Government will inspect at the source, supplies or services not manufactured or performed within the Government's facility, including those at Subcontractor or Vendor facilities. The Contractor shall notify the Contracting Officer at least 48 hours in advance of commencement of

contract work at off-site facilities; and 48 hours in advance of each in-house inspection or test, so that the Government may witness it.

## 3.4 HOLD POINT OF INSPECTIONS/TESTS

The Contractor shall schedule required inspections/tests with the Contracting Officer at least 48 hours in advance, and shall provide opportunity, access, and samples required. Failure to notify the Contracting Officer shall require the work to be uncovered at no additional cost to the Government. Other required inspections and tests are listed in the various technical sections of this specification.

### 3.4.1 Inspections

The following are required hold points for inspections to be made by the Government. At least 2 hours shall be allowed for Government inspection at each of these hold points.

FORMWORK/REBAR. Performed after formwork/rebar are in place & ready, but before concrete is mixed.

ENCASEMENT OF DUCTS AND CAST-IN CONCRETE FOR GUARD POSTS. Performed after conduits, piping, utilities and equipment is in place, but before concrete is mixed.

CONCRETE SLAB OR UNDERFLOOR. Performed after conduits, piping, utilities & equipment is in place, but before concrete is mixed or subfloor is installed.

FRAME. Performed after framing, insulation, rough electrical, rough plumbing, vents and ductwork are in place, but before final sheathing.

LATH/GYPSUM BOARD/SHEATHING. Performed after lath, sheathing, and gypsum board (interior or exterior) are in place, but before taping, plastering or roofing.

UNDERGROUND UTILITIES. Performed after piping/conduit is in place & bedded, but before it is covered.

BOLTING/WELDING. Performed after bolts are tightened & welds are made, but before touch-up painting or covering of these.

SURFACE PREPARATION. Performed after preparation for painting has been made, but before setup for painting.

ELECTRICAL INSPECTION. Performed prior to releasing equipment to the Government for final energization (placing into service).

### 3.4.2 Tests

The following items are required hold points for tests to be made by the Contractor and witnessed by the Government. At least 2 hours notice shall be given the Government before each of these tests.

GROUNDING/MEGGERING. Required of all electrical power circuits designed for 480 volts or more, before connection to power source.

HOLIDAY TESTING. Required of all pipe wrap, before backfilling.

## 3.5 REPORTING

Any discrepancies noted by the Government will be forwarded to the Contractor on an "Inspection Report". The Contractor shall return these forms after noting the corrective action to be taken.

Reports on tests conducted by the Contractor shall be submitted to the Government within one working day of the test's completion, regardless of whether or not the article passed the test.

## 3.6 CORRECTIVE ACTION

The Contractor shall promptly correct work that does not conform to the requirements of the contract.

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# SECTION 01 50 00

# ENVIRONMENTAL COMPLIANCE AND POLLUTION PREVENTION

## PART 1 GENERAL

### 1.1 SUMMARY

The pollution prevention and environmental compliance provisions described in this section apply to all work conducted on Ames Research Center and Moffett Federal Airfield under this contract. The requirements in this section are in addition to those in the detailed sections.

### 1.2 REFERENCES

The Contractor is required to conform to the applicable local, state, and federal environmental regulations including references listed below. The Contractor shall use the latest issue of the referenced document in effect at the date of award of this contract, unless otherwise noted. The publications listed below form a part of this section. Items marked with an asterisk are available for review in the Ames Research Center Main Library, Building N202.

BAY AREA AIR QUALITY MANAGEMENT DISTRICT (BAAQMD)

| | |
|---|---|
| BAAQMD Regulation 2 | Permit Requirements |
| BAAQMD Regulation 11 | Hazardous Air Pollutants |
| BAAQMD Regulation 8, Rule 3 | VOC Content, Architectural Coating Limits |
| BAAQMD Regulation 8, Rule 48 | VOC Content,Industrial Maintenance Coating Limits |
| BAAQMD Regulation 8, Rule 49 | VOC Content, Aerosol Coatings |
| BAAQMD Regulation 8, Rule 51 | Volatile Organic Compounds, Adhesives and Sealants |

CODE OF FEDERAL REGULATIONS (CFR)

| | |
|---|---|
| 10 CFR Part 435 | Energy Conservation |
| 29 CFR 1910.120 | Emergency Response Awareness Level/Operators Training |
| 29 CFR 1910.1200 | Hazard Communication Training |
| 40 CFR 82 | Protection of Stratospheric Ozone |
| 40 CFR 112 | Oil Pollution Prevention |
| 40 CFR 1500 | National Environmental Policy Act |
| 40 CFR 260 | Proper Management of Hazardous Waste |

| | |
|---|---|
| 40 CFR 66265.16 | Generator Training |
| 40 CFR Part 247 | Comprehensive Procurement Guidelines |
| 49 CFR | Transportation |
| 50 CFR 402 | Endangered Species Act Regulations |

United States Codes (USC)

| | |
|---|---|
| 16 USC 703 | Migratory Bird Treaty |
| 42 USC 6901 | Resource Conservation and Recovery Act |
| 42 USC 8251 | Federal Energy Management |
| 42 USC 13101-13109 | Pollution Prevention Act of 1990 |

CALIFORNIA CODE OF REGULATIONS (CCR)

| | |
|---|---|
| CCR Title 22 Section 66260 | Hazardous Waste Management |
| CCR Title 22 Division 19 | State Fire Marshal |
| CCR Title 22 Division 19.1 | Office of Emergency Services |
| CCR Title 23 | Waters |
| CCR Title 24, Part 6 | California's Energy Efficiency Standard |

NASA POLICY AND PLANS

| | |
|---|---|
| * APG 8800.3 | Ames Environmental Handbook |
| * SWPP | Ames Storm Water Pollution Prevention Plan (SWPP) |
| * SPCC | Ames Spill Control and Countermeasures Plan (SPCC) |

SANTA CLARA COUNTY

| | |
|---|---|
| * NS-517.31 | Santa Clara County Hazardous Materials Storage Permit Ordinance |
| * Sunnyvale Municipal Code Title 12 | City of Sunnyvale Waters and Sewer Ordinance |
| * Palo Alto Chapter 16 | City of Palo Alto Sewer Use Ordinance |
| * CAG6 12001 General | Industrial Storm Water Discharge Application |

## 1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00, SUBMITTAL PROCEDURES.

SD-01 Preconstruction Submittals

Request for Incidental Sewer Discharge, at least 10 work days prior to commencement of discharge.

Hazardous Materials Inventories Statement (HMIS) and Material Safety Data Sheets (MSDS), at project commencement and as necessary to reflect changes in materials stored.

MSDSs of proposed coating and/or adhesive materials for approval, prior to bringing these materials on-site.

Hazardous Waste Disposal Subcontractors prior to project commencement.

Hazardous Waste Profiles, and supporting analytical data prior to disposal.

SD-07 Certificates

Training records, prior to project commencement and personnel changes.

Records of wastewater discharges, including dates and quantities of water discharged, weekly.

Spill Cleanup Records, as necessary.

Records of Solvent (paints and other organic coatings) usage, monthly.

## 1.4 GENERAL RESPONSIBILITIES

The Contractor shall conduct all project activities in a manner that protects surface/ground water and air quality, conserves resources, and minimizes the use of toxic chemicals and hazardous materials.

## 1.5 DEFINITIONS

Hazardous Material: Any material that poses a significant present or potential hazard to human health and safety or to the environment if released into the work place or the environment. Common examples are: oil, fuel, caustic and acid cleaners, mineral spirits, petroleum distillate based solvents, oil based paints, aerosol spray paints, coolants and antifreeze, solvents/cleaners containing chlorinated compounds.

Solid Waste: Includes rubbish, debris, garbage, and other discarded solid materials resulting from industrial, commercial, construction, and agricultural operations, and from community activities.

Reclamation: Means that a material is processed to recover a usable product, or that it is regenerated. Examples are recovery of lead from spent batteries and regeneration of spent solvents.

Hazardous Waste: A"Hazardous Waste" includes extremely hazardous waste, acutely hazardous waste, RCRA hazardous waste, non-RCRA hazardous waste and special waste. Examples include waste paint, solvents, PCB fluorescent light ballasts, oil etc.

Non-Sewerable: Wastewater that contains at least one contaminant above the

allowable discharge limit set by the Publicly Owned Treatment Works (POTWs) for discharges to the sanitary sewer.

## PART 2 MATERIALS

### 2.1 AIR QUALITY

All construction operations and materials used on the project shall be in compliance with the BAAQMD Rules and Regulations for Air Quality.

### 2.2 Adhesives and Sealants

All adhesive and sealant products shall conform to Bay Area Air Quality Management District BAAQMD Regulation 8, Rule 51 for Volatile Organic Compound (VOC) content - Adhesives and Sealants.

### 2.3 Architectural Coatings

All architectural coatings and paints shall conform with BAAQMD Regulation 8, Rule 3 for VOC Content - Architectural Coating Limits, and BAAQMD Regulation 8, Rule 48 for Industrial Maintenance Coating for VOC content limits.

### 2.4 Spray Paints

All spray paints shall conform to BAAQMD Regulation 8, Rule 29 for Aerospace Operations and BAAQMD Regulation 8, Rule 49 - Aerosol Coatings, for VOC content limits.

### 2.5 Chlorofluorocarbons (CFCs) and Other Class I Ozone Depleting Substances

Class I Ozone Depleting Substances (ODS) as defined and identified herein shall not be used in the performance of this contract, nor be provided as part of the equipment. This prohibition shall prevail over any other provision, specification, drawing, or referenced documents.

Class I ODS is defined in Section 602(a) of the Clean Air Act and includes the following chemicals:

| | |
|---|---|
| chlorofluorocarbon-11 (CFC-11) | chlorofluorocarbon-213 (CFC-213) |
| chlorofluorocarbon-12 (CFC-12) | chlorofluorocarbon-214 (CFC-214) |
| chlorofluorocarbon-13 (CFC-13) | chlorofluorocarbon-215 (CFC-215) |
| chlorofluorocarbon-111 (CFC-111) | chlorofluorocarbon-216 (CFC-216) |
| chlorofluorocarbon-112 (CFC-112) | chlorofluorocarbon-217 (CFC-217) |
| chlorofluorocarbon-113 (CFC-113) | halon-1211 |
| chlorofluorocarbon-114 (CFC-114) | halon-1301 |
| chlorofluorocarbon-115 (CFC-115) | halon-2402 |
| chlorofluorocarbon-211 (CFC-211) | carbon tetrachloride |
| chlorofluorocarbon-212 (CFC-212) | methyl chloroform (TCA) |

Service, maintain, renovate, and demolish ODS containing equipment in accordance with 40 CFR 82. Prevent a discharge of ODS to the atmosphere. ODS recovery equipment shall meet all applicable EPA requirements. Place recovered ODS in cylinders suitable for the type ODS (filled to no more than 80 percent capacity) and provide appropriate labeling. For new ODS added to existing equipment, provide the following data to Code QE, mail stop 218-1, within 48 hours of adding the new ODS: Type of ODS, quantity added, and date the work was performed.

The Contractor shall ensure that CFC refrigerants are recovered by a certified technician in accordance with the Final Rule of the Clean Air Act of 1990, Section 608 before the equipment is removed from Government property.

## 2.6 STORAGE AREAS

### 2.6.1 Hazardous Materials Storage

Hazardous materials storage shall be in accordance with Santa Clara County Hazardous Materials Storage Ordinance No. NS-517.31, and the General Storm Water Permit. All hazardous materials shall be handled in a manner which minimizes the potential for releases. All liquid hazardous materials shall be secondarily contained. Adequate spill response equipment shall be readily available.

Hazardous materials and hazardous wastes shall be labeled and handled properly. Secondary containment shall be of adequate size and compatible with materials stored. Storage areas shall be properly labeled and secured.

At the beginning of the project, an accurate inventory of hazardous materials and hazardous wastes that will be generated, including the estimated maximum quantity of each hazardous material to be brought on-site shall be provided to the Contracting Officer. Material Safety Data Sheets (MSDSs) for all hazardous materials on-site shall be maintained by the Contractor so they are immediately available to assist emergency response personnel in the event of a hazardous materials incident.

### 2.6.2 Staging Area

In accordance with the Clean Water Act and Ames Storm Water Pollution Prevention Plan (SWPP), to the maximum extent practicable, the staging area must be located away from storm drain inlets, gutters, drainage ditches, and creeks.

### 2.6.3 Refuse Bins

Refuse bins shall not be overloaded. Liquid materials shall not be placed in dumpsters or bins. Leaking dumpsters shall be replaced. Dumpsters and bins shall not be cleaned on-site.

### 2.6.4 Granular Material Storage

In accordance with the Clean Water Act and Ames SWPP, granular material shall be stored at least 10 feet from drainage ditches, catch basins, and curbs.

### 2.6.5 Site Inspections

In accordance with Santa Clara County Hazardous Materials Storage Permit Ordinance No. NS-517.31 Ames Industrial Storm Water Discharge, the project site and all hazardous materials storage areas shall be inspected weekly by the Government to ensure compliance. The Contractor shall implement corrective actions to the satisfaction of the Contracting Officer.

## 2.7 CHEMICAL USAGE AND HANDLING

Hazardous materials shall be used only as described on the Material Safety Data Sheets and product labels. The Contractor shall wear the protective

equipment recommended by the manufacturer. Containers of hazardous materials and hazardous wastes shall be kept closed except when in use. Containers of liquid hazardous materials shall be stored in secondary containment at the end of each work shift.

2.7.1 Reclamation of Equipment Containing Hazardous Material Residues

The Contractor shall disclose hazardous material content to the facility to which the equipment containing residues is shipped for reclamation (i.e. electrical wire wrapped with asbestos, electrical panels containing asbestos, etc.) The disclosure shall be documented on the Bill of Lading or by other written means.

2.7.2 Disposal of Non-Hazardous Waste Containing Hazardous Material Residue

The Contractor shall disclose hazardous material content to the facility to which the non-hazardous waste is shipped for disposal(i.e. steel coated with lead paint, etc.). The disclosure shall be documented on the Bill of Lading or by other written means. Supporting analytical data shall be included to document the material is not a hazardous waste.

2.7.3 Labeling

All containers, drums, vessels, tanks, and associated piping containing hazardous materials shall be labeled in accordance with California Code of Regulations Title 8 Section 5194 and the most recent edition of the Uniform Fire Code.

Label containers with: description of contents, percentages of components, hazardous properties, name of contact person or waste generator, phone number, and date. If material is a waste, container must have a completed hazardous waste accumulation label.

PART 3 EXECUTION

3.1 WASTEWATER APPLICATION

In accordance with the Clean Water Act, City of Sunnyvale Water and Sewers Ordinance, and the City of Palo Alto Sewer Use Ordinance, a specific written Incidental Sewer Discharge Permit is required before discharging wastewaters to the sanitary sewer system from project activities such as saw cutting coolant water, excavation dewatering, cleaning operations, decontamination water, water removed from underground vaults, etc.

The Contractor shall complete and submit a "Request for Incidental Sewer Discharge" application to the Contracting Officer at least 10 work days prior to the planned discharge. The request shall include the estimated discharge volume, discharge rate, source of the wastewater and the duration of discharge. The Government will sample the wastewater and obtain the discharge approval.

3.1.1 Wastewater Discharge/Disposal

With the exception of groundwater from excavations, all wastewater from Contractor operations shall be containerized by the Contractor until the Contractor is notified the discharge has been approved.

The Contractor shall record and submit all information specified in the discharge permit issued to the project including the dates of discharge,

quantity of water discharged, source of the wastewater, dates wastewater was sampled and analyzed (if required), and filtering method (if required).

With the exception of non-sewerable fluids drained from tanks, piping, and equipment, non-sewerable wastewater shall be treated, managed, and disposed of properly by the Contractor in accordance with the paragraph entitled "Contractor Disposal" of this section.

3.1.2 Groundwater Discharge

Groundwater from excavations shall be discharged in accordance with Section 02200 "Site Preparation and Earthwork".

3.1.3 Fluorescent Light Tubes and PCB Light Ballast

All fluorescent light tubes and PCB ballasts shall be removed by the Contractor, boxed and properly labeled.

Tubes and Ballasts shall be disposed of by the Government in accordance with the paragraph entitled "Government Disposal" of this section.

3.2 TRAINING REQUIREMENTS

All personnel shall be trained in the hazards and safe work practices for their tasks. Personnel using personal protective equipment (PPE) shall receive training on its proper use.

All personnel handling hazardous materials shall have received Hazard Communication Training per 29 CFR 1910.1200 and CCR Title 8 Section 5194 and Emergency Response Awareness Level training per 29 CFR 1910.120. Employee training documents shall be kept at the job site.

Personnel containing spills or conducting cleanup of small spills must have received First Responder Operators level training per 29 CFR 1910.120.

Personnel generating hazardous waste shall have received training on the proper management of hazardous waste per 40 CFR 66265.16 and CCR Title 22 Section 66265.16.

3.3 SITE OPERATIONS AND MAINTENANCE

Site Operations shall be conducted in accordance with the Clean Water Act and Ames Storm Water Pollution Prevention Plan.

3.3.1 Equipment Fueling and Maintenance

Equipment fluid changes and fueling shall be conducted over drip pans to prevent spilled materials from contacting the ground surface. All other maintenance and repairs of Contractor equipment is prohibited on-site.

3.3.2 Paint Clean Up

Painting operations shall be conducted in accordance with Ames Storm Water Pollution Prevention Plan and applicable BAAQMD requirements.

3.3.2.1 Water Based Paints

The Contractor shall paint out as much excess paint as possible from brushes, rollers, and equipment before starting clean up. Rinse brushes,

rollers, and other tools over a sink which drains to the sanitary sewer using water only. Tools and equipment shall not be cleaned into streets, gutters, storm drains, or creeks. Dispose of dry brushes, rollers, rags, and drop cloths as solid waste.

Disposal of containers with any liquids as a solid waste is prohibited. These materials must be used elsewhere or handled as a hazardous waste and disposed of in accordance with the paragraph entitled "Contractor Disposal" of this section.

3.3.2.2 Oil Based Paints

The Contractor shall paint out as much excess paint as possible from brushes, rollers, and equipment before starting clean up. Cleaning wash water must be containerized and disposed of as a hazardous waste. Reuse thinners and solvents by pouring back into original container through a filter.

Dispose of waste thinners, solvents, paint sludge, and wash water from cleaning of equipment and tools as hazardous waste. Containers with residual product, etc. shall be managed as a hazardous waste and disposed of in accordance with the paragraph entitled "Contractor Disposal" of this section.

3.3.3 Concrete/Asphalt Cutting and Core Drilling

The Contractor shall not allow slurry run off from saw cutting or core drilling to enter the storm or sanitary sewer collection systems. Catch basins and drains shall be protected. The Contractor shall sweep/shovel up slurry cutting waste from work areas before leaving an area or at the end of each work day, whichever is sooner. If saw cut slurry enters a drain, the Contractor shall remove the slurry and notify the Contracting Officer immediately.

3.3.4 Concrete Truck / Wash Out

Washing out concrete trucks or equipment into streets, gutters, storm drains, or creeks is prohibited. Trucks may be washed out on the ground surface in a location approved by the Contracting Officer. Concrete debris from wash out shall be broken up and disposed of by the Contractor at the end of the project.

3.3.5 Sweeping

Roadways and on-site paved areas impacted by the project shall be cleaned to the satisfaction of the Contracting Officer and swept at the end of each phase or at project completion. Hosing down paved areas and streets is prohibited.

3.3.6 Reclaimed Water

The Contractor shall use reclaimed water for dust control and other on-site operations unless an exception is granted by the Contracting Officer. Reclaimed water is available at no cost from a hydrant located on Moffett Federal Airfield, approximately south of the intersection of Macon Road and Fifth Avenue.

### 3.3.7 Storm Drain Management

Catch basins near the project shall be protected to prevent debris, pollutants, sediments and releases from entering the storm drain system. Catch basins shall be inspected and cleaned out to the satisfaction of the Contracting Officer at the end of each phase or at project completion.

The Contractor shall control soil erosion and storm runoff from the Contractor's site to the satisfaction of the Contracting Officer.

### 3.3.8 Broken / Ruptured Pipes

If the Contractor breaks a utility pipe, or observes any broken or leaking pipes, they shall immediately notify the Contracting Officer. The Contractor shall berm the area to prevent run off from releases of non-potable water from entering the storm drain. The Contractor shall immediately notify the Ames Environmental Office by dialing 911 from any NASA phone or (650) 604-6659 from an outside phone if the pipe contained any liquid except potable water.

### 3.3.9 Draining Tanks, Piping, and Equipment

Tanks, piping, and equipment shall be drained as required. Devices to properly contain the product shall be provided by the Contractor. Storm drains in the vicinity shall be covered during drainage operations.

The Government will conduct the sampling of drained fluid in order to determine disposal options unless there is sufficient knowledge to determine disposal options.

The Government will obtain the necessary sanitary sewer discharge permit(s) if the discharge is sewerable. Non-sewerable water that is not a hazardous waste, shall be treated to a level to allow discharge to the sanitary sewer or managed and disposed of properly. Hazardous waste shall be disposed of properly -- not treated on-site.

Disposal of drained fluid and all associated costs shall be by the Contractor in accordance with the paragraph entitled "Contractor Disposal" of this section.

### 3.3.10 Contaminated Soil Management

The Contractor shall notify the Contracting Officer immediately if soil appears discolored or has an odor. The Contractor shall place suspect soil on plastic sheeting and cover with a plastic tarpaulin. The suspect soil will be tested by the Government for contamination.

Contaminated soil shall be disposed of by the Government.

### 3.3.11 Paving Operations

Catch basins and manholes shall be protected when paving or applying seal coat, tack coat, slurry seal, or fog seal. Sweeping or washing down excess sand (from applying sand seals or covering excess oil) into gutters, storm drains, or drainage swales is prohibited. Excess materials shall either be collected and returned to the stockpile or disposed of properly.

Paving operations shall not obscure existing utility boxes, ground water monitoring wells, manholes, valve boxes or similar features.

## 3.4 ELECTRICAL PCB SPILL CLEAN UP

Refer to the Electrical Specifications.

## 3.5 SPILL PREVENTION, CONTROL, AND REPORTING

In accordance with Ames Spill Prevention Control and Countermeasures Plan and 40 CFR 112, spill clean up materials (such as rags, absorbent booms/pads), and tools (such as shovels and brooms) shall be maintained at the project site and be readily accessible. All releases of hazardous materials to the environment shall be contained and measures implemented to prevent leaks and spills from entering storm drains. Spills of hazardous materials in excess of to unpaved surfaces, storm or sewer drains shall immediately be reported to the Ames Environmental Office.

Dial 911 from any NASA phone or (650) 604-5555 from an outside phone to request assistance if the spill cannot be cleaned up safely by the Contractor's trained personnel.

## 3.6 BURROWING OWL HABITAT

The Contractor shall conduct all activities in a manner which does not negatively impact fauna or flora, in accordance with 40 CFR 1500, 50 CFR 402, and the Ames Environmental Handbook APG 8800.3.

The Contractor shall notify the Government immediately if burrowing owls are found during construction. Burrows found after the nesting season has begun will not be relocated. Construction shall cease until a qualified Natural Resource Specialist has inspected the burrows to ensure the young have fledged.

## 3.7 LEAD ABATEMENT

Refer to Section 02 09 00 LEAD PAINT ABATEMENT.

## 3.8 ASBESTOS ABATEMENT

Refer to Section 02 08 00 ASBESTOS ABATEMENT.

## 3.9 GOVERNMENT DISPOSAL

### 3.9.1 Hazardous Waste Manifest

NASA Ames Research Center shall be designated as the generator on the manifest and only approved Ames Environmental Office personnel shall sign the Uniform Hazardous Waste Manifests. Contractors shall not sign hazardous waste manifests.

NASA Ames Research Center Environmental Office shall be designated as the emergency contact.

## 3.10 CONTRACTOR DISPOSAL

Hazardous wastes generated by the Contractor shall be properly handled, shipped, and disposed of as required by federal, state, and local regulations. No hazardous materials shall remain at the work site upon completion of the project unless specified otherwise. The Government shall sample waste streams for purposes of waste characterization. Waste

Profiles shall be submitted to the Contracting Officer. Hazardous wastes shall be disposed of at a permitted Treatment, Storage, and Disposal Facility (TSDF) authorized to accept the specific waste to be shipped. Use of deep well injection as a treatment or disposal method is prohibited.

### 3.10.1 Hazardous Waste Manifest

NASA Ames Research Center shall be designated as the generator on the manifest and only approved Ames Environmental Office personnel shall sign the Uniform Hazardous Waste Manifests. Contractors shall not sign hazardous waste manifests.

NASA Ames Research Center Environmental Office shall be designated as the emergency contact.

### 3.10.2 Disposal

The Contractor shall perform all disposal services in compliance with 49 CFR. The Contractor shall meet the removal and disposal time frames established by law.

The Contractor shall use only disposal facilities that have a valid permit to manage hazardous waste, and shall be responsible for determining that permit allows for the type of management and disposal intended for that waste. The Contractor shall be responsible for ensuring that any party handling hazardous waste, including subcontractors, transporters, and TSDF's are in compliance with all applicable federal, state, and local regulations.

### 3.10.3 Treatment, Storage, And Disposal Facility List

The Contractor shall provide a list of storage and disposal facilities (TSDF) which perform treatment, storage, or disposal services under this contract. Each facility shall have, as a minimum, EPA RCRA interim status or state approval as a treatment or disposal facility and be in good standing with the regulatory community. Recycling facilities shall meet applicable Federal, State, and local regulations. No facility other than those initially approved for use under this contract shall be used, without first obtaining the written approval of the Contracting Officer.

### 3.10.4 Hazardous Waste Transportation

Certified Waste Haulers shall be utilized. All Government directed waste shall be transported to the disposal facility or interim storage facility without delay, in accordance with Department of Transportation (DOT) manifest regulations. The Contractor shall notify the Government if ten (10) days or more have elapsed during shipment.

### 3.10.5 Containerized Hazardous Waste

Hazardous wastes and other materials, picked up by the Contractor from other facilities, may not be added to any container of Government hazardous waste.

### 3.10.6 Bulk Hazardous Waste

Bulk hazardous waste shipments must be weighed to confirm shipping weight.

-- End of Section --

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# SECTION 02 05 00

# ALTERATIONS, DEMOLITION, AND REMOVAL

## PART 1 GENERAL

### 1.1 SUMMARY

This section applies to all work involving alteration, demolition, and/or removal of existing buildings, materials, equipment or utilities.

### 1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00, SUBMITTAL PROCEDURES:

SD-01, Data

Survey data of areas to be demolished.

SD-18, Records

Record of existing conditions

SD-20, Work Plan

### 1.3 TEMPORARY PROTECTION

The Contractor's work shall not degrade the appearance or condition of buildings and facilities adjacent to the work. Contractor shall provide protection of persons and property throughout the progress of the work. The Contractor shall provide temporary coverings to protect existing, finished surfaces and equipment when work is being done in adjacent areas.

Dust and dirt rising during demolition operations shall be effectively controlled by water sprinkling or other approved method.

The Contractor shall provide, subject to NASA approval, temporary enclosures, partitions, and protective covers or barriers prior to starting work, to protect personnel and existing equipment, and components from damage by weather and construction operations; to protect from noise; to prevent unauthorized entry; and maintain security of the exposed area or facility.

## PART 2 PRODUCTS (Not Applicable)

## PART 3 EXECUTION

### 3.1 PRECAUTION AGAINST MOVEMENT

The Contractor shall provide shoring and bracing or other supports to prevent movement, settlement, or collapse of facilities adjacent to areas of alteration and removal that are to remain.

## 3.2 DEMOLITION

### 3.2.1 Below-Grade Construction

Voids resulting from demolition shall be completely filled as specified in Section 02200 "Earthwork", and graded.

## 3.3 REMOVAL & SALVAGE

Materials and equipment to be salvaged are designated on the drawings.

Salvageable materials and equipment shall be removed in a manner that will cause the least possible damage thereto. Contractor personnel shall handle, sort by type and size, store off the ground, and protect salvaged items that are to be reused in the work or are to be retained by the Government.

Identification tags indicating type, size, and quantity of materials shall be provided for items boxed or placed in containers.

### 3.3.1 Scrap Metal

Scrap metal shall be stockpiled in designated areas, according to type of metal.

Scrap metal shall become the Contractor's property and shall be removed from the site as it accumulates.

### 3.3.2 Electrical Wiring, Equipment, and Fixtures

Unless otherwise noted, electrical items shall be removed and disposed offsite except for the electromechanical relays, which shall be retained by the Government.

Circuits shall be disconnected at the point of attachment to their distribution system.

Wiring systems and components shall be salvaged. Loose items shall be boxed and tagged for identification.

Electrical devices: Switches, receptacles, switchgear, transformers, regulators, meters, instruments, plates, circuit breakers, panelboards, outlet boxes, and similar items shall be salvaged; boxed and tagged for identification according to type and size.

Conductors, including insulated wire and nonmetallic, sheathed, and flexible armored cable, shall be removed and salvaged.

Conduit, except where embedded in concrete or masonry, shall be salvaged.

## 3.4 DISPOSAL

Debris, rubbish, scrap, and other nonsalvageable materials resulting from removal operations shall be legally disposed of off Government property, and materials shall not be stored on the project site.

Discarded materials shall be recycled to the maximum extent practicable.

Burning of materials structures is prohibited on Government property.

Waste soil shall be legally disposed of off Government property.

3.5 ALTERATION

Where required to patch or extend existing construction, such alteration work shall match existing exposed surface materials in finish, color, texture and pattern. Cutting, patching, repairing and other alteration work shall be done by mechanics skilled in the particular trade or work required.

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# SECTION 02 08 00

# ASBESTOS ABATEMENT

## PART 1 GENERAL

### 1.1 SUMMARY

The performing Contractor shall furnish all labor, materials, services, and equipment necessary for the complete enclosure, encapsulation, removal, and approved disposal of asbestos located at the jobsite and asbestos-contaminated materials resulting from the work performed.

All work shall be performed per documents referenced herein, and with all applicable federal, state, and local regulations. Nothing specified herein shall be construed as waiving any legal requirements.

### 1.2 REFERENCES

The performing Contractor shall abide by the provisions and recommendations of:

CODE OF FEDERAL REGULATIONS (CFR)

U.S. DEPARTMENT OF LABOR, OCCUPATIONAL SAFETY & HEALTH ADMIN (OSHA)

| | |
|---|---|
| 29 CFR PART 1910 | General Industry Safety and Health Standards |

CODE OF FEDERAL REGULATIONS (CFR)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (CAL/OSHA)

CALIFORNIA HEALTH AND WELFARE AGENCY

| | |
|---|---|
| Title 26, Division 21.5 | Proposition 65 |

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

### 1.3 SUBMITTALS

Prior to start of work, the Contractor shall submit the following, per Section 01 33 00, SUBMITTAL PROCEDURES:

SD-04, Drawings

of work areas including clean room/change area, shower, equipment room, work area, emergency routing, and areas to be modified.

SD-06, Instructions

Manufacturer's Instructions for:

encapsulation products

adhesives
wetting agents

SD-18, Records

Documented proof that the employees have had the required training.

Documented proof that the on-site supervisor meets the criteria for a "competent person" of 29 CFR PART 1926.1101.

Statement by the performing Contractor of the name and location of the proposed disposal site.

Copy of notifications per paragraph entitled "Notices"

Copy of all applicable permits and licenses (per paragraph entitled "Permits & Licenses")

Copy of respirator program in compliance with 29 CFR PART 1910.134 and Title 8, Div 1, Ch 4, Subchapter 4.

Copy of medical certification of physical examination on all employees engaged in the operation clearly showing medical qualification for both asbestos-related work and wearing of a respirator.

Copies of Contractor-performed air monitoring tests shall be submitted within two working days of the sampling.

SD-20, Work Plan

Outlining containment and removal procedures, the number, location, and type of HEPA ventilating units, the quantity and location of on-site waste storage, the name and location of the approved disposal site, and the proposed air monitoring program.

Copy of initial exposure assessment, if required to support the work plan.

Copy of evaluation and certification of any alternative control methods proposed, including the license number(s) of the certifier.

SD-08, Records

Copies of Contractor-performed air monitoring tests shall be submitted within two working days of the sampling.

Upon completion of work, submit originals of strip chart record of "negative-air pressure" meter.

Upon completion, copy of all manifests for asbestos-containing waste.

## 1.4 NOTICES

The following written notifications shall be made by the Contractor at least 10 days prior to starting work.

California Occupational Safety and Health Administration

1900 S. Norfolk, Suite 215
San Mateo, CA 94403

Bay Area Air Quality Management District (BAAQMD)
939 Ellis Street
San Francisco, CA 94109

## 1.5 PERMITS AND LICENSES

The Contractor must possess current permits and licenses as required by applicable regulations, including the following:

INDUSTRIAL WASTE HAULER PERMIT, specifically for asbestos materials or LICENSED HAZARDOUS WASTE HAULER PERMIT (required for actual hauler)

CALIFORNIA ASBESTOS CONTRACTORS LICENSE, (if applicable)

CALIFORNIA GENERAL CONTRACTOR'S LICENSE or CALIFORNIA SPECIALTY CONTRACTOR'S LICENSE

### 1.5.1 CAUTION SIGNS AND LABELS

The Contractor shall provide and post adequate warning signs at designated entrances to the regulated area, as required by Cal/OSHA, Proposition 65 ( Title 26, Division 21.5), and the EPA.

The Contractor shall provide and post, in the clean room and the equipment room (if applicable), the decontamination and work procedures to be used by all workers and visitors.

Caution labels shall be provided affixed to all bags and containers and other products which are to be filled with asbestos waste material.

# PART 2 PRODUCTS

## 2.1 WORK CLOTHING

The performing Contractor shall provide for each person present at the jobsite (workers, supervisors, inspectors, and others) work clothing consisting of full body disposable coveralls, appropriate footwear, disposable head covers, protective gloves, and respirators. Other safety clothing shall be available as appropriate.

## 2.2 MISCELLANEOUS EQUIPMENT

Air purifying equipment shall be used when necessary and shall be a type such as the High Efficiency Particulate Air Filtrations Systems, Electronic Precipitators, or a system approved by OSHA.

All vacuum cleaners used shall be equipped with HEPA filters.

# PART 3 EXECUTION

## 3.1 REQUIREMENTS BY TYPE OF OPERATION

All operations shall be performed using the work practices and controls specified by 29 CFR PART 1926.1101(g) "Methods of Compliance". If alternative control methods are proposed, these must be submitted to and be approved by the Contracting Officer prior to beginning work.

All operations shall use the respiratory protection at least as stringent as specified by 29 CFR PART 1926.1101(h). In addition, all Class I removal and bagging operations shall be performed by employees wearing a powered air purifying respirator (PARR), as a minimum. Employees engaged in Class II removal and bagging operations, and those engaged in all waste-handling and clean up operations, shall wear half-mask respirators, as a minimum.

## 3.2 PREPARATION

If impermeable drop cloths are required, then prior to beginning work, all furniture and equipment shall be removed from the work area or completely enclosed by 4 mil polyethylene sheeting, securely taped in place with duct tape. Draping and taping of piping is also required.

If a negative-pressure enclosure (NPE) or critical barrier is required per 29 CFR PART 1926.1101(g), the Contractor shall thoroughly seal all openings and fixtures including heating and ventilating ducts, skylights, doors, windows, and lighting with polyethylene taped securely in place. Care must be taken in sealing off lighting fixtures to avoid burning or melting the plastic sheeting. The use of facility air handling systems shall be discontinued within the regulated area throughout the abatement operation. All electrical power in the area (except that entering by means of GFCI-protected circuits) shall be disconnected and tagged off.

## 3.3 WORK AREA ISOLATION

### 3.3.1 Regulated Area

The performing Contractor shall establish the work area as a regulated area. For those operations which require it, this shall be the negative pressure enclosure; for other operations, this shall be by means of suitable demarcation.

Outside work clothes, except respirators, shall be removed in the regulated area prior to departure from this area. No smoking, eating, or drinking shall take place in the regulated area. Work footwear shall remain inside the regulated area until completion of the job, unless thoroughly washed inside and out.

### 3.3.2 Negative Pressure Enclosure

Exits and emergency exits from the enclosure shall be clearly marked.

The enclosure shall be evacuated to maintain an average negative pressure of 0.003" of water within the enclosure. At no time shall the negative pressure fall below 0.02" of water. This shall be demonstrated by employment of an electronic negative pressure recorder, calibrated within the manufacturer's recommended limits, which will record the pressure difference continuously on chart paper. The paper shall be signed and dated by the supervisor daily. The recorder shall be continuously functioning throughout the abatement operation. The Government shall check the negative pressure with a calibrated magnehelic. If this shows a vacuum of less than 0.02" of water, work shall be stopped and corrective action taken.

## 3.4 DECONTAMINATION

Decontamination of personnel shall be performed in accordance with 29 CFR

PART 1926.1101(j).

Procedures shall be written and distributed for evacuation of injured workers. Aid for a seriously injured worker will not be delayed for reasons of decontamination. The procedure shall be submitted to the Contracting Officer for approval.

All containers shall be sealed, labeled, and cleaned on the outside prior to removing from the work area.

## 3.5 AIR MONITORING

The Contractor shall be fully responsible for personal air monitoring needed to demonstrate compliance with OSHA and Cal/OSHA regulations and standards of good practice in worker protection.

For Class I abatement jobs involving more than 26.25' or 10.76 $ft^2$ of material, the Contractor shall provide perimeter air monitoring as required by 29 CFR PART 1926.1101, g.(4)(ii)(B). The air sampling limit that will be imposed will be 0.01 fiber/cc (PCM) or 70 structures/mm2 (TEM), and isolation will be improved and maintained to achieve this level.

If, at any time, the air samples inside the work area exceed the limit allowed by the respirators being employed by the workers, the work will stop immediately and air cleaning and surface cleaning procedures will be employed. If the air levels exceed this limit in the work area three times, Type C respirators (air supplied) will be required of all workers entering the work area.

For Class I abatement jobs involving more than 26.25' or 10.76 $ft^2$ of material, the Government shall provide clearance air sampling as required by 29 CFR PART 1926.1101,g.(4)(ii)(B). Samples shall confirm decontamination of work area should be collected within 48 hours after completion of all cleaning work. The number of samples taken will be determined by the Contracting Officer.

## 3.6 REMOVAL

Removal of asbestos containing material shall be accomplished as specified by 29 CFR PART 1926.1101(g).

If pipes, valves, or structural members that are covered with ACM are to be removed as units, these units shall be wetted and double wrapped with polyethylene sheeting. The polyethylene sheeting shall be securely sealed with duct tape and labeled.

## 3.7 CLEANUP

Following removal work, but prior to removal of barriers, all asbestos-containing waste shall be properly packaged in double containers, labeled, and removed form the work area to the holding area or hazardous waste container. The entire area shall be wet-cleaned or HEPA vacuumed, and the Contracting Officer shall be notified that it is ready for inspection. Upon approval by the Contracting Officer of the cleaning, all structural and mechanical surfaces from which insulation has been removed shall be sprayed with a fine, lock-down spray of encapsulant. Any secondary barriers or protective coverings will be removed prior to clearance testing.

For full-scale, Class I abatement, and interior Class II ACM removal operations, when the encapsulant has dried, the Government shall conduct aggressive post-abatement air sampling. If the results are satisfactory (less than 70 structures/mm2), approval will be granted to remove the barriers and enclosures. All barriers and enclosures, and all cleaning materials shall be packaged and disposed as hazardous waste. After removal of the barriers, the surfaces covered by them shall be wet-cleaned or HEPA vacuumed.

## 3.8 DISPOSAL

All asbestos-containing waste, friable and non-friable, containing more than 1% asbestos, shall be considered as, and treated as hazardous waste.

All asbestos-containing materials, and all materials contaminated during operations, shall be sealed in double-containers. The inner container shall be a 6-mil polyethylene bag (or wrapping). The outer container may be an additional bag or wrapping or a sealed drum. The outer container must be cleaned and labeled (per 40 CFR PART 262, Title 26, Secs 22-66261 et seq, and other applicable regulations) before removal from the equipment room or work area.

Clean, sealed containers may be stored in a holding area adjacent to the work area until a sufficient volume has accumulated for disposal, but not for longer than 60 days. The holding area will be prominently marked, and waste containers will be covered with plastic sheeting and protected from damage.

All asbestos wastes will be carefully handled to prevent container rupture and release of asbestos fibers. Workers loading or unloading asbestos waste shall wear approved respirators.

The performing Contractor shall be fully responsible for the disposal of waste in an approved landfill in accordance with the rules and regulations of the California Department of Health Services, the Regional Water Quality Control Board, and any other applicable agency. Removal from the site shall be by a licensed hazardous waste hauler, and the manifest shall be signed by the Government. All asbestos materials and miscellaneous debris in sealed drums shall be transported to the designated disposal site per EPA 40 CFR PART 61, SUBPART M guidelines. Labels and all necessary signs shall be per EPA 40 CFR PART 61, SUBPART M, OSHA 29 CFR PART 1910.1001, "Asbestos".

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# SECTION 02 09 00

# LEAD PAINT ABATEMENT/DEMOLITION

## PART 1 GENERAL

### 1.1 SUMMARY

The performing Contractor shall furnish all labor, materials, services, and equipment necessary for the removal and approved disposal of lead-based paint and/or items covered with lead-based paint located at the jobsite and lead-contaminated materials resulting from the work performed.

This work includes manual demolition, saw-cutting, manual scraping, hand-tool cleaning, manual sanding, use of heat guns, caustic strippers, and power-tool cleaning with dust collection system. Abrasive blasting, water blasting, and power-tool cleaning without dust collection systems shall not be used on this project, unless otherwise specified. Torch-cutting, burning, and welding within 6 inches of a lead-based painted surface are prohibited.

All work shall be performed per documents referenced herein, and with all applicable federal, state, and local regulations Nothing specified herein shall be construed as waiving any legal requirements.

### 1.2 REFERENCES

The performing Contractor shall abide by the provisions and recommendations of:

BAY AREA AIR QUALITY MANAGEMENT DISTRICT (BAAQMD)

| | |
|---|---|
| Regulation 11, Rule 1 | Lead |

US DEPARTMENT OF LABOR, OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

| | |
|---|---|
| CFR 29 1910 | Safety and Health Standards for General Industry |
| CFR 29 PART 1926.62 | Safety and Health Standards for the Construction Industry-Lead |

US ENVIRONMENTAL PROTECTION AGENCY (EPA)

| | |
|---|---|
| CFR 40 PART 50.12 | National Primary and Secondary Ambient Air Quality Standards for Lead |

### 1.3 SUBMITTALS

Prior to start of work, Contractor shall submit the following per Section 01 33 00, SUBMITTAL PROCEDURES:

SD-04 Drawings

of work areas including change area, shower if any, equipment room,

work area, emergency routing, and areas to be modified.

SD-06 Instructions

Manufacturer's Instructions for any caustic strippers and neutralizers to be employed.

SD-08 Records

Documented proof that the employees have had required training

Copy of notification to EPA, Bay Area Air Quality Management District, and/or Cal/OSHA, if applicable.

Copy of all applicable permits and licenses.

Copy of respirator program in compliance with CFR 29 1910 and 8 CCR Section 5144.

SD-20 Work Plan

Written compliance program per CFR 29 PART 1926.62(e)(2), and an initial determination of exposure assessment per CFR 29 PART 1926.62(d).

The Contractor shall submit the following, per Section 01 33 00, SUBMITTAL PROCEDURES.

Copy of medical certification of physical examination on all employees engaged in the operation, clearly showing medical qualification for both lead-related work and wearing of a respirator, if applicable.

Copies of Contractor-performed personal air monitoring tests shall be submitted within two working days of the sampling.

Copy of Contractor-performed risk assessment, per CFR 29 PART 1926.62(d), to be approved by Contracting Officer before any reduction in controls.

## 1.4 QUALIFICATIONS AND TRAINING

The supervisor for the Contractor actually performing the work must be a "competent person", as defined by CFR 29 PART 1926.62(b).

Each worker must have received training per CFR 29 PART 1926.62(l), including the wearing and fitting of respirators.

# PART 2 PRODUCTS

## 2.1 WORK CLOTHING

The Contractor shall provide, for each person present at the jobsite (workers, supervisors, inspectors, and others), work clothing consisting of full body disposable coveralls, disposable head covers, boots or sneakers, protective gloves, and respirators. Other safety clothing shall be available as appropriate.

## 2.2 MISCELLANEOUS EQUIPMENT

Vacuum cleaners shall be a type such as the High Efficiency Particulate Air.

# PART 3 EXECUTION

## 3.1 REQUIREMENTS BY TYPE OF OPERATION

Use of caustic strippers shall be in strict accordance with the approved manufacturer's instructions, including all recommended precautions. Caustic strippers will not be allowed to be used in occupied buildings except after-hours. If used, ventilation will be provided by the Contractor to remove all fumes and odors prior to the start of the following work day. Use of strippers containing volatile organic compounds shall be in accordance with BAAQMD Regulation 11, Rule 1.

All other operations shall use the respiratory protection at least as stringent as specified by CFR 29 PART 1926.62(d)(2) "Protection of Employees during assessment of exposure," until and unless a risk assessment demonstrating a lower hazard is approved by the Contracting Officer.

## 3.2 WORK AREA ISOLATION

The Contractor shall establish the work area as a regulated area, with signage per CFR 29 PART 1926.62(m) and Proposition 65. In addition to isolation required by OSHA, the following procedures will be used.

### 3.2.1 Interior Work

The work area is defined as the room, corridor, or other space in which the work is being performed, from floor to ceiling, and between walls or other full-height partitions. In large spaces, the work area consists of that portion of the space which extends laterally from the limits of the work surface to a distance of five feet plus the height of the surface above the floor. The Contractor may reduce the size of the work area by installing dust-tight floor-ceiling temporary partitions to divide the work area from the remainder of the space. The work area specifically includes the dumpster or other container in which unwrapped debris is to be placed and the path to that container.

If the Government or unprotected contractor employees are to remain in the building during work covered by this section, all entrances and windows into the work area shall be sealed with one layer of 6-mil plastic, and two-stage airlock will be employed between the work area and occupied areas. Otherwise, doors into the work area shall be closed and locked or a primitive air-lock flap shall be used (with signs) to separate the work area from other building areas and from the outside. All HVAC ducts into the work area shall be sealed with one layer of 6-mil plastic.

Finished floors shall be covered with a double-layer of 6-mil plastic. The upper layer shall be vacuumed clean and removed at the end of each work day. Concrete floors or any subfloors will be vacuumed clean at the end of each workday. All furniture and equipment shall be removed from the area, or shall be covered with double-layer of 6-mil plastic. The upper layer shall be vacuumed clean and removed at the end of each work day.

Negative-pressure enclosures are not required.

### 3.2.2 Exterior Work

The work area is defined as the work surface and an area extending 20 feet

from that surface in all directions (but not including the building interior), also included is projection of that area down to the ground. The Contractor may reduce the size of the work area by installing dust-tight tarpaulins to divide the work area from the exterior. The work area specifically includes the dumpster or other container in which unwrapped debris is to be placed and the path to that container.

The work area shall be isolated from other exterior areas by suitable demarcation, including signage. If exterior work is to require less than one day, the demarcation may be by means of sawhorse barriers and caution tape. Otherwise, temporary 6-foot high cyclone fence shall be used.

If the Government or unprotected contractor employees are to remain in the building during work covered by this section, all entrances and operable windows into the work area shall be sealed with one layer of 6-mil plastic. Otherwise, doors into the work area shall be closed and locked (with signs) to separate the work area from the building. All HVAC inlets in the work area shall be sealed with one layer of 6-mil plastic. All mechanical and electrical equipment shall be moved or covered in plastic.

The ground and all landscaping shall be covered by one layer of 6 mil plastic, to and secured to the building wall. Ladders and scaffolding shall not be placed directly on the plastic, rather they shall be placed on boards or plywood on top of the plastic. Plastic shall be securely ballasted or anchored to prevent lifting by the wind.

No work shall be performed in winds exceed 20 mph, nor if rain is imminent. All plastic shall be HEPA vacuumed at the close of each shift and prior to shutting down for weather.

## 3.3 DECONTAMINATION

Protective clothing shall be provided by the Contractor in accordance with CFR 29 PART 1926.62(g).

Decontamination of personnel shall be performed in accordance with CFR 29 PART 1926.62(i).

The Contractor shall provide and post in the clean room, the decontamination and work procedures to be used by all workers and visitors.

Procedures shall be written and distributed for evacuation of injured workers. Aid for seriously injured worker will not be delayed for reasons of decontamination. The procedure shall be submitted to the Contracting Officer for approval.

The containers shall be sealed and cleaned on the outside prior to removing from the work area.

## 3.4 AIR MONITORING

The Contractor shall be fully responsible for personal air monitoring needed to demonstrate compliance with OSHA and CalOSHA regulations and standards of good practice in worker protection. The Government may conduct area air monitoring, at its sole discretion. The techniques employed shall be consistent with regulator requirements.

All air monitoring sites will be coordinated with the performing Contractor and selected by the Contracting Officer's representative. The air sampling

limit that will be imposed will be the BAAQMD "ambient" standard.

If any test shows the air samples inside the work area exceed the TWA allowed by the respirators being employed by the workers, the respiratory protection will be increased and additional controls will be instituted.

## 3.5 CLEANUP

Following removal work, but prior to removal of barriers, all waste containers shall be sealed and cleaned. The entire work area shall be HEPA vacuumed and the Contracting Officer shall be notified that it is ready for inspection. The Contracting Officer, or her representative, shall conduct a visual inspection to assure that the area is clean. If the results are satisfactory, approval will be granted to remove the barriers and enclosures. After removal of the barriers, the surfaces covered by them shall be wet-cleaned or HEPA vacuumed.

The Government may elect to perform wipe samples at its sole discretion. If the results are unsatisfactory (greater than 2mg/m2) for tables, desks and similar surfaces (greater than 8mg/m2) for floors and other surfaces) the Contractor must re-clean the entire area to pass this wipe test.

If the Contractor's operations contaminate surrounding soil, they shall be required to restore the site to pre-existing conditions.

## 3.6 DISPOSAL

All dust, chips, and abrasive and contaminated soil shall be contained, removed form the surroundings, and disposed of by the Contractor as hazardous waste, unless the Contractor provides testing and certification by an independent testing agency which demonstrates that it is not classified as hazardous. Workers loading or unloading hazardous waste shall wear NIOSH approved respirators.

Other debris is unlikely to be considered as hazardous, and may be disposed as construction debris, transported in a covered container. All plastic, suits, and other protective material must be HEPA vacuumed prior to disposal.

The Contractor shall be fully responsible for the disposal of waste in an approved landfill in accordance with the rules and regulations of the California Department of Toxic Substance Control, the regional water quality control board, and any other applicable agency. Removal of hazardous waste from the site shall be by a licensed hazardous waste hauler, and the manifest shall be signed by the Government. All hazardous debris shall be transported to the designated disposal site per EPA CFR 40 PART 50.12 SUBPART M guidelines.

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# SECTION 02 20 00

# SITE PREPARATION AND EARTHWORK

## PART 1 GENERAL

### 1.1 SUMMARY

This section covers all site preparation and earthwork, including excavation and backfill for structures and utilities and definitions of soils materials used under other sections of this specification. The actual installation of site utility lines/systems is covered in other sections.

### 1.2 REFERENCES

The following publications form a part of these specifications to the extent indicated by their references. The exclusion of a publication from this section will not relieve the Contractor from complying with the publication reference elsewhere.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM D 1557 | 1978 Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-In. (457-mm) Drop |
| ASTM D 2487 | 1985 Standard Test Method for Classification of Soils for Engineering Purposes |
| ASTM D 2922 | 1981 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth) |
| ASTM D 3017 | 1988 Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth) |
| ASTM D 75 | 1987 Standard Practice for Sampling Aggregates |

### 1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00, SUBMITTAL PROCEDURES:

SD-18, Records

Record of existing conditions

## 1.4 QUALITY CONTROL

### 1.4.1 Testing Service

Soil testing service will be provided by the Government, unless otherwise noted. The Contractor shall submit samples of all materials proposed for use in the project, including in-situ materials.

### 1.4.2 Testing requirements

| MATERIAL | REQUIREMENT | TEST METHOD | NUMBER OF TESTS |
|---|---|---|---|
| Soil materials | Sampling | ASTM D 75 | One per type & source & whenever |
| | Classification | ASTM D 2487 | there is any apparent change. |
| | Moisture-density relations | ASTM D 1557, Method D | |
| Fill & Backfill | Density | ASTM D 2922 (Nuclear Method) | Three per lift in-place or layer, at least |
| | Moisture content | ASTM D 3017 (Nuclear Method) | three per day. |
| Spoil | Petroleum | EPA Methods | One per 100 cy, at least one per site, whenever contamination is known or suspected. |

### 1.4.3 Evaluation of Test Results

Soil materials shall be considered satisfactory for use if they meet the classification requirements for a particular use and are free of organic matter, trash, frozen material, any stones greater than 3" in any dimension, and any other deleterious substances.

The results of soil-in-place tests shall be considered satisfactory if:

The average of the density tests equals or exceeds that specified,

No density test is less than 2% below the specified density, AND

All moisture content tests are within 2% of the optimum.

## 1.5 DEFINITIONS

Subgrade: the top surface of a backfill or fill or the uppermost surface of an excavation, graded to conform to the required subgrade elevation and compacted.

Topsoil: The top (6-8 inches average, deeper pockets, if found) layer of natural, friable, dark, sandy, loam surface soil.

Spoil: Soil material, below the level of topsoil, removed from excavations on the project site.

Clean Soil or Topsoil: Uncontaminated soil or topsoil which is free of clay clods, rock, and gravel larger than 3" in any dimension; which is free of debris, waste, frozen material, and other deleterious substances.

Uncontaminated Soil: Soil which is not "contaminated" with petroleum products or other substances, as defined by applicable local, state, and federal regulations.

Suitable Topsoil: Clean topsoil possessing the characteristics of representative soils at the site, and which support heavy growths of crops, grass, or other vegetation.

Satisfactory Soil: Clean soil, meeting the requirements in Paragraph 2.1, for the proposed use.

Degree of compaction: Expressed as a percentage of the maximum density obtained by the test procedure in ASTM D 1557, Methods B or D.

Unsatisfactory Soil: Soil which does not conform to the definition of satisfactory soil material.

## PART 2 PRODUCTS

### 2.1 SOIL MATERIALS

All soil materials shall be clean before use or re-use in the work.

Spoil shall be tested, per Paragraph 1.4, above. Spoil shall be considered a satisfactory fill/backfill material, unless otherwise determined by the Contracting Officer. If the Contracting Officer determines that spoil is unsatisfactory, the Contractor shall use borrow material, and the cost shall be borne by the Government.

| MATERIAL DESIGNATION | MAXIMUM PARTICLE SIZE | UNIFIED SOIL CLASSIFICATION |
|---|---|---|
| BORROW | 3" | SW, SW-SM, SW-SC, SM, SC, GW-GM, GW-GC, GM, GC |
| SUB-BASE | 1-1/2" | SW, SW-SM, SW-SC, GW, GW-GM, GW-GC |
| BASE | 1-1/2" | GW-GM, GW-GC |
| SAND, BEDDING MATERIAL | #4 | SP |
| GRAVEL, FILTER MATERIAL, | 1-1/2" | GP (less than 5 0002:0000assing #4) |
| DRAIN ROCK | | |
| CLAY, IMPERVIOUS FILL | #40 | CL, CM |

## 2.2 USE OF SOIL MATERIALS

Soil materials shall be used as specified below.

| AREA CLASSIFICATION | SOIL MATERIALS | PERCENT COMPACTION COHESIVE | PERCENT COMPACTION NON-COHESIVE |
|---|---|---|---|
| Fill & backfill, unless otherwise specified | Clean spoil or borrow | 90% | 90% |
| Within 24" below structures and pavements; below level of sub-base/base course | Clean spoil or borrow | 95% | 95% |
| Against face of structures, where drains are specified, to a distance equal to three drain diameters. | Filter material | N/A | 95% |
| In foundation subdrain trenches | Filter material | N/A | 95% |
| Against surfaces having applied waterproofing, for a distance of at least 6 inches. | Sand | N/A | 95% |
| The top 2" below building slabs and within 6" around un-cased utilities | Sand | N/A | 95% |
| Within 6" below structures and pavements | Subbase | 95% | 90% |
| The top 6" below structures and pavements | Base | N/A | 95% |
| Below subdrains | Impervious fill | 100% | N/A |

## 2.3 RECYCLED MATERIALS

The Contractor may use recycled materials (containing asphalt), however, unless the Contractor provides, by an independent testing agency, a moisture correction for use for in-place tests, a correction of zero will be used.

# PART 3 EXECUTION

## 3.1 GENERAL

Before earthwork is started, the location of underground utilities shall be carefully verified by hand methods. Utilities to be left in place shall be protected from damage.

Excavated soil shall be piled in an orderly manner, shaped to drain, and sufficiently distant from excavations to prevent overloading, slides, and cave-ins (24" minimum).

Trenches and excavations shall be protected to prevent surface water from flowing into them and prevent flooding of the site and surrounding area.

## 3.2 SURFACE PREPARATION

### 3.2.1 Clearing

Completely remove trees, stumps, roots, brush, and other vegetation in areas to be cleared except those indicated or directed to be left standing. Trees to be left standing shall be trimmed of dead branches 1-1/2 inches or larger in diameter and of live branches to the indicated height; neatly cut close to the bole of the tree or main branches. Paint cuts with tree-wound paint. Protect trees and vegetation to be left standing by the erection of barriers or other means as required.

### 3.2.2 Grubbing

Completely remove stumps, roots, and organic or other debris, to a depth of not less than 8 inches below the surface level of the original ground. Mechanical grubbing equipment shall not be used inside the drip lines of trees indicated to remain standing.

### 3.2.3 Stripping

Strip topsoil from the surface of those areas to receive fills, embankments, or excavation. Transport topsoil to, and stockpile in, designated storage areas. Remove excessive subsoil, clay lumps, brush, objectionable weeds, roots greater than 12" in length, and stones larger than 2" in any dimension.

### 3.2.4 Filling Depressions

Completely fill depressions resulting from grubbing operations with acceptable backfilling material, unless further excavation is required. Prior to filling, subgrade surfaces of depressions shall be free of standing water, frost, or frozen material. Unsatisfactory soil materials shall be removed.

## 3.3 EXCAVATION

### 3.3.1 Shoring and Bracing

Shore and brace sides of excavations over 5 feet in depth. Shore and brace excavations when sides are subject to vibrations from vehicular traffic, the operation of machinery, or any other source. Shore and brace all trenches over 2 feet in depth, which are to remain open for 7 days or more. Any trench which has been open 7 days shall be shored, regardless of how much longer that trench is to remain open.

For excavations over 12 feet in depth, shoring and bracing shall be designed by a California-licensed Civil Engineer, and design shall be submitted to the Contracting Officer for approval.

Wherever subsequent removal of sheet piling could permit the lateral movement of soil under adjacent structures, steel sheet piling or pressure-treated timber sheet piling shall be used and left permanently in place, cut off as required.

### 3.3.2 Dewatering

Groundwater in the area of work may be contaminated with petroleum products. The Contractor shall provide a sample of groundwater, for

analysis by the Government, at least 10 days prior to commencement of dewatering operations. Depending on the results of this analysis, the groundwater may be disposed of into the sanitary sewer, or into Government-provided decontamination equipment. In either case, the Contractor shall keep detailed records, by date, of the quantity of groundwater removed and shall provide a copy of these to the Government with each payment request.

Water shall not be permitted to accumulate in excavations. Provide a dewatering system as required; conveying water to approved collecting or discharge areas. Provide and maintain temporary drainage ditches and other diversions as necessary outside of excavation limits. Dewatering system and method of disposal must be approved by the Contracting Officer.

Continue dewatering until construction subject to water pressure has obtained full specified strength and backfill is completed.

Trench excavations for utilities shall not be used for temporary drainage ditches.

### 3.3.3 Excavation for Structures

Excavation for structures shall conform to the dimensions and elevations indicated within a tolerance of plus or minus 0.10 foot and shall extend a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services and other construction indicated, and for inspection.

In excavating for footings and foundations, care shall be taken not to disturb the bottom of the excavation.

For pile foundations, excavation shall stop at an elevation of from 6 to 12 inches above the bottom of the footing before piles are driven. After pile driving has been completed, loose and displaced material shall be removed and excavation to final grade shall be done, leaving a solid bed to receive concrete.

### 3.3.4 Utility Trench Excavation

Side slopes of the trenches shall be as nearly vertical as practicable. Grade bottoms of the trenches accurately, at an elevation to allow for specified bedding or filter material. Dig bell holes and depressions for joints after the trench bottom has been graded; bell holes shall be dug only of such length, depth, and width as required to make the joint. Except as specified for wet or otherwise unstable material, backfill overdepths with materials specified for backfilling the lower portion of trenches.

Unless otherwise shown, excavations for water, gas, and electrical distribution shall be of a depth to allow a minimum of 2 feet cover over the lines, and deeper, if necessary to clear existing utilities.

Sequence trenching for underground utilities to minimize the time a trench is open, if any area of trench is left open more than 7 days, the Contracting Officer will require the Contractor to desist from further trenching until all existing trenches are completely backfilled.

### 3.3.5 Removal of Unsatisfactory Soil Materials

Excavate unsatisfactory soil materials which extend below the required elevations, to the depth directed by the Contracting Officer.

### 3.3.6 Unauthorized Excavation

Unauthorized excavation is removal of materials beyond indicated subgrade elevations or side dimensions specified without specific direction and shall be replaced as specified at no additional cost to the Government.

Unauthorized excavation under foundations or retaining walls shall be filled by lowering the bottom elevation of the footing or base to the excavation bottom without altering the approved top elevation.

Elsewhere unauthorized excavations shall be backfilled and compacted as specified for authorized excavations of the same classification.

### 3.3.7 Removal of Existing Underground Utilities

Existing underground utilities indicated to be removed shall be demolished and completely removed from the excavation. Open ends of existing underground utilities shall be permanently closed with masonry bulkheads, threaded galvanized metal caps, plastic plugs, or other suitable, approved method. Wood plugs shall not be used.

## 3.4 FILLING, BACKFILLING, AND COMPACTION

### 3.4.1 Preparation for Backfill

Backfill excavations as promptly as the work permits but not until completion of the following:

Removal of concrete formwork, shoring, and bracing.

Completion of concrete waterproofing and subdrainage system.

Inspection, testing, and approval of underground utilities, sub-drains, and other construction

Removal of trash and debris.

### 3.4.2 Preparation for Fill

Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials prior to the placement of fills. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stripped, or broken up in such manner that fill material will bond with the existing material. Scarify, condition, and compact existing ground surface to the required depth (at least 6 inches), and percentage of maximum density.

### 3.4.3 Placement and Compaction

Place backfill and fill materials in layers not more than 8 inches in loose depth. Moisten or aerate as necessary to provide the optimum moisture content then compact to the specified density. Backfill or fill material shall not be placed on surfaces that are muddy, frozen, icy, or contain frost.

Backfill and fill materials adjacent to structures shall be brought up evenly around the structure. Within a horizontal distance from structures equal to the depth of backfill or fill and within 24" of uncased utilities; compact with power-driven hand tampers.

### 3.4.4 Use of Sand Slurry

If specified, or if desired by the Contractor, the Contracting Officer may approve use of sand slurry, in lieu of sand, around underground utilities; in areas which will not permit adequate compaction; and to fill undercuts of existing pavement, provided that the pavement is undamaged. The Contractor shall submit a mix design for the slurry, per Section 01 33 00, SUBMITTAL PROCEDURES. The mix will be a minimum of one part cement to ten parts sand (by weight), and have a maximum water/cement ratio of 1.7.

## 3.5 GRADING

Areas within the limits of grading, including adjacent transition areas, shall be uniformly graded. The finished surface shall be smooth within the specified tolerances, compacted, and with uniform levels or slopes.

Areas adjacent to the structure shall be hand-graded to drain away from the structure and to prevent ponding of water after rains.

The finished surface shall be not more than 0.10 foot above or below the indicated subgrade elevations; except below walks, where the limits are 0.0 foot above and 0.1 foot below.

The surface shall be smooth and even, free of voids, when tested with a 10-foot straightedge, the finished surface shall show no deviation in excess of 0.1 foot.

## 3.6 MAINTENANCE

Protect newly graded areas from traffic and erosion and maintain them free of trash and debris.

Where disturbed by subsequent construction operations or adverse weather, the surface shall be scarified, reshaped, and compacted as specified to the required density prior to further construction.

## 3.7 DISPOSAL OF EXCESS AND WASTE MATERIALS

Excess satisfactory soil materials shall be transported to designated areas on Government property, and spread as directed.

Other excess and waste materials shall be removed form Government property, and legally disposed of by the Contractor.

The Contractor shall be responsible for compliance with federal, state, and local laws and regulations pertaining to the control of environmental pollution in the disposal of waste materials. Permission to dispose of waste materials on private property shall be in writing, and a copy of such permit shall be filed with the Contracting Officer. Costs of all permits and fees for disposal of waste materials shall be paid by the Contractor.

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# CAST-IN-PLACE CONCRETE

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### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACI INTERNATIONAL (ACI)

| | |
|---|---|
| ACI/MCP-1 | (2008) Manual of Concrete Practice Part 1: ACI 104-71R-97 to 223-98 |
| ACI/MCP-2 | (2008) Manual of Concrete Practice Part 2 - ACI 224R-01 to ACI 313R-97 |
| ACI/MCP-3 | (2008) Manual of Concrete Practice Part 3 - ACI 315-99 to ACI 343R-95 |
| ACI/MCP-4 | (2008) Manual of Concrete Practice Part 4 - ACI 345R-05 to 355.2R-04 |

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO M 182 | (2005) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats |
| AASHTO M 322M/M 322 | (2007) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement |

AMERICAN HARDBOARD ASSOCIATION (AHA)

| | |
|---|---|
| AHA A135.4 | (2004) Basic Hardboard |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.4/D1.4M | (2005; Errata 2005) Structural Welding Code - Reinforcing Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 123/A 123M | (2008) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A 185/A 185M | (2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete |

| | |
|---|---|
| ASTM A 496/A 496M | (2007) Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement |
| ASTM A 497/A 497M | (2007) Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete |
| ASTM A 53/A 53M | (2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 615/A 615M | (2008b) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM A 706/A 706M | (2008a) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement |
| ASTM A 767/A 767M | (2005) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement |
| ASTM A 775/A 775M | (2007b) Standard Specification for Epoxy-Coated Steel Reinforcing Bars |
| ASTM A 780 | (2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A 82/A 82M | (2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement |
| ASTM A 934/A 934M | (2007) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars |
| ASTM A 996/A 996M | (2006a) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars or Concrete Reinforcement |
| ASTM C 1017/C 1017M | (2007) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete |
| ASTM C 1107/C 1107M | (2008) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) |
| ASTM C 1116/C 1116M | (2008) Standard Specification for Fiber-Reinforced Concrete |
| ASTM C 1240 | (2005) Standard Specification for Silica Fume Used in Cementitious Mixtures |
| ASTM C 1260 | (2007) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method) |
| ASTM C 143/C 143M | (2008) Standard Test Method for Slump of |

| | |
|---|---|
| | Hydraulic-Cement Concrete |
| ASTM C 150 | (2007) Standard Specification for Portland Cement |
| ASTM C 156 | (2005) Standard Test Method for Water Retention by Concrete Curing Materials |
| ASTM C 1567 | (2008) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method) |
| ASTM C 171 | (2007) Standard Specification for Sheet Materials for Curing Concrete |
| ASTM C 172 | (2008) Standard Practice for Sampling Freshly Mixed Concrete |
| ASTM C 173/C 173M | (2008) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method |
| ASTM C 192/C 192M | (2007) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory |
| ASTM C 231 | (2008c) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C 233 | (2007) Standard Test Method for Air-Entraining Admixtures for Concrete |
| ASTM C 260 | (2006) Standard Specification for Air-Entraining Admixtures for Concrete |
| ASTM C 295 | (2008) Petrographic Examination of Aggregates for Concrete |
| ASTM C 309 | (2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete |
| ASTM C 31/C 31M | (2008a) Standard Practice for Making and Curing Concrete Test Specimens in the Field |
| ASTM C 311 | (2007) Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete |
| ASTM C 33 | (2007) Standard Specification for Concrete Aggregates |
| ASTM C 330 | (2005) Standard Specification for Lightweight Aggregates for Structural Concrete |
| ASTM C 39/C 39M | (2005e1e2) Standard Test Method for |

| | |
|---|---|
| | Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C 42/C 42M | (2004) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete |
| ASTM C 494/C 494M | (2008a) Standard Specification for Chemical Admixtures for Concrete |
| ASTM C 567 | (2005a) Determining Density of Structural Lightweight Concrete |
| ASTM C 595 | (2008) Standard Specification for Blended Hydraulic Cements |
| ASTM C 618 | (2008a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete |
| ASTM C 881/C 881M | (2002) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete |
| ASTM C 920 | (2008) Standard Specification for Elastomeric Joint Sealants |
| ASTM C 932 | (2006) Standard Specification for Surface-Applied Bonding Compounds for Exterior Plastering |
| ASTM C 94/C 94M | (2007) Standard Specification for Ready-Mixed Concrete |
| ASTM C 989 | (2006) Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars |
| ASTM C 990 | (2008) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants |
| ASTM C 990M | (2008) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants (Metric) |
| ASTM D 1190 | (1997) Standard Specification for Concrete Joint Sealer, Hot-Applied Elastic Type |
| ASTM D 1557 | (2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3) |
| ASTM D 1751 | (2004; R 2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural |

| | |
|---|---|
| | Construction (Nonextruding and Resilient Bituminous Types) |
| ASTM D 1752 | (2004a; R 2008) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion |
| ASTM D 2103 | (2008) Standard Specification for Polyethylene Film and Sheeting |
| ASTM D 2628 | (1991; R 2005) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements |
| ASTM D 4397 | (2008) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications |
| ASTM D 5759 | (1995; R 2005) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses |
| ASTM D 7116 | (2005) Standard Specification for Joint Sealants, Hot Applied, Jet Fuel Resistant Types, for Portland Cement Concrete |
| ASTM E 1155 | (1996; R 2008) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers |
| ASTM E 329 | (2008) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction |
| ASTM E 648 | (2008a) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source |

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

| | |
|---|---|
| CRSI 10MSP | (2001; 27Ed) Manual of Standard Practice |

FOREST STEWARDSHIP COUNCIL (FSC)

| | |
|---|---|
| FSC STD 01 001 | (2000) Principles and Criteria for Forest Stewardship |

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

| | |
|---|---|
| NIST PS 1 | (2007) Construction and Industrial Plywood |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| COE CRD-C 572 | (1974) Specifications for Polyvinylchloride Waterstops |

U.S. DEPARTMENT OF COMMERCE (DOC)

| | |
|---|---|
| PS1 | (1995) Construction and Industrial Plywood |

(APA V995)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FS LLL-B-810 | (Rev B) Building Board, (Hardboard) Hard Pressed, Vegetable Fiber |
| FS MMM-A-001993 | (1978) Adhesive, Epoxy, Flexible, Filled (For Binding, Sealing, and Grouting) |
| FS SS-S-1614 | (Rev A; Am 1) Sealants, Joint,Jet-Fuel-Resistant, Hot-Applied, for Portland Cement and Tar Concrete Pavements |
| FS SS-S-200 | (Rev E; Am 2) Sealant, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement |
| FS UU-B-790 | (Rev A) Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellent and Fire Resistant) |

U.S. GREEN BUILDING COUNCIL (USGBC)

| | |
|---|---|
| LEED | (2002; R 2005) Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC) |

## 1.2 DEFINITIONS

a. "Cementitious material" as used herein must include all portland cement, pozzolan, fly ash, ground granulated blast-furnace slag, and silica fume.

b. "Exposed to public view" means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.

c. "Chemical admixtures" are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.

d. "Workability (or consistence)" is the ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, chemical admixtures, aggregate (shape and size distribution), cementitious content and age (level of hydration).

## 1.3 SUBMITTALS

SD-02 Shop Drawings

Fabrication Drawings for concrete formwork must be submitted by the Contractor in accordance with paragraph entitled, "Shop Drawings," of this section, to include the following:

Floor Forms

Reinforcing steel; G

Reproductions of contract drawings are unacceptable.

SD-03 Product Data

Materials for curing concrete
Joint sealants; (LEED)

Submit manufacturer's product data, indicating VOC content. Manufacturer's catalog data for the following items must include printed instructions for admixtures, bonding agents, epoxy-resin adhesive binders, waterstops, and liquid chemical floor hardeners.

Joint filler; (LEED)
Cement; (LEED)
Portland Cement
Ready-Mix Concrete
Water-Vapor Barrier Subgrade Cover
Bonding Materials
Floor Finish Materials
Concrete Curing Materials
Reinforcement; (LEED)
Reinforcement Materials
Liquid Chemical Floor Hardener
Wood Forms

SD-05 Design Data

Concrete mix design

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolans, ground slag, and admixtures; and applicable reference specifications. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which produce a range of strength encompassing those required for each class and type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Submit additional data regarding concrete aggregates if the source of aggregate changes. Submit copies of the fly ash, and pozzolan test results, in addition. The approval of fly ash, and pozzolan test results must be within 6 months of submittal date. Obtain acknowledgement of receipt prior to concrete placement.

Calculations

SD-06 Test Reports

Concrete mix design

Fly ash

Pozzolan

Ground granulated blast-furnace slag

Aggregates

Tolerance report

Compressive strength tests

Air Content

Slump

Air Entrainment

SD-07 Certificates

Curing concrete elements

Pumping concrete

Silica fume manufacturer's representative

Finishing plan

VOC Content for form release agents, curing compounds, and concrete penetrating sealers

Material Safety Data Sheets

Forest Stewardship Council (FSC) Certification

Batch Plant Certificate Record

SD-08 Manufacturer's Instructions

Fly ash

Ground granulated blast-furnace slag

Welding Procedures must be in accordance with AWS D1.4/D1.4M.

Submit mill certificates for Steel Bar according to the paragraph entitled, "Fabrication," of this section.

Provide certificates for concrete that are in accordance with the paragraph entitled, "Classification and Quality of Concrete," of this section. Provide certificates that contain project name and number, date, name of Contractor, name of concrete testing service, source of concrete aggregates, material manufacturer, brand name of manufactured materials, material name, values as specified for each material, and test results. Provide certificates for Welder Qualifications that are in accordance with the paragraph entitled, "Qualifications for Welding Work," of this section.

Welding Procedures

SD-11 Closeout Submittals

1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. ACI/MCP-2 for job site storage of materials. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed. Do not store concrete curing compounds or sealers with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions. Do not store concrete curing compounds or sealers in occupied spaces.

1.5.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

1.6 QUALITY ASSURANCE

1.6.1 Design Data

1.6.2 Drawings

1.6.2.1 Reinforcing Steel

ACI/MCP-4. Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars.

1.6.3 Control Submittals

1.6.3.1 Curing Concrete Elements

Submit proposed materials and methods for curing concrete elements.

1.6.3.2 Pumping Concrete

Submit proposed materials and methods for pumping concrete. Submittal must include mix designs, pumping equipment including type of pump and size and material for pipe, and maximum length and height concrete is to be pumped.

1.6.3.3 Silica Fume Manufacturer's Representative

Provide statement that the manufacturer's representative must be present at mix plant to ensure proper mix, including high range water reducer, and

batching methods during the first 3 days of concrete mix preparation and placement. After which the manufacturer's representative must designate a representative at the concrete producer's plant to ensure the concrete mix procedures meet the silica fume manufacturer's recommendations. Representative to attend and advise at finishing of sample slab.

1.6.3.4 Finishing Plan

Submit proposed material and procedures to be used in obtaining the finish for the floors. Include qualification of person to be used for obtaining floor tolerance measurement, description of measuring equipment to be used, and a sketch showing lines and locations the measuring equipment will follow.

1.6.3.5 Material Safety Data Sheets

Submit Material Safety Data Sheets (MSDS) for all materials that are regulated for hazardous health effects. Prominently post the MSDS at the construction site.

1.6.4 Test Reports

1.6.4.1 Concrete Mix Design

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix must be suitable for the job conditions. Include mill test and all other test for cement, silica fume, aggregates, and admixtures in the laboratory test reports. Provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Submit test reports along with the concrete mix design. Obtain approval before concrete placement.

1.6.4.2 Fly Ash and Pozzolan

Submit test results in accordance with ASTM C 618 for fly ash and pozzolan. Submit test results performed within 6 months of submittal date. Submit manufacturer's policy statement on fly ash use in concrete.

1.6.4.3 Ground Granulated Blast-Furnace Slag

Submit test results in accordance with ASTM C 989 for ground granulated blast-furnace slag. Submit test results performed within 6 months of submittal date. Submit manufacturer's policy statement on slag use in concrete.

1.6.4.4 Aggregates

ASTM C 1260 for potential alkali-silica reactions, ASTM C 295 for petrographic analysis.

1.6.5 Special Finisher Qualifications

For 35 percent or more fly ash content as a percentage of cementitious materials, finisher must have a minimum of 3 years' experience finishing high-volume fly ash concrete.

## 1.7 QUALIFICATIONS FOR CONCRETE TESTING SERVICE

Perform concrete testing by an approved laboratory and inspection service experienced in sampling and testing concrete. Testing agency must meet the requirements of ASTM E 329.

## 1.8 QUALIFICATIONS FOR WELDING WORK

Welding procedures must be in accordance with AWS D1.4/D1.4M.

Verify that Welder qualifications are in accordance with AWS D1.4/D1.4M or under an equivalent qualification test approved in advance. Welders are permitted to do only the type of welding for which each is specifically qualified.

## 1.9 CONCRETE SAMPLING AND TESTING

Testing by the Contractor must include sampling and testing concrete materials proposed for use in the work and testing the design mix for each class of concrete. Perform quality control testing during construction.

Sample and test concrete aggregate materials proposed for use in the work in accordance with ASTM C 33.

Sample and test portland cement in accordance with ASTM C 150.

Sample and test air-entraining admixtures in accordance with ASTM C 233.

Testing must be performed by a Grade I Testing Technician.

# PART 2 PRODUCTS

## 2.1 MATERIALS FOR FORMS

Provide wood, plywood, plastic, carton, or steel. Use plywood or steel forms where a smooth form finish is required.

### 2.1.1 Concrete Form Plywood (Standard Rough)

Provide plywood that conforms to NIST PS 1, B-B, concrete form, not less than 5/8-inch thick.

## 2.2 FORM TIES AND ACCESSORIES

The use of wire alone is prohibited. Provide form ties and accessories that do not reduce the effective cover of the reinforcement.

## 2.3 CONCRETE

### 2.3.1 Contractor-Furnished Mix Design

ACI/MCP-1, ACI/MCP-2, and ACI/MCP-3 except as otherwise specified. Indicate the compressive strength (f'c) of the concrete for each portion of the structure(s) and as specified below.

| f'c (Min. 28-Day Comp. Strength) | ASTM C 33 Maximum Nominal Aggregate | Range of Slump | Maximum Water-Cement Ratio | Air Entr. |
|---|---|---|---|---|

| Location | (psi) | (Size No.) | (inches) | (by weight) | (percent) |
|---|---|---|---|---|---|
| Concrete exposed to weather | 3000 | 57 | 4 | 0.50 | 6 |

Maximum slump shown above may be increased 1 inch for methods of consolidation other than vibration. Slump may be increased to 8 inches when superplasticizers are used. Provide air entrainment using air-entraining admixture. Provide air entrainment within plus or minus 1.5 percent of the value specified.

2.3.1.1 Mix Proportions for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified are the responsibility of the Contractor. Base mixture proportions on compressive strength as determined by test specimens fabricated in accordance with ASTM C 192/C 192M and tested in accordance with ASTM C 39/C 39M. Samples of all materials used in mixture proportioning studies must be representative of those proposed for use in the project and must be accompanied by the manufacturer's or producer's test report indicating compliance with these specifications. Base trial mixtures having proportions, consistencies, and air content suitable for the work on methodology described in ACI/MCP-1. In the trial mixture, use at least three different water-cement ratios for each type of mixture, which must produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratio required must be based on equivalent water-cement ratio calculations as determined by the conversion from the weight ratio of water to cement plus pozzolan, silica fume, and ground granulated blast-furnace slag by weight equivalency method. Design laboratory trial mixture for maximum permitted slump and air content. Each combination of material proposed for use must have separate trial mixture, except for accelerator or retarder use can be provided without separate trial mixture. Report the temperature of concrete in each trial batch. For each water-cement ratio, at least three test cylinders for each test age must be made and cured in accordance with ASTM C 192/C 192M and tested in accordance with ASTM C 39/C 39M for 7 and 28 days. From these results, plot a curve showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition, plot a curve showing the relationship between 7 and 28 day strengths.

2.3.1.2 Required Average Strength of Mix Design

The selected mixture must produce an average compressive strength exceeding the specified strength by the amount indicated in ACI/MCP-2. When a concrete production facility has a record of at least 15 consecutive tests, the standard deviation must be calculated and the required average compressive strength must be determined in accordance with ACI/MCP-2. When a concrete production facility does not have a suitable record of tests to establish a standard deviation, the required average strength must follow ACI/MCP-2 requirements.

2.3.2 Ready-Mix Concrete

Provide concrete that meets the requirements of ASTM C 94/C 94M.

Ready-mixed concrete manufacturer must provide duplicate delivery tickets

with each load of concrete delivered. Provide delivery tickets with the following information in addition to that required by ASTM C 94/C 94M:

Type and brand cement

Cement content in 95-pound bags per cubic yard of concrete

Maximum size of aggregate

Amount and brand name of admixtures

Total water content expressed by water/cement ratio

2.3.3 Concrete Curing Materials

2.3.3.1 Absorptive Cover

Provide burlap cloth cover for curing concrete made from jute or kenaf, weighing 10 ounces plus or minus 5 percent per square yard when clean and dry, conforming to ASTM C 171, Class 3; or cover may be cotton mats as approved.

2.3.3.2 Moisture-Retaining Cover

Provide waterproof paper cover for curing concrete conforming to ASTM C 171, regular or white, or polyethylene sheeting conforming to ASTM C 171, or polyethylene-coated burlap consisting of a laminate of burlap and a white opaque polyethylene film permanently bonded to the burlap; burlap must conform to ASTM C 171, Class 3, and polyethylene film must conform to ASTM C 171. When tested for water retention in accordance with ASTM C 156, weight of water lost 72 hours after application of moisture retaining covering material must not exceed 0.039 gram per square centimeter of the mortar specimen surface.

2.3.3.3 Membrane-Forming Curing Compound

Provide liquid type compound conforming to ASTM C 309, Type 1, clear, Type 1D with fugitive dye for interior work and Type 2, white, pigmented for exterior work.

2.4 MATERIALS

2.4.1 Cement

ASTM C 150, Type I or II or ASTM C 595. Provide blended cement that consists of a mixture of ASTM C 150, Type II, cement and one of the following materials: ASTM C 618 pozzolan or fly ash, ASTM C 989 ground granulated blast-furnace slag. For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch. Supplier must certify that no hazardous waste is used in the fuel mix or raw materials. For exposed concrete, use one manufacturer for each type of cement, ground slag, fly ash, and pozzolan.

2.4.1.1 Fly Ash and Pozzolan

ASTM C 618, Type N, F, or C, except that the maximum allowable loss on ignition must be 6 percent for Types N and F. Add with cement. Fly ash content must be a minimum of 25 percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete

mix below the minimum requirements of local building codes. Where the use of fly ash cannot meet the minimum level, provide the maximum amount of fly ash permittable that meets the code requirements for cement content. Report the chemical analysis of the fly ash in accordance with ASTM C 311. Evaluate and classify fly ash in accordance with ASTM D 5759.

High contents of supplementary cementitious materials can have some detrimental effects on the concrete properties, such as slowing excessively the strength gain rate, and delaying and increasing the difficulty of finishing. The recommended maximum content (by weight of the total cementitious material) for these materials are:

1. For GGBF slag: 50 percent

2. For fly ash or natural pozzolan: 40 percent (25 percent in cold climates)

3. For silica fume: 10 percent

2.4.1.2 Portland Cement

Provide cement that conforms to ASTM C 150, Type I, IA, II, or IIA. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

2.4.2 Water

Minimize the amount of water in the mix. The amount of water must not exceed 45 percent by weight of cementitious materials (cement + pozzolans), and in general, improve workability by adjusting the grading rather than by adding water. Water must be fresh, clean, and potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

2.4.3 Aggregates

ASTM C 33, except as modified herein. Furnish aggregates for exposed concrete surfaces from one source. Provide aggregates that do not contain any substance which may be deleteriously reactive with the alkalies in the cement.

2.4.4 Nonshrink Grout

ASTM C 1107/C 1107M.

2.4.5 Admixtures

ASTM C 494/C 494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E, water-reducing and accelerating admixture. Do not use calcium chloride admixtures.

2.4.5.1 Air-Entraining

ASTM C 260.

2.4.5.2 High Range Water Reducer (HRWR) (Superplasticizers)

ASTM C 494/C 494M, Type F.

2.4.5.3 Pozzolan

Provide fly ash or other pozzolans used as admixtures that conform to ASTM C 618.

2.4.6 Materials for Curing Concrete

Use water-based curing compounds, sealers, and coatings with low (maximum 160 grams/liter, less water and less exempt compounds) VOC content.

Consider the use of water based or vegetable or soy based curing agents in lieu of petroleum based products. Consider agents that are not toxic and emit low or no Volatile Organic Compounds (VOC). Consider the use of admixtures that offer high performance to increase durability of the finish product but also have low toxicity and are made from bio-based materials such as soy, and emit low levels of Volatile Organic Compounds (VOC).

2.4.6.1 Impervious Sheeting

ASTM C 171; waterproof paper, clear or white polyethylene sheeting, or polyethylene-coated burlap.

2.4.6.2 Pervious Sheeting

AASHTO M 182.

2.4.6.3 Liquid Membrane-Forming Compound

ASTM C 309, white-pigmented, Type 2, Class B.

2.4.7 Liquid Chemical Sealer-Hardener Compound

Provide magnesium fluorosilicate compound which when mixed with water seals and hardens the surface of the concrete. Do not use on exterior slabs exposed to freezing conditions. Provide compound that does not reduce the adhesion of resilient flooring, tile, paint, roofing, waterproofing, or other material applied to concrete.

2.4.8 Expansion/Contraction Joint Filler

ASTM D 1751, ASTM D 1752, cork or 100% post-consumer paper meeting ASTM D 1752 (subparagraphs 5.1 to 5.4). Material must be 1/2 inch thick, unless otherwise indicated.

2.4.8.1 Preformed Joint Filler Strips

Provide nonextruding and resilient bituminous type filler strips conforming to ASTM D 1751.

2.4.9 Joint Sealants

Use concrete penetrating sealers with a low (maximum 100 grams/liter, less water and less exempt compounds) VOC content.

2.4.9.1 Joint Sealant Compound

Provide hot-poured, elastic type compound conforming to ASTM D 1190.

2.4.10 Epoxy Bonding Compound

ASTM C 881/C 881M. Provide Type I for bonding hardened concrete to hardened concrete; Type II for bonding freshly mixed concrete to hardened concrete; and Type III as a binder in epoxy mortar or concrete, or for use in bonding skid-resistant materials to hardened concrete. Provide Grade 1 or 2 for horizontal surfaces and Grade 3 for vertical surfaces. Provide Class A if placement temperature is below 40 degrees F; Class B if placement temperature is between 40 and 60 degrees F; or Class C if placement temperature is above 60 degrees F.

2.5 REINFORCEMENT

2.5.1 Reinforcing Bars

ACI/MCP-2 unless otherwise specified. Use deformed steel. ASTM A 615/A 615M Grade 60.

2.5.1.1 Weldable Reinforcing Bars

Provide weldable reinforcing bars that conform to ASTM A 706/A 706M and ASTM A 615/A 615M and Supplement S1, Grade 60, except that the maximum carbon content must be 0.55 percent.

2.5.2 Wire

ASTM A 82/A 82M or ASTM A 496/A 496M.

2.5.3 Reinforcing Bar Supports

Provide bar ties and supports of coated or non corrodible material.

2.5.4 Supports for Reinforcement

Supports include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening reinforcing bars and wire fabric in place.

Provide wire bar type supports conforming to ACI/MCP-3 and CRSI 10MSP.

Legs of supports in contact with formwork must be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

2.6 BONDING MATERIALS

2.6.1 Concrete Bonding Agent

Provide aqueous-phase, film-forming, nonoxidizing, freeze and thaw-resistant compound agent suitable for brush or spray application conforming to ASTM C 932.

2.6.2 Epoxy-Resin Adhesive Binder

Provide two-component, epoxy-polysulfide polymer type binder with an amine-type curing-agent conforming to FS MMM-A-001993, Type I or ASTM C 881/C 881M.

## 2.7 CLASSIFICATION AND QUALITY OF CONCRETE

### 2.7.1 Concrete Classes and Usage

Provide concrete classes, compressive strength, requirements for air entrainment, and usage as follows:

| CONCRETE CLASS | MIN. 28-DAY COMPRESSIVE STRENGTH POUNDS PER SQ. IN. | REQUIREMENT FOR AIR ENTRAINMENT | USAGE |
|---|---|---|---|
| 3A | 3,000 | Air-entrained | For foundation concrete work exposed to freezing and thawing or subjected to hydraulic pressure, such as foundation walls, grade beams, pits, tunnels. For exterior concrete slabs, such as steps, platforms, walks |

### 2.7.2 Limits for Concrete Proportions

Provide limits for maximum water/cement ratio and minimum cement content for each concrete class as follows:

| CONCRETE CLASS | MAX. WATER/CEMENT RATIO BY WEIGHT | MIN. CEMENT FOR 3- TO 4-INCH SLUMP, (NO. OF 94-POUND SACKS) PER CU. YD. |
|---|---|---|
| 3A | 0.50 | 5.25 |

* Weight of water to weight of cement in pounds in one cubic yard of concrete

### 2.7.3 Maximum Size of Aggregate

Size of aggregate, designated by the sieve size on which maximum amount of retained coarse aggregate is 5 to 10 percent by weight, must be as follows:

| MAXIMUM SIZE OF AGGREGATE | ASTM C 33 SIZE NUMBER | TYPE OF CONSTRUCTION |
|---|---|---|
| 1-1/2 inches | 467 | Monolithic slabs on ground, concrete fill, and other flatwork having a depth of not less than 5 inches and a clear distance between reinforcing bars of not less than 2 inches |

Maximum size of aggregate may be that required for most critical type of construction using that concrete class.

Specify gradation of aggregates for separate floor topping.

2.7.4 Slump

Provide slump for concrete at time and in location of placement as follows:

| TYPE OF CONSTRUCTION | SLUMP |
|---|---|
| Footings, unreinforced walls | Not less than 1 inch nor more than 3 inches |

2.7.5 Total Air Content

Air content of exposed concrete and interior concrete must be in accordance with ASTM C 260 and/or as follows:

| LIMITS CONCRETE EXPOSURE | REQUIREMENT FOR AIR ENTRAINMENT | MAXIMUM SIZE OF AGGREGATE | TOTAL AIR CONTENT BY VOLUME |
|---|---|---|---|
| Exposed to freezing and thawing or subjected to hydraulic pressure | Air-entrained | 1-1/2 or 2 inches | 4 to 6 percent |
| | | 3/4 inch | 5 to 7 percent |

Provide concrete exposed to freezing and thawing or subjected to hydraulic pressure that is air-entrained by addition of approved air-entraining admixture to concrete mix.

PART 3 EXECUTION

3.1 EXAMINATION

Do not begin installation until substrates have been properly constructed; verify that substrates are plumb and true.

If substrate preparation is the responsibility of another installer, notify Architect/Engineer of unsatisfactory preparation before processing.

Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Architect/Engineer and wait for instructions before beginning installation.

3.2 PREPARATION

Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.

3.2.1 General

Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing.

Remove standing water without washing over freshly deposited concrete. Divert flow of water through side drains provided for such purpose.

3.2.2 Subgrade Under Foundations and Footings

When subgrade material is semiporous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time concrete is deposited. When subgrade material is porous, seal subgrade surface by covering surface with specified water barrier subgrade cover; this may also be used over semiporous, dry subgrade material instead of water sprinkling.

3.2.3 Subgrade Under Slabs on Ground

Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.

Previously constructed subgrade or fill must be cleaned of foreign materials and inspected by the Contractor for adequate compaction and surface tolerances as specified.

Actual density of top 12 inches of subgrade soil material-in-place must not be less than the following percentages of maximum density of same soil material compacted at optimum moisture content in accordance with ASTM D 1557.

| SOIL MATERIAL | PERCENT MAXIMUM DENSITY |
|---|---|
| Drainage fill | 100 |
| Cohesionless soil material | 100 |
| Cohesive soil material | 95 |

Finish surface of drainage fill under interior slabs on ground must not show deviation in excess of 1/4 inch when tested with a 10-foot straightedge parallel with and at right angles to building lines.

Finished surface of subgrade or fill under exterior slabs on ground must not be more than 0.02-foot above or 0.10-foot below elevation indicated.

Cover drainage fill surface under interior slabs on ground with specified water-vapor barrier subgrade cover immediately prior to placing reinforcement. Install subgrade cover to avoid puncture or tear. Patch punctures or tears over 12 inches with separate sheets lapped not less than 6 inches. Seal all punctures or tears less than 12 inches with pressure-sensitive vapor barrier tape not less than 2-inches wide. Seal lapped joints with vapor barrier adhesive or pressure-sensitive vapor barrier tape not less than 2-inches wide. Lay subgrade cover sheets with not less than a 6-inch lap at edges and ends and in direction in which concrete is to be placed.

Prepare subgrade or fill surface under exterior slabs on ground as specified for subgrade under foundations and footings.

3.2.4 Formwork

Complete and approve formwork. Remove debris and foreign material from interior of forms before start of concrete placing.

3.2.5 Edge Forms and Screed Strips for Slabs

Set edge forms or bulkheads and intermediate screed strips for slabs to

obtain indicated elevations and contours in finished slab surface and must be strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment. Align concrete surface to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

### 3.2.6 Reinforcement and Other Embedded Items

Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.

## 3.3 FORMS

ACI/MCP-2. Provide forms, shoring, and scaffolding for concrete placement. Set forms mortar-tight and true to line and grade. Chamfer above grade exposed joints, edges, and external corners of concrete 0.75 inch unless otherwise indicated. Provide formwork with clean-out openings to permit inspection and removal of debris. Forms submerged in water must be watertight.

### 3.3.1 General

Construct forms to conform, within the tolerances specified, to shapes dimensions, lines, elevations, and positions of cast-in-place concrete members as indicated. Forms must be supported, braced, and maintained sufficiently rigid to prevent deformation under load.

### 3.3.2 Design and Construction of Formwork

Provide formwork design and construction that conforms to and ACI/MCP-2, Chapter 4.

Provide forms that are tight to prevent leakage of cement paste during concrete placing.

Support form facing materials by structural members spaced close to prevent deflection of form facing material. Fit forms placed in successive units for continuous surfaces to accurate alignment to ensure a smooth completed surface within the tolerances specified. Where necessary to maintain the tolerances specified, such as long spans where immediate supports are not possible, camber formwork for anticipated deflections in formwork due to weight and pressure of fresh concrete and to construction loads.

Chamfer exposed joints, edges, and external corners a minimum of 3/4 inch by moldings placed in corners of column, beam, and wall forms.

Provide shores and struts with a positive means of adjustment capable of taking up formwork settlement during concrete placing operations. Obtain adjustment with wedges or jacks or a combination thereof. When adequate foundations for shores and struts cannot be secured, provide trussed supports.

Provide temporary openings in wall forms, column forms, and at other points where necessary to permit inspection and to facilitate cleaning.

Provide forms that are readily removable without impact, shock, or damage to concrete.

3.3.3 Coating

Before concrete placement, coat the contact surfaces of forms with a nonstaining mineral oil, nonstaining form coating compound, or two coats of nitrocellulose lacquer. Do not use mineral oil on forms for surfaces to which adhesive, paint, or other finish material is to be applied.

3.3.4 Reshoring

Reshore concrete elements where forms are removed prior to the specified time period. Do not permit elements to deflect or accept loads during form stripping or reshoring. Forms on columns, walls, or other load-bearing members may be stripped after 2 days if loads are not applied to the members. After forms are removed, reshore slabs and beams over 10 feet in span and cantilevers over 4 feet for the remainder of the specified time period in accordance with paragraph entitled "Removal of Forms." Perform reshoring operations to prevent subjecting concrete members to overloads, eccentric loading, or reverse bending. Provide reshoring elements with the same load-carrying capabilities as original shoring and spaced similar to original shoring. Firmly secure and brace reshoring elements to provide solid bearing and support.

3.3.5 Reuse

Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised.

3.3.6 Forms for Standard Rough Form Finish

Give rough form finish concrete formed surfaces that are to be concealed by other construction, unless otherwise specified.

Form facing material for standard rough form finish must be the specified concrete form plywood or other approved form facing material that produces concrete surfaces equivalent in smoothness and appearance to that produced by new concrete form plywood panels.

For concrete surfaces exposed only to the ground, undressed, square-edge, 1-inch nominal thickness lumber may be used. Provide horizontal joints that are level and vertical joints that are plumb.

3.3.7 Forms for Standard Smooth Form Finish

Give smooth form finish concrete formed surfaces that are to be exposed to view or that are to be covered with coating material applied directly to concrete or with covering material bonded to concrete, such as waterproofing, dampproofing, painting, or other similar coating system.

Form facing material for standard smooth finish must be the specified overlaid concrete form plywood or other approved form facing material that is nonreactive with concrete and that produce concrete surfaces equivalent in smoothness and appearance to that produced by new overlaid concrete form plywood panels.

Maximum deflection of form facing material between supports and maximum deflection of form supports such as studs and wales must not exceed 0.0025 times the span.

Provide arrangement of form facing sheets that are orderly and symmetrical,

and sheets that are in sizes as large as practical.

Arrange panels to make a symmetrical pattern of joints. Horizontal and vertical joints must be solidly backed and butted tight to prevent leakage and fins.

3.3.8 Form Ties

Provide ties that are factory fabricated metal, adjustable in length, removable or snap-off type that do allow form deflection or do not spall concrete upon removal. Portion of form ties remaining within concrete after removal of exterior parts must be at least 1-1/2 inches back from concrete surface. Provide form ties that are free of devices that leave a hole larger than 7/8 inch or less than 1/2 inch in diameter in concrete surface. Form ties fabricated at the project site or wire ties of any type are not acceptable.

3.3.9 Tolerances for Form Construction

Construct formwork to ensure that after removal of forms and prior to patching and finishing of formed surfaces, provide concrete surfaces in accordance with tolerances specified in ACI/MCP-1 and ACI/MCP-2.

3.3.10 Removal of Forms and Supports

After placing concrete, forms must remain in place for the time periods specified in ACI/MCP-4. Do not remove forms and shores (except those used for slabs on grade and slip forms) until the client determines that the concrete has gained sufficient strength to support its weight and superimposed loads. Base such determination on compliance with one of the following:

a. The plans and specifications stipulate conditions for removal of forms and shores, and such conditions have been followed, or

b. The concrete has been properly tested with an appropriate ASTM standard test method designed to indicate the concrete compressive strength, and the test results indicate that the concrete has gained sufficient strength to support its weight and superimposed loads.

Prevent concrete damage during form removal. Clean all forms immediately after removal.

3.3.10.1 Special Requirements for Reduced Time Period

Forms may be removed earlier than specified if ASTM C 39/C 39M test results of field-cured samples from a representative portion of the structure indicate that the concrete has reached a minimum of 85 percent of the design strength.

3.4 WATERSTOP SPLICES

Fusion weld in the field.

3.5 FORMED SURFACES

3.5.1 Preparation of Form Surfaces

Coat contact surfaces of forms with form-coating compound before

reinforcement is placed. Provide a commercial formulation form-coating compound that does not bond with, stain, nor adversely affect concrete surfaces and impair subsequent treatment of concrete surfaces that entails bonding or adhesion nor impede wetting of surfaces to be cured with water or curing compounds. Do not allow excess form-coating compound to stand in puddles in the forms nor to come in contact with concrete against which fresh concrete is placed. Make thinning of form-coating compound with thinning agent of the type, in the amount, and under the conditions recommended by form-coating compound manufacturer's printed or written directions.

### 3.5.2 Tolerances

ACI/MCP-4 and as indicated.

### 3.5.3 As-Cast Form

Provide form facing material producing a smooth, hard, uniform texture on the concrete. Arrange facing material in an orderly and symmetrical manner and keep seams to a practical minimum. Support forms as necessary to meet required tolerances. Do not use material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which can impair the texture of the concrete surface.

## 3.6 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

ACI/MCP-2. Provide bars, wire fabric, wire ties, supports, and other devices necessary to install and secure reinforcement. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

### 3.6.1 General

Provide details of reinforcement that are in accordance with, and ACI/MCP-4 and as specified.

### 3.6.2 Reinforcement Supports

Place reinforcement and secure with galvanized or non corrodible chairs, spacers, or metal hangers. For supporting reinforcement on the ground, use concrete or other non corrodible material, having a compressive strength equal to or greater than the concrete being placed.

### 3.6.3 Splicing

As indicated. For splices not indicated ACI/MCP-2. Do not splice at points of maximum stress.

### 3.6.4 Future Bonding

Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Provide bolt threads that match the connector. Countersink the connector in the concrete. Calk the depression after the bolt is installed.

3.6.5 Cover

ACI/MCP-2 for minimum coverage, unless otherwise indicated.

3.6.6 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.6.7 Construction Joints

Locate joints to least impair strength. Continue reinforcement across joints unless otherwise indicated.

3.6.8 Expansion Joints and Contraction Joints

Provide expansion joint at edges of interior floor slabs on grade abutting vertical surfaces, and as indicated. Make expansion joints 1/2 inch wide unless indicated otherwise. Fill expansion joints not exposed to weather with preformed joint filler material. Completely fill joints exposed to weather with joint filler material and joint sealant. Do not extend reinforcement or other embedded metal items bonded to the concrete through any expansion joint unless an expansion sleeve is used. Provide contraction joints, either formed or saw cut or cut with a jointing tool, to the indicated depth after the surface has been finished. Complete saw joints within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.6.9 Fabrication

Shop fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

Provide fabrication tolerances that are in accordance with ACI/MCP-1, ACI/MCP-2 and ACI/MCP-3.

Provide hooks and bends that are in accordance with and ACI/MCP-3.

Reinforcement must be bent cold to shapes as indicated. Bending must be done in the shop. Rebending of a reinforcing bar that has been bent incorrectly is not be permitted. Bending must be in accordance with standard approved practice and by approved machine methods.

Tolerance on nominally square-cut, reinforcing bar ends must be in accordance with ACI/MCP-3.

Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

Do not use reinforcement that has any of the following defects:

a. Bar lengths, depths, and bends beyond specified fabrication tolerances

b. Bends or kinks not indicated on drawings or approved shop drawings

c. Bars with reduced cross-section due to rusting or other cause

Replace defective reinforcement with new reinforcement having required shape, form, and cross-section area.

3.6.10 Placing Reinforcement

Place reinforcement in accordance withACI/MCP-4.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire fabric on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

For slabs other than on grade, supports for which any portion is less than 1 inch from concrete surfaces that are exposed to view or to be painted must be of precast concrete units, plastic-coated steel, or stainless steel protected bar supports. Precast concrete units must be wedge shaped, not larger than 3-1/2 by 3-1/2 inches, and of thickness equal to that indicated for concrete protection of reinforcement. Provide precast units that have cast-in galvanized tie wire hooked for anchorage and blend with concrete surfaces after finishing is completed.

Contractor must cooperate with other trades in setting of anchor bolts, inserts, and other embedded items. Where conflicts occur between locating reinforcing and embedded items, the Contractor must notify the Contracting Officer so that conflicts may be reconciled before placing concrete. Anchors and embedded items must be positioned and supported with appropriate accessories.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

Provide supports for reinforcing bars that are sufficient in number and sufficiently heavy to carry the reinforcement they support, and in accordance with ACI/MCP-4 and CRSI 10MSP. Do not use supports to support runways for concrete conveying equipment and similar construction loads.

Equip supports on ground and similar surfaces with sand-plates.

Support welded wire fabric as required for reinforcing bars.

Secure reinforcements to supports by means of tie wire. Wire must be black, soft iron wire, not less than 16 gage.

With the exception of temperature reinforcement, tied to main steel approximately 24 inches on center, reinforcement must be accurately placed, securely tied at intersections with 18-gage annealed wire, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to ACI/MCP-3.

Bending of reinforcing bars partially embedded in concrete is permitted only as specified inand ACI/MCP-4.

3.6.11 Spacing of Reinforcing Bars

Spacing must be as indicated. If not indicated, spacing must be in accordance with theACI/MCP-3.

Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to approval.

3.6.12 Concrete Protection for Reinforcement

Concrete protection must be in accordance with the ACI/MCP-4, ASTM E 648,and ACI/MCP-3.

3.6.13 Welding

Welding must be in accordance with AWS D1.4/D1.4M.

3.7 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

ASTM C 94/C 94M, and ACI/MCP-2, except as modified herein. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

3.7.1 Measuring

Make measurements at intervals as specified in paragraphs entitled "Sampling" and "Testing."

3.7.2 Mixing

ASTM C 94/C 94M and ACI/MCP-2. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 84 degrees F. Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 84 degrees F except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, provided that both the specified maximum slump and water-cement ratio are not exceeded. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required. If the entrained air content falls below the specified limit, add a sufficient quantity of admixture to bring the entrained air content within the specified limits. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch.

3.7.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

## 3.8 PLACING CONCRETE

Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris, water, snow, and ice from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of 3 feet from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other. Position grade stakes on 10 foot centers maximum in each direction when pouring interior slabs and on 20 foot centers maximum for exterior slabs.

### 3.8.1 General Placing Requirements

Deposit concrete continuously or in layers of such thickness that no concrete is placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as specified. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic. Deposit concrete as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation.

Concrete to receive other construction must be screeded to proper level to avoid excessive skimming or grouting.

Do not use concrete which becomes nonplastic and unworkable or does not meet quality control limits as specified or has been contaminated by foreign materials. Use of retempered concrete is permitted. Remove rejected concrete from the site.

### 3.8.2 Footing Placement

Concrete for footings may be placed in excavations without forms upon inspection and approval by the Contracting Officer. Excavation width must be a minimum of 4 inches greater than indicated.

### 3.8.3 Vibration

ACI/MCP-2. Furnish a spare, working, vibrator on the job site whenever concrete is placed. Consolidate concrete slabs greater than 4 inches in depth with high frequency mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs 4 inches or less in depth by wood tampers, spading, and settling with a heavy leveling straightedge. Operate internal vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 6000 impulses per minute when submerged. Do not use vibrators to transport the concrete in the forms. Insert and withdraw vibrators approximately 20 inches apart. Penetrate the previously placed lift with the vibrator when more than one lift is required. Place concrete in 20 inch maximum vertical lifts. Use external vibrators on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of the concrete.

### 3.8.4 Application of Epoxy Bonding Compound

Apply a thin coat of compound to dry, clean surfaces. Scrub compound into

the surface with a stiff-bristle brush. Place concrete while compound is stringy. Do not permit compound to harden prior to concrete placement. Follow manufacturer's instructions regarding safety and health precautions when working with epoxy resins.

3.8.5 Pumping

ACI/MCP-2. Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 2 inches. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of course aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

3.8.6 Cold Weather

ACI/MCP-2. Do not allow concrete temperature to decrease below 50 degrees F Obtain approval prior to placing concrete when the ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 37 degrees F in any 1 hour and 50 degrees F per 24 hours after heat application.

3.8.7 Hot Weather

Maintain required concrete temperature using Figure 2.1.5 in ACI/MCP-2 to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.8.8 Follow-up

Check concrete within 24 hours of placement for flatness, levelness, and other specified tolerances. Adjust formwork and placement techniques on subsequent pours to achieve specified tolerances.

3.8.9 Placing Concrete in Forms

Deposit concrete placed in forms in horizontal layers not exceeding 24 inches.

Remove temporary spreaders in forms when concrete placing has reached elevation of spreaders.

Consolidate concrete placed in forms by mechanical vibrating equipment

supplemented by hand spading, rodding, or tamping. Design vibrators to operate with vibratory element submerged in concrete and maintain a speed of not less than 9,000 impulses per minute when submerged in concrete. Provide vibrating equipment adequate in number of units and power of each unit to properly consolidate concrete. Vibration of forms and reinforcement is not be permitted. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced points not farther apart than visible effectiveness of machine. Do not insert vibrator into lower courses of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of concrete mix.

Do not start placing of concrete in supporting elements until concrete previously placed in columns and walls is no longer plastic and has been in place a minimum of 2 hours.

### 3.8.10 Placing Concrete Slabs

Place and consolidate concrete for slabs in a continuous operation, within the limits of approved construction joints until placing of panel or section is completed.

During concrete placing operations, consolidate concrete by mechanical vibrating equipment so that concrete is worked around reinforcement and other embedded items and into corners. Consolidate concrete placed in beams and girders of supported slabs and against bulkheads of slabs on ground by mechanical vibrators as specified. Consolidate concrete in remainder of slabs by vibrating bridge screeds, roller pipe screeds, or other approved method. Limit consolidation operations to time necessary to obtain consolidation of concrete without bringing an excess of fine aggregate to the surface. Concrete to be consolidated must be as dry as practical and surfaces thereof must not be manipulated prior to finishing operations. Bring concrete correct level with a straightedge and struck-off. Use bull floats or darbies to smooth surface, leaving it free of humps or hollows. Sprinkling of water on plastic surface is not permitted.

Provide finish of slabs as specified.

### 3.8.11 Bonding

Surfaces of set concrete at joints, except where bonding is obtained by use of concrete bonding agent, must be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner that exposes the aggregate uniformly and does not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Obtain bonding of fresh concrete that has set as follows:

At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; roughened and cleaned surface of set concrete must be dampened, but not saturated, immediately prior to placing of fresh concrete.

At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, other structural members; in work designed to contain liquids; the roughened

and cleaned surface of set concrete must be dampened but not saturated and covered with a cement grout coating.

Provide cement grout that consists of equal parts of portland cement and fine aggregate by weight with not more than 6 gallons of water per sack of cement. Apply cement grout with a stiff broom or brush to a minimum thickness of 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.

Bonding of fresh concrete to concrete that has set may be obtained by use of a concrete bonding agent. Apply such bonding material to cleaned concrete surface in accordance with approved printed instructions of bonding material manufacturer.

## 3.9 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

### 3.9.1 Defects

Repair formed surfaces by removing minor honeycombs, pits greater than 1 square inch surface area or 0.25 inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with nonshrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive honeycomb including exposed steel reinforcement, cold joints, entrapped debris, separated aggregate, or other defects which affect the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain approval of corrective action prior to repair. The surface of the concrete must not vary more than the allowable tolerances of ACI/MCP-4. Exposed surfaces must be uniform in appearance and finished to a smooth form finish unless otherwise specified.

### 3.9.2 Not Against Forms (Top of Walls)

Surfaces not otherwise specified must be finished with wood floats to even surfaces. Finish must match adjacent finishes.

### 3.9.3 Formed Surfaces

#### 3.9.3.1 Tolerances

ACI/MCP-1 and as indicated.

#### 3.9.3.2 As-Cast Rough Form

Provide for surfaces not exposed to public view. Patch these holes and defects and level abrupt irregularities. Remove or rub off fins and other projections exceeding 0.25 inch in height.

#### 3.9.3.3 Standard Smooth Finish

Finish must be as-cast concrete surface as obtained with form facing material for standard smooth finish. Repair and patch defective areas as specified; and all fins and remove other projections on surface.

## 3.10 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

ACI/MCP-2, unless otherwise specified. Slope floors uniformly to drains where drains are provided. Where straightedge measurements are specified, Contractor must provide straightedge.

3.10.1 Finish

Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater.

3.10.1.1 Concrete Containing Silica Fume

Finish using magnesium floats or darbies.

3.10.1.2 Steel Troweled

Use for floors intended as walking surfaces and surfaces under equipment. First, provide a floated finish. Next, the finish must be power troweled two times, and finally hand troweled. The first troweling after floating needs to produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Perform additional trowelings done by hand after the surface has hardened sufficiently. The final troweling is done when a ringing sound is produced as the trowel is moved over the surface. Thoroughly consolidate the surface by the hand troweling operations. The finished surface must be essentially free of trowel marks and uniform in texture and appearance. The finished surface must produce a surface level to within 1/4 inch in 10 feet. On surfaces intended to support floor coverings, remove any defects of sufficient magnitude to show through the floor covering by grinding.

3.10.1.3 Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as necessary. Obtain final finish by belting. Lay belt flat on the concrete surface and advance with a sawing motion; continue until a uniform but gritty nonslip surface is obtained. Round edges and joints with an edger having a radius of 1/8 inch.

3.10.2 Concrete Walks

Provide 4 inches thick minimum. Provide contraction joints spaced every 5 linear feet unless otherwise indicated. Cut contraction joints one inch deep with a jointing tool after the surface has been finished. Provide 0.5 inch thick transverse expansion joints at changes in direction where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space expansion joints every 50 feet maximum. Give walks a broomed finish. Unless indicated otherwise, provide a transverse slope of 1/48. Limit variation in cross section to 1/4 inch in 5 feet.

3.10.3 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.10.4 Curbs and Gutters

Provide contraction joints spaced every 10 feet maximum unless otherwise indicated. Cut contraction joints 3/4 inch deep with a jointing tool after

the surface has been finished. Provide expansion joints 1/2 inch thick and spaced every 100 feet maximum unless otherwise indicated. Perform pavement finish.

3.10.5 Splash Blocks

Provide at outlets of downspouts emptying at grade. Splash blocks may be precast concrete, and must be 24 inches long, 12 inches wide, and 4 inches thick, unless otherwise indicated, with smooth-finished countersunk dishes sloped to drain away from the building.

3.11 CURING AND PROTECTION

ACI/MCP-2 unless otherwise specified. Begin curing immediately following form removal. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer-hardener or epoxy coating. Allow curing compound/sealer installations to cure prior to the installation of materials that adsorb VOCs.

3.11.1 General

Protect freshly placed concrete from premature drying and cold or hot temperature and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of cement and proper hardening of concrete.

Start initial curing as soon as free water has disappeared from surface of concrete after placing and finishing. Keep concrete moist for minimum 72 hours.

Final curing must immediately follow initial curing and before concrete has dried. Continue final curing until cumulative number of hours or fraction thereof (not necessarily consecutive) during which temperature of air in contact with the concrete is above 50 degrees F has totaled 168 hours. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, final curing may be terminated when the average compressive strength has reached 70 percent of the 28-day design compressive strength. Prevent rapid drying at end of final curing period.

3.11.2 Moist Curing

Remove water without erosion or damage to the structure. Prevent water run-off.

3.11.2.1 Ponding or Immersion

Continually immerse the concrete throughout the curing period. Water must

not be more than 50 degrees F less than the temperature of the concrete. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.11.2.2 Fog Spraying or Sprinkling

Apply water uniformly and continuously throughout the curing period. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.11.2.3 Pervious Sheeting

Completely cover surface and edges of the concrete with two thicknesses of wet sheeting. Overlap sheeting 6 inches over adjacent sheeting. Provide sheeting that is at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.

3.11.2.4 Impervious Sheeting

Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12 inches minimum. Provide sheeting not less than 18 inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap columns, walls, and other vertical structural elements from the top down with impervious sheeting; overlap and continuously tape sheeting joints; and introduce sufficient water to soak the entire surface prior to completely enclosing.

3.11.3 Liquid Membrane-Forming Curing Compound

Seal or cover joint openings prior to application of curing compound. Prevent curing compound from entering the joint. Apply in accordance with the recommendations of the manufacturer immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. Provide and maintain compound on the concrete surface throughout the curing period. Do not use this method of curing where the use of Figure 2.1.5 in ACI/MCP-2 indicates that hot weather conditions cause an evaporation rate exceeding 0.2 pound of water per square foot per hour.

3.11.3.1 Application

Unless the manufacturer recommends otherwise, apply compound immediately after the surface loses its water sheen and has a dull appearance, and before joints are sawed. Mechanically agitate curing compound thoroughly during use. Use approved power-spraying equipment to uniformly apply two coats of compound in a continuous operation. The total coverage for the two coats must be 200 square feet maximum per gallon of undiluted compound unless otherwise recommended by the manufacturer's written instructions. The compound must form a uniform, continuous, coherent film that does not check, crack, or peel. Immediately apply an additional coat of compound to areas where the film is defective. Re-spray concrete surfaces subjected to rainfall within 3 hours after the curing compound application.

3.11.3.2 Protection of Treated Surfaces

Prohibit pedestrian and vehicular traffic and other sources of abrasion at least 72 hours after compound application. Maintain continuity of the coating for the entire curing period and immediately repair any damage.

3.11.4 Requirements for Type III, High-Early-Strength Portland Cement

The curing periods are required to be not less than one-fourth of those specified for portland cement, but in no case less than 72 hours.

3.11.5 Curing Periods

ACI/MCP-2 except 10 days for retaining walls, pavement or chimneys, 21 days for concrete that is in full-time or intermittent contact with seawater, salt spray, alkali soil or waters. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the Contracting Officer.

3.11.6 Curing Methods

Accomplish curing by moist curing, by moisture-retaining cover curing, by membrane curing, and by combinations thereof, as specified.

Moist curing:

Accomplish moisture curing by any of the following methods:

Keeping surface of concrete wet by covering with water

Continuous water spraying

Covering concrete surface with specified absorptive cover for curing concrete saturated with water and keeping absorptive cover wet by water spraying or intermittent hosing. Place absorptive cover to provide coverage of concrete surfaces and edges with a slight overlap over adjacent absorptive covers.

Moisture-cover curing:

Accomplish moisture-retaining cover curing by covering concrete surfaces with specified moisture-retaining cover for curing concrete. Place cover directly on concrete in widest practical width, with sides and ends lapped at least 3 inches. Weight cover to prevent displacement; immediately repair tears or holes appearing during curing period by patching with pressure-sensitive, waterproof tape or other approved method.

Membrane curing:

Accomplish membrane curing by applying specified membrane-forming curing compound to damp concrete surfaces as soon as moisture film has disappeared. Apply curing compound uniformly in a two-coat operation by power-spraying equipment using a spray nozzle equipped with a wind guard. Apply second coat in a direction at right angles to direction of first coat. Total coverage for two coats must be not more than 200

square feet per gallon of curing compound. Respray concrete surfaces which are subjected to heavy rainfall within 3 hours after curing compound has been applied by method and at rate specified. Maintain continuity of coating for entire curing period and immediately repair damage to coating during this period.

Membrane-curing compounds must not be used on surfaces that are to be covered with coating material applied directly to concrete or with a covering material bonded to concrete, such as other concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, painting, and other coatings and finish materials.

3.11.7 Curing Formed Surfaces

Accomplish curing of formed surfaces, including undersurfaces of girders, beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed before end of curing period, accomplish final curing of formed surfaces by any of the curing methods specified above, as applicable.

3.11.8 Curing Unformed Surfaces

Accomplish initial curing of unformed surfaces, such as monolithic slabs, floor topping, and other flat surfaces, by membrane curing.

Unless otherwise specified, accomplish final curing of unformed surfaces by any of curing methods specified above, as applicable.

Accomplish final curing of concrete surfaces to receive liquid floor hardener of finish flooring by moisture-retaining cover curing.

3.11.9 Temperature of Concrete During Curing

When temperature of atmosphere is 41 degrees F and below, maintain temperature of concrete at not less than 55 degrees F throughout concrete curing period or 45 degrees F when the curing period is measured by maturity. When necessary, make arrangements before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.

When the temperature of atmosphere is 80 degrees F and above or during other climatic conditions which cause too rapid drying of concrete, make arrangements before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.

Changes in temperature of concrete must be uniform and not exceed 37 degrees F in any 1 hour nor 80 degrees F in any 24-hour period.

3.11.10 Protection from Mechanical Injury

During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration and from damage caused by rain or running water.

3.11.11 Protection After Curing

Protect finished concrete surfaces from damage by construction operations.

3.12 FIELD QUALITY CONTROL

3.12.1 Sampling

ASTM C 172. Collect samples of fresh concrete to perform tests specified. ASTM C 31/C 31M for making test specimens.

3.12.2 Testing

3.12.2.1 Slump Tests

ASTM C 143/C 143M. Take concrete samples during concrete placement. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cement ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 20 cubic yards (maximum) of concrete.

3.12.2.2 Temperature Tests

Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 50 degrees F and above 80 degrees F ) for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

3.12.2.3 Compressive Strength Tests

ASTM C 39/C 39M. Make five test cylinders for each set of tests in accordance with ASTM C 31/C 31M. Take precautions to prevent evaporation and loss of water from the specimen. Test two cylinders at 7 days, two cylinders at 28 days, and hold one cylinder in reserve. Take samples for strength tests of each mix design of and for concrete placed each day not less than once a day, nor less than once for each 160 cubic yards of concrete, nor less than once for each 5400 square feet of surface area for slabs or walls. For the entire project, take no less than five sets of samples and perform strength tests for each mix design of concrete placed. Each strength test result must be the average of two cylinders from the same concrete sample tested at 28 days. If the average of any three consecutive strength test results is less than f'c or if any strength test result falls below f'c by more than 450 psi, take a minimum of three ASTM C 42/C 42M core samples from the in-place work represented by the low test cylinder results and test. Concrete represented by core test is considered structurally adequate if the average of three cores is equal to at least 85 percent of f'c and if no single core is less than 75 percent of f'c. Retest locations represented by erratic core strengths. Remove concrete not meeting strength criteria and provide new acceptable concrete. Repair core holes with nonshrink grout. Match color and finish of adjacent concrete.

3.12.2.4 Air Content

ASTM C 173/C 173M or ASTM C 231 for normal weight concrete. Test air-entrained concrete for air content at the same frequency as specified for slump tests.

3.12.2.5 Strength of Concrete Structure

Compliance with the following is considered deficient if it fails to meet the requirements which control strength of structure in place, including following conditions:

Failure to meet compressive strength tests as evaluated

Reinforcement not conforming to requirements specified

Concrete which differs from required dimensions or location in such a manner as to reduce strength

Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified

Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration

Poor workmanship likely to result in deficient strength

3.12.2.6 Testing Concrete Structure for Strength

When there is evidence that strength of concrete structure in place does not meet specification requirements, make cores drilled from hardened concrete for compressive strength determination in accordance with ASTM C 42/C 42M, and as follows:

Take at least three representative cores from each member or area of concrete-in-place that is considered potentially deficient. Location of cores will be determined by the Contracting Officer.

Test cores after moisture conditioning in accordance with ASTM C 42/C 42M if concrete they represent is more than superficially wet under service.

Air dry cores, (60 to 80 degrees F with relative humidity less than 60 percent) for 7 days before test and test dry if concrete they represent is dry under service conditions.

Strength of cores from each member or area are considered satisfactory if their average is equal to or greater than 85 percent of the 28-day design compressive strength of the class of concrete.

Core specimens will be taken and tested by the Government. If the results of core-boring tests indicate that the concrete as placed does not conform to the drawings and specification, the cost of such tests and restoration required must be borne by the Contractor.

Fill core holes solid with patching mortar and finished to match adjacent concrete surfaces.

Correct concrete work that is found inadequate by core tests in a manner approved by the Contracting Officer.

3.13 WASTE MANAGEMENT

As specified in the Waste Management Plan and as follows.

3.13.1 Mixing Equipment

Before concrete pours, designate Company-owned site meeting environmental standards for cleaning out concrete mixing trucks. Minimize water used to wash equipment.

3.13.2 Hardened, Cured Waste Concrete

Crush and reuse hardened, cured waste concrete as fill or as a base course for pavement.

3.13.3 Reinforcing Steel

Collect reinforcing steel and place in designated area for recycling.

3.13.4 Other Waste

Identify concrete manufacturer's or supplier's policy for collection or return of construction waste, unused material, deconstruction waste, and/or packaging material. Return excess cement to supplier.

3.14 JOINTS

3.14.1 Construction Joints

Make and locate joints not indicated so as not to impair strength and appearance of the structure, as approved. Locate construction joints as follows:

a. In walls at not more than 60 feet in any horizontal direction; at top of footing; at top of slabs on ground; at top and bottom of door and window openings or where required to conform to architectural details; and at underside of deepest beam or girder framing into wall

b. In columns or piers, at top of footing; at top of slabs on ground; and at underside of deepest beam or girder framing into column or pier

c. Near midpoint of spans for supported slabs, beams, and girders unless a beam intersects a girder at the center, in which case construction joints in girder must offset a distance equal to twice the width of the beam. Make transfer of shear through construction joint by use of inclined reinforcement.

d. In slabs on ground, so as to divide slab into areas not in excess of 1,200 square feet

Provide keyways at least 1-1/2-inches deep in construction joints in walls and slabs and between walls and footings; approved bulkheads may be used for slabs.

Joints must be perpendicular to main reinforcement. Reinforcement must be continued across construction joints.

3.14.2 Isolation Joints in Slabs on Ground

Provide joints at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

Fill joints with premolded joint filler strips 1/2 inch thick, extending full slab depth. Install filler strips at proper level below finish floor elevation with a slightly tapered, dress-and-oiled wood strip temporarily secured to top of filler strip to form a groove not less than 3/4 inch in depth where joint is sealed with sealing compound and not less than 1/4 inch in depth where joint sealing is not required. Remove wood strip after concrete has set. Contractor must clean groove of foreign matter and loose particles after surface has dried.

### 3.14.3 Control Joints in Slabs on Ground

Provide joints to form panels as indicated.

Under and on exact line of each control joint, cut 50 percent of welded wire fabric reinforcement before placing concrete.

Joints must be 1/8-inch wide by 1/5 to 1/4 of slab depth and formed by inserting hand-pressed fiberboard strip into fresh concrete until top surface of strip is flush with slab surface or by cutting the concrete with a saw after the concrete has set. After concrete has cured for at least 7 days, the Contractor must remove inserts and clean groove of foreign matter and loose particles.

### 3.14.4 Sealing Joints in Slabs on Ground

Isolation and control joints which are to receive finish flooring material must be sealed with joint sealing compound after concrete curing period. Slightly underfill groove with joint sealing compound to prevent extrusion of compound. Remove excess material as soon after sealing as possible.

Sealing is not required for isolation and control joints to be covered with finish flooring material. Groove must be left ready to receive filling material that is provided as part of finish floor covering work.

## 3.15 INSTALLATION OF ANCHORAGE DEVICES

### 3.15.1 General

Anchorage devices and embedded items required for other work that is attached to, or supported by, set and build in cast-in-place concrete as part of the work of this section, using setting drawings, instructions, and directions for work to be attached thereto.

### 3.15.2 Placing Anchorage Devices

Anchorage devices and embedded items must be positioned accurately and supported against displacement. Fill openings in anchorage devices such as slots and threaded holes with an approved, removable material to prevent entry of concrete into openings.

## 3.16 CONCRETE CONVEYING

### 3.16.1 Transfer of Concrete At Project Site

Handle concrete from point of delivery and transfer to concrete conveying equipment and to locations of final deposit as rapidly as practical by methods which prevent segregation and loss of concrete mix materials.

### 3.16.2 Mechanical Equipment for Conveying Concrete

Equipment must ensure a continuous flow of concrete at delivery end, as approved. Provide runways for wheeled concrete-conveying equipment from concrete delivery point to locations of final deposit. Interior surfaces of concrete conveying equipment must be free of hardened concrete, debris, water, snow, ice, and other deleterious substances.

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# STRUCTURAL STEEL

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO HB-17 | (2002; Errata 2003; Errata 2005) Standard Specifications for Highway Bridges |

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 303 | (2005) Code of Standard Practice for Steel Buildings and Bridges |
| AISC 317 | (1992; Reprint 1999) ASD Manual of Steel Construction, Vol II: Connections |
| AISC 325 | (2005) Manual of Steel Construction |
| AISC 326 | (2002) Detailing for Steel Construction |
| AISC 341 | (2005; Supp 2005) Seismic Provisions for Structural Steel Buildings |
| AISC 348 | (2000) Structural Joints Using ASTM A325 or A490 Bolts |
| AISC 350 | (2005) Load and Resistance Factor Design (LRFD)Specification for Structural Steel Buildings |
| AISC 360 | (2005) Specification for Structural Steel Buildings, with Commentary |
| AISC 810 | (1997) Erection Bracing of Low-Rise Structural Steel Frames/Fisher and West |
| AISC FCD | (1995a) Quality Certification Program Description |

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

| | |
|---|---|
| AREMA Eng Man | (2008) Manual for Railway Engineering |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A2.4 | (2007) Standard Symbols for Welding, Brazing and Nondestructive Examination |
| AWS D1.1/D1.1M | (2008) Structural Welding Code - Steel |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B46.1 | (2002) Surface Texture (Surface Roughness, Waviness and Lay) |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 108 | (2007) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished |
| ASTM A 123/A 123M | (2008) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A 143/A 143M | (2007) Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement |
| ASTM A 153/A 153M | (2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A 242/A 242M | (2004e1) Standard Specification for High-Strength Low-Alloy Structural Steel |
| ASTM A 276 | (2008a) Standard Specification for Stainless Steel Bars and Shapes |
| ASTM A 307 | (2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength |
| ASTM A 325 | (2007a) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength |
| ASTM A 325M | (2008) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 Mpa Minimum Tensile Strength (Metric) |
| ASTM A 36/A 36M | (2008) Standard Specification for Carbon Structural Steel |
| ASTM A 490 | (2008a) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength |
| ASTM A 490M | (2004ae1) Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric) |

| | |
|---|---|
| ASTM A 500/A 500M | (2007) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A 501 | (2007) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing |
| ASTM A 514/A 514M | (2005) Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding |
| ASTM A 529/A 529M | (2005) Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality |
| ASTM A 53/A 53M | (2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 563 | (2007a) Standard Specification for Carbon and Alloy Steel Nuts |
| ASTM A 563M | (2007) Standard Specification for Carbon and Alloy Steel Nuts (Metric) |
| ASTM A 572/A 572M | (2007) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel |
| ASTM A 588/A 588M | (2005) Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point, with Atmospheric Corrosion Resistance |
| ASTM A 6/A 6M | (2008a) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling |
| ASTM A 618/A 618M | (2004) Standard Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing |
| ASTM A 668/A 668M | (2004) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use |
| ASTM A 709/A 709M | (2008) Standard Specification for Structural Steel for Bridges |
| ASTM A 780 | (2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A 852/A 852M | (2003; R 2007) Standard Specification for Quenched and Tempered Low-Alloy Structural Steel Plate with 70 ksi (485 MPa) Minimum |

| | |
|---|---|
| | Yield Strength to 4 in. (100 mm) Thick |
| ASTM A 992/A 992M | (2006a) Standard Specification for Structural Steel Shapes |
| ASTM B 695 | (2004) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel |
| ASTM C 1107/C 1107M | (2008) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) |
| ASTM C 827 | (2001a; R 2005) Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures |
| ASTM F 436 | (2007a) Hardened Steel Washers |
| ASTM F 436M | (2004) Hardened Steel Washers (Metric) |
| ASTM F 844 | (2007a) Washers, Steel, Plain (Flat), Unhardened for General Use |
| ASTM F 959 | (2007a) Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners |
| ASTM F 959M | (2007) Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners (Metric) |

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

| | |
|---|---|
| CMAA 70 | (2004) EnviroTop Running and Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes, No. 70 |

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC PA 1 | (2000; E 2004) Shop, Field, and Maintenance Painting |
| SSPC PS 13.01 | (1982; E 2004) Epoxy-Polyamide Painting System |
| SSPC Paint 25 | (1997; E 2004) Paint Specification No. 25Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel Type I and Type II |
| SSPC SP 3 | (2004; E 2004) Power Tool Cleaning |
| SSPC SP 6 | (7) Commercial Blast Cleaning |

## 1.2 SYSTEM DESCRIPTION

Provide the structural steel system, including galvanizing, complete and ready for use. Structural steel systems including design, materials, installation, workmanship, fabrication, assembly, erection, inspection,

quality control, and testing shall be provided in accordance with AISC 325 and AISC 317 except as modified in this contract.

1.3 MODIFICATIONS TO REFERENCES

Conform to AISC 325, AISC 317, AISC 360, AISC 303, AISC 348, except as modified in this section.

1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Erection Plan, including description of temporary supports

Fabrication drawings including description of connections

SD-03 Product Data

Shop primer

Welding electrodes and rods

Load indicator washers

Non-Shrink Grout

SD-06 Test Reports

Bolts, nuts, and washers

Supply the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners.

SD-07 Certificates

Steel

Bolts, nuts, and washers

Galvanizing

AISC Quality Certification

Overhead, top running crane rail beam

Welding procedures and qualifications

1.5 AISC QUALITY CERTIFICATION

Work shall be fabricated in an AISC certified Category Sbd fabrication plant.

1.6 SEISMIC PROVISIONS

The structural steel system shall be provided in accordance with AISC 341.

## 1.7 QUALITY ASSURANCE

### 1.7.1 Drawing Requirements

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 326, AISC 325 and AISC 317. Fabrication drawings shall not be reproductions of contract drawings. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols. Shoring and temporary bracing shall be designed and sealed by a registered professional engineer and submitted for record purposes, with calculations, as part of the drawings. Member substitutions of details shown on the contract drawings shall be clearly highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

### 1.7.2 Certifications

#### 1.7.2.1 Erection Plan

Submit for record purposes. Indicate the sequence of erection, temporary shoring and bracing, and a detailed sequence of welding, including each welding procedure required.

#### 1.7.2.2 Welding Procedures and Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. If the qualification date of the welding operator is more than one-year old, the welding operator's qualification certificate shall be accompanied by a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.

Conform to all requirements specified in AWS D1.1/D1.1M.

# PART 2 PRODUCTS

## 2.1 STEEL

### 2.1.1 Structural Steel

ASTM A 36/A 36M.

### 2.1.2 High-Strength Structural Steel

#### 2.1.2.1 Low-Alloy Steel

ASTM A 572/A 572M, Grade 50. ASTM A 992/A 992M Grade 50.

### 2.1.3 Structural Shapes for Use in Building Framing

Wide flange shapes, ASTM A 992/A 992M.

2.1.4 Structural Steel Tubing

ASTM A 500/A 500M, Grade B 46 ksi.

2.1.5 Steel Pipe

ASTM A 53/A 53M, Type E or S, Grade B, weight class STD (Standard).

2.2 BOLTS, NUTS, AND WASHERS

Provide the following unless indicated otherwise.

2.2.1 Structural Steel, Steel Pipe

2.2.1.1 Bolts

ASTM A 325, Type 1,. The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

2.2.1.2 Nuts

ASTM A 563, Grade and Style for applicable ASTM bolt standard recommended.

2.2.1.3 Washers

ASTM F 844 washers for ASTM A 307 bolts, and ASTM F 436 washers for ASTM A 325 and ASTM A 490 bolts.

2.2.2 High-Strength Structural Steel and Structural Steel Tubing

2.2.2.1 Bolts

ASTM A 325, Type 1.

2.2.2.2 Nuts

ASTM A 563, Grade and Style as specified in the applicable ASTM bolt standard.

2.2.2.3 Washers

ASTM F 436, plain carbon steel.

2.2.3 Foundation Anchorage

2.2.3.1 Anchor Bolts

ASTM A 307.

2.2.3.2 Anchor Nuts

ASTM A 563, Grade A, hex style.

2.2.3.3 Anchor Washers

ASTM F 844.

## 2.3 STRUCTURAL STEEL ACCESSORIES

### 2.3.1 Welding Electrodes and Rods

AWS D1.1/D1.1M.

### 2.3.2 Non-Shrink Grout

ASTM C 1107/C 1107M, with no ASTM C 827 shrinkage. Grout shall be nonmetallic.

### 2.3.3 Welded Shear Stud Connectors

AWS D1.1/D1.1M.

## 2.4 GALVANIZING

ASTM A 123/A 123M or ASTM A 153/A 153M, as applicable, unless specified otherwise galvanize after fabrication where practicable.

## 2.5 FABRICATION

### 2.5.1 Markings

Prior to erection, members shall be identified by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections shall be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded. Do not locate match markings in areas that will decrease member strength or cause stress concentrations. Affix embossed tags to hot-dipped galvanized members.

### 2.5.2 Shop Primer

#### 2.5.2.1 Cleaning

SSPC SP 6, except steel exposed in spaces above ceilings, attic spaces, furred spaces, and chases that will be hidden to view in finished construction may be cleaned to SSPC SP 3 when recommended by the shop primer manufacturer. Maintain steel surfaces free from rust, dirt, oil, grease, and other contaminants through final assembly.

### 2.5.3 Surface Finishes

ASME B46.1 maximum surface roughness of 125 for pin, pinholes, and sliding bearings, unless indicated otherwise.

## 2.6 DRAINAGE HOLES

Adequate drainage holes shall be drilled to eliminate water traps. Hole diameter shall be 1/2 inch and location shall be indicated on the detail drawings. Hole size and location shall not affect the structural integrity.

# PART 3 EXECUTION

## 3.1 FABRICATION

Fabrication shall be in accordance with the applicable provisions of AISC 325. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under

the AISC FCD for Category sbd structural steelwork.

Compression joints depending on contact bearing shall have a surface roughness not in excess of 500 micro inch as determined by ASME B46.1, and ends shall be square within the tolerances for milled ends specified in ASTM A 6/A 6M.

Shop splices of members between field splices will be permitted only where indicated on the Contract Drawings. Splices not indicated require the approval of the Contracting Officer.

## 3.2 ERECTION

Erection of structural steel, except as indicated in item b. below, shall be in accordance with the applicable provisions of AISC 325. Erection plan shall be reviewed, stamped and sealed by a licensed structural engineer.

Provide for drainage in structural steel. After final positioning of steel members, provide full bearing under base plates and bearing plates using nonshrink grout. Place nonshrink grout in accordance with the manufacturer's instructions.

### 3.2.1 STORAGE

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

## 3.3 CONNECTIONS

Except as modified in this section, connections not detailed shall be designed in accordance with AISC 360. Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque wrenches. Punch, subpunch and ream, or drill bolt holes perpendicular to the surface of the member. Holes shall not be cut or enlarged by burning. Bolts, nuts, and washers shall be clean of dirt and rust, and lubricated immediately prior to installation.

### 3.3.1 Common Grade Bolts

ASTM A 307 bolts shall be tightened to a "snug tight" fit. "Snug tight" is the tightness that exists when plies in a joint are in firm contact. If firm contact of joint plies cannot be obtained with a few impacts of an impact wrench, or the full effort of a man using a spud wrench, contact the Contracting Officer for further instructions.

### 3.3.2 High-Strength Bolts

ASTM A 325 and ASTM A 490 bolts shall be fully tensioned to 70 percent of their minimum tensile strength. Provide load indicator bolts or washers in all ASTM A 325M bolted connections, except provide only load indicator washers for slip critical connections. Direct tension indicator tightening, shall be the only acceptable tightening methods. Use only direct tension indicator tightening for slip critical connections. Bolts shall be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, bolts shall then be fully tensioned, progressing from the most rigid part of a connection to the free edges.

3.3.2.1 Installation of Load Indicator Washers (LIW)

ASTM F 959. Where possible, the LIW shall be installed under the bolt head and the nut shall be tightened. If the LIW is installed adjacent to the turned element, provide a flat ASTM F 436 washer between the LIW and nut when the nut is turned for tightening, and between the LIW and bolt head when the bolt head is turned for tightening. In addition to the LIW, provide flat ASTM F 436 washers under both the bolt head and nut when ASTM A 490 bolts are used.

3.4 GAS CUTTING

Use of gas-cutting torch in the field for correcting fabrication errors will not be permitted on any major member in the structural framing. Use of a gas cutting torch will be permitted on minor members not under stress only after approval has been obtained from the Contracting Officers.

3.5 WELDING

AWS D1.1/D1.1M. Provide AWS D1.1/D1.1M qualified welders, welding operators, and tackers.

The Contractor shall develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures. Prequalified procedures may be submitted for information only; however, procedures that are not prequalified shall be submitted for approval.

3.5.1 Removal of Temporary Welds, Run-Off Plates, and Backing Strips

Remove only from finished areas.

3.6 GALVANIZING REPAIR

Provide as indicated or specified. Galvanize after fabrication where practicable. Repair damage to galvanized coatings using ASTM A 780 zinc rich paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

3.7 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required for testing. The Contracting Officer shall be notified in writing of defective welds, bolts, nuts, and washers within 7 working days of the date of weld inspection.

3.7.1 Welds

3.7.1.1 Visual Inspection

AWS D1.1/D1.1M. Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections. Welding inspectors shall visually inspect and mark welds, including fillet weld end returns.

3.7.1.2 Nondestructive Testing

AWS D1.1/D1.1M. Test locations shall be selected by the Contracting

Officer. If more than 20 percent of welds made by a welder contain defects identified by testing, then all welds made by that welder shall be tested by radiographic or ultrasonic testing, as approved by the Contracting Officer. When all welds made by an individual welder are required to be tested, magnetic particle testing shall be used only in areas inaccessible to either radiographic or ultrasonic testing. Retest defective areas after repair.

a. Testing frequency: Provide the following types and number of tests:

| Test Type | Number of Tests |
|---|---|
| Radiographic | 100% |
| Ultrasonic | 100% |
| Magnetic Particle | 25% |
| Dye Penetrant | 25% |

3.7.2 Load Indicator Washers

3.7.2.1 Load Indicator Washer Compression

Load indicator washers shall be tested in place to verify that they have been compressed sufficiently to provide the 0.015 inch gap when the load indicator washer is placed under the bolt head and the nut is tightened, and to provide the 0.005 inch gap when the load indicator washer is placed under the turned element, as required by ASTM F 959.

3.7.3 High-Strength Bolts

3.7.3.1 Testing Bolt, Nut, and Washer Assemblies

Test a minimum of 3 bolt, nut, and washer assemblies from each mill certificate batch in a tension measuring device at the job site prior to the beginning of bolting start-up. Demonstrate that the bolts and nuts, when used together, can develop tension not less than the provisions specified in AISC 348, Table 4, depending on bolt size and grade. The bolt tension shall be developed by tightening the nut. A representative of the manufacturer or supplier shall be present to ensure that the fasteners are properly used, and to demonstrate that the fastener assemblies supplied satisfy the specified requirements.

3.7.3.2 Inspection

Inspection procedures shall be in accordance with AISC 348, Section 9. Confirm and report to the Contracting Officer that the materials meet the project specification and that they are properly stored. Confirm that the faying surfaces have been properly prepared before the connections are assembled. Observe the specified job site testing and calibration, and confirm that the procedure to be used provides the required tension. Monitor the work to ensure the testing procedures are routinely followed on joints that are specified to be fully tensioned.

The Contractor shall inspect proper preparation, size, gaging location, and acceptability of welds; identification marking; operation and current characteristics of welding sets in use; and calibration of torque wrenches for high-strength bolts.

The Contractor shall inspect high-strength bolted connections in accordance with AISC 317.

3.7.3.3 Testing

The Government has the option to perform nondestructive tests on 5 percent of the installed bolts to verify compliance with pre-load bolt tension requirements. The nondestructive testing will be done in-place using an ultrasonic measuring device or any other device capable of determining in-place pre-load bolt tension. The test locations shall be selected by the Contracting Officer. If more than 10 percent of the bolts tested contain defects identified by testing, then all bolts used from the batch from which the tested bolts were taken, shall be tested. Retest new bolts after installation.

3.7.4 Testing for Embrittlement

ASTM A 143/A 143M for steel products hot-dip galvanized after fabrication.

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# PAINTING AND COATING

## PART 1 GENERAL

### 1.1 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items. Data shall include detailed analysis of each coating material required, with constituents measured as percentages of the total weight of coating.

Inhibitive Metal Primer
Acrylic Epoxy

SD-04 Samples

Manufacturer's Standard Color Charts shall be submitted in accordance with paragraph entitled, "Manufacturer's and Materials," of this section.

SD-07 Certificates

A Safety Plan shall be submitted in accordance with paragraph entitled, "General," of this section.

SD-08 Manufacturer's Instructions

Manufacturer's instructions shall be submitted for architectural coatings including details of thinning, mixing, handling, and application, in accordance with paragraph entitled, "General," of this section.

### 1.2 CONTRACTOR PERSONNEL QUALIFICATION

Personnel assigned to the work shall be certified by the Contractor to have had adequate previous experience in the successful application of paints and coatings similar to those specified.

### 1.3 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered in their original, unbroken containers bearing the manufacturer's name and product identification. Containers breached by rough handling shall be removed from the site, together with their contents.

Paint materials, thinners, and cleaners shall be stored in tightly closed containers in a covered, well-ventilated area where they will not be exposed to excessive heat, sparks, flame, or direct sunlight. Water-based materials shall be protected against freezing.

# PART 2 PRODUCTS

## 2.1 MANUFACTURER'S AND MATERIALS

Manufacturer's Standard Color Charts shall be submitted showing manufacturer's recommended finish colors. Three color chips of each color and gloss scheduled shall also be submitted.

The following are suggested paint manufacturers and their products. Other paint manufacturers' products of equal quality will be considered when submitted and approved by the Contracting Officer.

| COATING | PITTSBURGH | SHERWIN WILLIAMS | GLIDDEN |
|---|---|---|---|
| Inhibitive Metal Primer | 6-712 | B50WZ1 | 6970 |
| Water base Acrylic Epoxy | 16 line | B70 SERIES | 5277/5278 |

# PART 3 EXECUTION

## 3.1 GENERAL

A Safety Plan shall be submitted for architectural coating systems in accordance with OSHA regulations.

Manufacturer's recommendations for surface preparation, thinning, mixing, handling, and application shall be considered a part of this specification.

## 3.2 PROTECTION OF FACILITIES

Contractor shall remove and reinstall or provide acceptable protection for hardware, accessories, lighting and electrical components, factory-finished materials, plumbing fixtures and fittings, and any other materials that may become splattered or damaged by the painting work.

## 3.3 SURFACE PREPARATION

### 3.3.1 General Requirements

Surfaces shall be clean, dry, and free from contaminants and foreign matter. Mildew and chalking shall be removed and the surface thoroughly sterilized. Chipped, peeling, or blistered paint shall be removed and the surface spot primed. Hard glossy surfaces shall be dulled and roughened to ensure proper adhesion.

### 3.3.2 Ferrous Metal

Surfaces shall be free from dirt, oil, grease, wax, and other contaminants. Heavy rust and loose mill scale shall be removed by hand, power tool, or blast cleaning.

### 3.3.3 Galvanized Steel

Surfaces shall be cleaned of all contaminants using a solvent such as lacquer thinner or xylol.

After cleaning, the surface shall be etched with a phosporic acid

pre-treatment solution.

3.3.4 Aluminum

Surfaces shall be clean, dry, and free from oil and grease. Oxide film and corrosion shall be removed by hand or power tool cleaning.

3.4 MIXING AND APPLICATION

3.4.1 General Procedures

No exterior painting shall be allowed in rainy weather or when rain is imminent. No paints or coatings shall be applied when the temperature or humidity is outside the limits recommended by the manufacturer.

Paints and coatings shall be applied by brush, roller, or airless spray.

Each coat of material applied shall be free from runs, sags, bubbles, foreign contaminants, variations in color, gloss, and texture, dry overspray, brush and roller marks, holidays (missed areas), or other evidence of poor application.

Paints and coatings shall be thoroughly worked into corners and crevices.

Newly painted surfaces shall be adequately protected from damage.

3.4.2 Procedures

There shall be at least three (3) coats of paint applied in accordance with the manufacturer's instructions.

Coatings shall be applied as follows:

Material shall be thoroughly stirred to produce a uniform mixture.

Material shall be thinned for workability and improved spray characteristics, but only according to the manufacturer's instructions.

Each coat shall be applied uniformly at the minimum wet-film thickness specified by the manufacturer.

Special attention shall be given when coating sharp edges, corners, and crevices to ensure complete coverage.

Finish coats shall show good hiding characteristics and uniform appearance.

3.5 ACCEPTANCE PROVISIONS

3.5.1 Inspection

Contractor shall provide qualified personnel for inspection of his work to ensure that the requirements of this section have been fulfilled.

3.5.2 Correction

Spot-painting to correct damaged surfaces will be allowed only when touchup area blends into the surrounding finish. Otherwise, the entire area shall be recoated. Touchup shall be accomplished using the same method of

application as was used to apply the original material.

3.6 PROTECTION

"WET PAINT" signs shall be posted to indicate newly painted surfaces.

3.7 PAINT SCHEDULE

| SURFACE | PRIMER | UNDERCOAT AND FINISH COAT | FINISH COLOR AND SHEEN |
|---|---|---|---|
| Interior metal | Inhibitive metal primer | Water-base acrylic enamel | gloss,color to be selected from manu-facturers standard color charts. |
| Exterior metal | Inhibitive metal primer | Water-base acrylic epoxy | gloss,color to be selected from manu-facturers standard color charts. |

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# SECTION 26 00 00.00 20

# BASIC ELECTRICAL MATERIALS AND METHODS

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D 709 | (2001; R 2007) Laminated Thermosetting Materials |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C2 | (2007; Errata 2007) National Electrical Safety Code |
| IEEE C57.12.28 | (2005) Standard for Pad-Mounted Equipment - Enclosure Integrity |
| IEEE C57.12.29 | (2005) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments |
| IEEE Std 100 | (2000) The Authoritative Dictionary of IEEE Standards Terms |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2003) Enclosures for Electrical Equipment (1000 Volts Maximum) |

CALIFORNIA CODE OF REGULATIONS (CCR)

| | |
|---|---|
| CEC | (2007) California Electrical Code |

### 1.2 RELATED REQUIREMENTS

This section applies to all sections of Division 26 and 33, ELECTRICAL and UTILITIES, of this project specification unless specified otherwise in the individual sections. This section has been incorporated into, and thus, does not apply to, and is not referenced in the following sections.

Section 26 11 16 SECONDARY UNIT SUBSTATIONS
Section 26 23 00.00 40 SWITCHBOARDS

### 1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

c. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

## 1.4 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be dual voltage 13.8x7.2 kV primary, three phase, three wire, 60 Hz, and 480Y/277 or 208Y/120 volts secondary, three phase, four wire. Final connections to the power distribution system shall be made by the Contractor as directed by the Contracting Officer.

## 1.5 ADDITIONAL SUBMITTALS INFORMATION

Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

### 1.5.1 Shop Drawings (SD-02)

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

### 1.5.2 Product Data (SD-03)

Submittal shall include performance and characteristic curves.

## 1.6 QUALITY ASSURANCE

### 1.6.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of CEC unless more stringent requirements are specified or indicated.

### 1.6.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on

the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

1.6.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.8 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

a. Wiring diagrams, control diagram, and control sequence for each principal system and item of equipment.

b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.

c. Safety precautions.

d. The procedure in the event of equipment failure.

e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.9 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

## 1.10 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Refer to drawing E80 for nameplate details.

## 1.11 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field.

## 1.12 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, CEC, and requirements specified herein.

## 1.13 INSTRUCTION TO GOVERNMENT PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instructions to acquaint the operating personnel with the changes or modifications.

## PART 2 PRODUCTS

### 2.1 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and the additional requirements specified in the technical sections.

## PART 3 EXECUTION

### 3.1 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in the section specifying the associated electrical equipment.

### 3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

### 3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

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# SECTION 26 05 00.00 40

# COMMON WORK RESULTS FOR ELECTRICAL

## PART 1 GENERAL

### 1.1 SUMMARY

This section covers: requirements common to all electrical sections, basic wiring materials and methods applicable to most types of interior electrical construction, and electrical system and equipment grounding including ground rods, grounding conductors, connectors, and other accessories.

### 1.2 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI C 80.1 | (2005) Rigid Steel Conduit - Zinc Coated |
| ANSI C 80.3 | (2005) Electrical Metallic Tubing - Zinc Coated |
| ANSI Z535.1 | (2006) Safety Color Code |
| ANSI Z535.4 | (2002) Standard for Product Safety Signs and Labels |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM B 3 | (2001) Standard Specification for Soft or Annealed Copper Wire |
| ASTM D 2301 | (1999; R 2004) Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape |

CALIFORNIA CODE OF REGULATIONS (CCR)

| | |
|---|---|
| CEC | (2007) California Electrical Code |

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 81 | (1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System |
| IEEE C2 | (2002) National Electrical Safety Code |
| IEEE Std 383 | (2003) Standard for Qualifying Class 1E Electrical Cables and Field Splices for Nuclear Power Generating Stations 2004 |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2003) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA FB 1 | (2003) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable |
| NEMA PB 1 | (2006) Panelboards |
| NEMA RN 1 | (2005) Standard for Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit |
| NEMA VE 1 | (2003) Standard for Metallic Cable Tray Systems |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2007) Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems |

UNDERWRITERS LABORATORIES, INC. (UL)

| | |
|---|---|
| UL 1 | (2005) UL Standard for Safety Flexible Metal Conduit |
| UL 6 | (2004) UL Standard for Safety Rigid Metal Conduit |
| UL 44 | (2005) Standard for Safety Thermoset-Insulated Wires and Cables |
| UL 83 | (2008) Standard for Safety Thermoplastic-Insulated Wires and Cables |
| UL 489 | (2002) UL Standard for Safety Molded-Case Circuit Breakers and Circuit-Breaker Enclosures |
| UL 506 | (2000) UL Standard for Safety Specialty Transformers |
| UL 797 | (2004) UL Standard for Safety Electrical Metallic Tubing |
| UL 870 | (1995; Rev thru July 2003) Wireways, Auxiliary Gutters, and Associated Fittings |

## 1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00, SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixtures Lists shall be submitted for the following:

Conduits, Raceways and Fittings
Wire and Cable
Splices and Connectors
Pull Boxes
Circuit Breakers
Panelboards
Dry-Type Distribution Transformers

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Conduits, Raceways and Fittings
Wire and Cable
Splices and Connectors
Pull Boxes
Circuit Breakers
Panelboards
Dry-Type Distribution Transformers
Spare Parts

SD-04 Drawings

As-Built Drawings, which shall indicate the precise routing of all raceways; the location of all panelboards, switches, and wiring devices; ground rods; mats; grids; building ground bus; supplementary grounding electrodes; and metal structures connected to the grounding system.

SD-06 Instructions

Manufacturer's instructions shall be submitted.

SD-07 Reports

Test reports for all tests specified to be conducted by the Contractor.

SD-13 Certificates

Certificates of compliance on products required to meet UL, FM, ASTM, ANSI, NFPA, or other commercial listing requirements, when a label is not provided on the product.

SD-19 Operation and Maintenance Manuals

Data intended to be incorporated in an operations and maintenance manual.

Contractor shall furnish six (6) copies of a complete instruction manual for installation, operation, maintenance and lubrication requirements of all equipment, including but not limited to, each of the following items.

a. Switchgears

b. 15kV Vacuum Circuit Breakers

c. Switchboards and Panelboards

d. Overcurrent Protective Devices (Relays, Current/Voltage Transformers)

e. Cables

f. Low Voltage Breakers

g. Transformers

Each instruction manual furnished shall be in hard-back three-ring binders which are clearly labeled to designate the equipment for which they are intended. each instruction manual shall include all information required by the following:

a. Procedures for the installation, field testing and maintenance of the equipment.

b. Complete parts list (material inventory), including each item's catalog identification and description.

c. Complete electrical schematics and joint-to-joint wiring diagram.

d. Performance and nameplate data.

e. Installation and set-up instructions.

f. Procedure for starting and pre-operation checklist.

g. Proper adjustment including a list of all necessary information for calibrating, operating and recommendation settings of protective relays.

h. Trouble-shooting guide and safety precautions.

i. Detail assembly drawings with parts numbers, part lists, instruction for ordering spare parts, and complete preventive maintenance instructions.

## 1.4 QUALITY ASSURANCE

Approval of materials and equipment will be based on standards of UL, NEMA, ANSI, ASTM, NFPA, or other commercial standards.

Equipment design, fabrication, and installation shall, unless shown otherwise, comply with the applicable requirements of CEC and referenced industrial codes and standards.

Work shall not be covered up nor enclosed until it has been inspected, tested, and approved. Any work that is enclosed or covered up before such inspection and test shall be uncovered and, after it has been inspected and approved, shall be restored to its original condition at no additional cost.

## 1.5 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

It is the intent of these specifications and the contract drawings to

provide a complete and workable facility.

Design drawings are diagrammatic and do not show all offsets, bends, elbows, or other specific elements that may be required for proper installation of the work. Such work shall be accomplished at the site. Additional bends, offsets, and conduit, as required by vertical and horizontal equipment locations or other job conditions, shall be provided to complete the work at no additional cost to the Government.

Equipment sizes shown on the drawings are minimum unless otherwise indicated. Before installing any wire or conduit, the Contractor shall obtain the exact equipment requirements and install wire, conduit (above or underground), disconnect switches, motor, circuit breakers, and other items of the correct size for the equipment actually installed; however, wire and conduit sizes shown on the drawings shall be taken as a minimum and shall not be reduced without written approval.

## 1.6 COORDINATION

The electrical work shall be coordinated with the work of all other trades.

The Contractor shall conduct his operations so as to minimize interference with the electric service to any existing structure. Specific approval shall be obtained before any existing service is interrupted, either momentarily or for extended periods of time. When such work is contemplated, the Contractor shall notify the Contracting Officer at least fourteen days in advance of the time such work is planned and the Contractor shall not proceed with the work until approval has been given for interruption of service during the time requested.

## 1.7 RELAY COORDINATION STUDY AND TESTING

The Government shall perform the relay coordination study, including relay settings (pickups, time dials and trip settings) and programming for the Contractor. The Contractor shall install, test and calibrate the relays in accordance with Government settings.

The Contractor shall secure the services of a certified testing firm to provide a skilled relay technician actively engaged in the business of testing and calibrating power relays. The Contractor shall furnish all special equipment required.

Two relay wiring tests shall be made:

a. Primary circuit polarity test, including a dc test from the current transformer to each terminal block and relay terminal.

b. Relay and circuit breaker operation test by application of power from a portable relay test set.

Relay testing shall be accomplished after completion of the circuit breakers installation, using standard portable test set equipment and the relay manufacturer's testing directions.

Relays testing shall include (1) zero set test, (2) pick-up test, (3) time-current characteristics (operation at currents 3 and 4 times the calculated tap settings, and instantaneous at the calculated tap settings), and (4) target and seal-in operation.

The Contractor shall provide the Contracting Officer with six (6) copies of an attested certificate stating that the relays have been set, tested and adjusted in accordance with the data provided by a California certified Professional Electrical Engineer and indicating the relay settings as final. The tests shall be made for all new and existing circuit breaker relays and the wiring and relay operation of all circuit breakers whose control circuits may have been disturbed in any way during constructions or testing. Final field test information shall be reported on the "Electrical Distribution System coordination" form provided by a certified testing firm. Test data and Technician's initials shall be placed on a card in the relays window. Certification and test information shall be supplied to the Contracting Officer within ten days after completion of the testing.

## 1.8 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall have the standard finish by the manufacturer. Aluminum shall not be used in contact with earth and, where connected to dissimilar metal, shall be protected by approved fittings and treatment. Ferrous metals such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel shall be hot-dip galvanized in accordance with ASTM A 123 for exterior locations and cadmium-plated in conformance with FS W-J-800 for interior locations.

## 1.9 APPROVAL REQUIREMENTS

Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories (UL), Inc., the label of, or listing with re-examination, in UL-05 will be acceptable as sufficient evidence that the items conform to the requirements.

Where materials or equipment are specified to be constructed or tested in accordance with the standards of NEMA, ANSI, ASTM, or other recognized standards, a manufacturer's certificate of compliance indicating complete compliance of each item with the applicable NEMA, ANSI, ASTM, or other commercial standards specified will be acceptable as proof of compliance.

## 1.10 GOVERNMENT FURNISHED EQUIPMENT (GFE)

The Government shall furnish the equipment to the Contractor as listed in this section of the specification and elsewhere as indicated on the contract drawings. The Contractor shall provide all labor, loading and unloading to the specified job set, inspection, and installation according to the contractor drawings, and conduct field-testing for final energizing of this Government Furnished Equipment (GFE).

The GFE items are:

| Description of Equipment | Quantity | Approximate Dimensions (LxWxH) | Approx-imate Weight | Vendor |
|---|---|---|---|---|
| Microprocessor Protective Relay, P124 Refer to Section 26 05 73.00 40, Paragraph 2.8.1 for complete description | 4 Units | 5.8"x6.6"x5.5" | 15#/ea | Alstom |

| | | | | |
|---|---|---|---|---|
| Power Metering Devices | 4 Units | 3.8"x3.8"x6.3" | 25#/ea | PML |

1.10.1 Inspection on Receipt of the GFE Items by the Contractor

When the Contractor is ready to remove the GFE items from the temporary storage facilities to the project job site, the Contractor shall keep a record of all the equipment including the condition and the quantity of the equipment that have been removed from the temporary site. The Contractor shall assign Quality Assurance personnel to perform all inspections in the presence of Government personnel or their representative.

It is intended that documentation will be minimal; however, the Contractor shall provide objective evidence of quality in the form of records of inspections. The Contractor's existing documentation shall be utilized whenever possible, subject to review and approval by the Government. When receiving the GFE, the Contractor shall make a thorough external and internal inspection before the units are removed from the temporary storage site. All inspections shall be in accordance with the latest revision of the International Electrical Testing Association (NETA ATS) and/or equipment manufacturer requirements.

1.10.2 Installation and Field Testing of GFE Items by the Contractor

The Contractor shall follow the installation and field-testing procedures and requirements as described in an appropriate specification section under "EXECUTION".

Field testing shall be in accordance with the latest revision of the International Electrical Testing Association (NETA ATS) and this specification. If not, then follow the equipment manufacturer's requirements. The Government shall be informed ten (10) calendar days in advance of the date that the field test is to be conducted by a certified testing firm. Submit ten (10) copies of typewritten (handwriting is not acceptable) test procedures to the Government for approval. The Government and its representative reserve the right to attend and witness all tests. Submit all test results to the Government for approval fifteen (15) calendar days after the tests have been conducted.

PART 2 PRODUCTS

2.1 CONDUITS, RACEWAYS, AND FITTINGS

Materials and equipment to be provided shall be the standard cataloged products of manufacturers regularly engaged in the manufacture of the products. Materials and equipment shall meet the specified requirements, the detailed requirements indicated, be suitable for the installation shown, and shall represent products that have been in satisfactory use at least two years.

2.1.1 Rigid Steel Conduit

Rigid steel conduit must comply with UL 6 and be galvanized by the hot-dip process. Rigid steel conduit must be polyvinylchloride (PVC) coated in accordance with NEMA RN 1, where underground and in corrosive areas, or must be painted with bitumastic.

Fittings for rigid steel conduit must be threaded.

Gaskets must be solid. Conduit fittings with blank covers must have gaskets, except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

Covers must have captive screws and be accessible after the work has been completed.

2.1.2 Rigid PVC Conduit

Rigid PVC conduit shall be not lighter than Schedule 40. Rigid PVC shall be the slip-joint solvent-weld type, and fittings shall be unthreaded solid PVC. The minimum size of underground conduit is 3/4" unless otherwise noted on the drawing.

2.1.3 Electrical Metallic Tubing (EMT)

EMT shall be rigid metallic conduit of the thinwall type in straight lengths, elbows, or bends and shall conform to ANSI C 80.3 and the requirements of UL 797. Fittings for EMT shall meet the requirements of NEMA FB 1.

2.1.4 Flexible Metallic Conduit

Flexible metallic conduit must comply with UL 1 and be galvanized steel.

Fittings for flexible metallic conduit must be specifically designed for such conduit.

Liquidtight flexible metallic conduit shall be provided with a protective jacket of PVC extruded over a flexible interlocked galvanized steel core to protect wiring against moisture, oil, chemicals, and corrosive fumes.

Fittings for liquidtight flexible metallic conduit must be specifically designed for such conduit.

2.1.5 Cable Trays

Provide ladder type cable trays conforming to NEMA VE 1.

2.2 WIRE AND CABLE

All wire and cable shall conform to UL 83 or UL 44, as applicable.

2.2.1 Building Wire

Conductors shall be concentric stranded copper wire. Conductors shall be not less than No. 12, except that No. 14 may be used for control wiring where indicated.

Building wire shall be 600 volt Type THHN for dry location and THWN for underground and wet location with insulation of PVC and nylon jacket, or Type XHHW, with a minimum temperature rating of 90 degrees C for THHN and 75 degrees C for THWN.

2.2.2 Switchboard Wire

Switchboard wire used for instrument and control wiring on the back of switchboards and hinged-front instrument panels shall be single-conductor, 600-volt, flame- and heat-resistant insulated wire not smaller than AWG No.

14 with a minimum temperature rating of 90 degrees C.

Conductors rigidly mounted on the back of switchboards and instrument panels must be solid round, soft or annealed, copper wire conforming to ASTM B 3. Hinge connections must be rope-lay-stranded copper conductors, Class H, conforming to ASTM B 173. All wires before stranding must conform to ASTM B 3 for soft or annealed copper wire.

Switchboard wire must be Type SIS #10 minimum with cross-linked thermosetting polyethylene insulation.

### 2.2.3 Cable Tray Wire

Power and control wire installed in cable trays must be Type TC cable 600 volts, with current-carrying capacity as determined by CEC. Cable must also comply with UL 83 and IEEE Std 383.

### 2.2.4 Standard Flexible Cable

Flexible multiconductor cable for control and power below 600 volts shall contain one (green) grounding conductor and shall utilize a thermosetting or thermoplastic overall jacket (Type SJ, SJO, SO, STO, etc). A white conductor shall be included for the power neutral or grounded current-carrying conductor.

## 2.3 SPLICES AND CONNECTORS

Splices in building wire No. 8 and smaller and multiple conductor cables shall be made with indentor crimp-type connectors and compression tools to ensure a satisfactory mechanical and electrical joint.

No splices shall be made in raceway or conduit fitting. Splices shall be made in terminal boxes, junction boxes, pull boxes or inside manhole/handholes. Splices in current/potential transformers, metering, alarm, relaying and breaker control circuits are not to be allowed under this contract.

Splices in building wire No. 6 and larger and single-conductor cables shall be made with indentor crimp-type connectors and compression tools or with bolted clamp-type connectors to ensure a satisfactory mechanical and electrical joint.

Joints shall be wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor. Splices in rubber-insulated neoprene-jacket wire and cables shall be watertight.

Vinyl-plastic electrical insulating tape shall meet the requirements of ASTM D 2301.

Where pressure-sensitive tape is used, the surface must be cleaned free of dust, sand, or other foreign material and a primer recommended by the tape manufacturer must be applied prior to taping.

Where indicated and for building wire No. 8 and larger, and for all breaker control and relaying, terminations shall utilize a compression lug.

Where indicated, building wire AWG No. 10 and smaller must be terminated in pre-insulated crimp ring lugs on terminal blocks.

Solid wiring must be terminated with terminal blocks specifically designed for solid wire. Crimp type must not be used on solid wire for termination.

Stranded wire must use crimp type lugs for termination on terminal blocks.

## 2.4 BOXES AND FITTINGS

Boxes shall have sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of CEC. Boxes that are exposed to the weather or that are in normally wet locations must be cast-metal with threaded hubs. Surface-mounted boxes on interior walls must be cast-metal. Boxes in other areas must be cadmium-plated or zinc-coated sheet metal.

## 2.5 PANELBOARDS

Branch circuit panelboards must be the circuit-breaker type in accordance with NEMA PB 1. Bolt circuit breakers to the bus. Plug-in circuit breakers are not acceptable. Buses must be copper of the rating indicated, with main lugs or main circuit breakers as indicated. Provide all panelboards for use on grounded AC systems with a full-capacity isolated neutral bus and a separate grounding bus bonded to the panelboard enclosure. Panelboard enclosures must be NEMA 250, Type 1, in accordance with NEMA PB 1. Provide enclosure fronts with latchable hinged doors.

## 2.6 CIRCUIT BREAKERS (600 Volts and below)

Circuit breaker interrupting rating shall be not less than those indicated and in no event less than 22,000 amperes root-mean-square (rms) symmetrical for systems of 240 volts or less and no less than 42,000 amperes (rms) symmetrical for systems of 480 volts. Multipole circuit breakers shall be the common-trip type with a single handle. Molded case circuit breakers shall be bolt-on type conforming to UL 489.

## 2.7 GROUNDING SYSTEM COMPONENTS

### 2.7.1 Ground Rods

Ground rods shall be copper-clad or copper-coated steel rods not less than 3/4" o.d. and not less than 10' long per section. Rods shall be rolled to a commercially round shape from welded copper-coated steel and shall have a hard, clean, and smooth continuous copper surface. Ground rods shall be sectional with a cone-shaped point on the first section and shall be die-stamped near the top with the name or trademark of the manufacturer and the length of the rod in feet.

### 2.7.2 Ground Wires

Ground wires for substations, main panels and distribution points, and ground rod connections shall be annealed bare copper conforming to ASTM B 3, stranded, with 98% conductivity. Size of wires shall be as indicated and, if not otherwise indicated, shall be in accordance with the grounding requirements of CEC.

### 2.7.3 Grounding Connectors

Grounding connectors shall be exothermic weld type and UL approved and labeled.

## 2.8 IDENTIFICATION PLATES

Identification plates shall be 3-layer black-white-black, engraved to show white letters on a black background. Letters shall be uppercase. Identification plates 1-1/2 inches high and smaller than 1/16-inch thick with engraved lettering 1/8-inch high. Identification plates larger than 1-1/2 inches high shall be 1/8-inch thick with engraved lettering not less than 3/16-inch high. Identification plates having edges of 1-1/2 inches high and larger shall be beveled. For equipment and nameplate data, see contract drawing E80.

## 2.9 WARNING SIGNS

Each item of electrical equipment operating at 480 volts and above shall be provided with conspicuously located warning signs conforming to the requirements of Occupational Safety and Health Agency (OSHA) standards.

Any equipment with externally powered wiring shall be marked with a laminated plastic nameplate having 3/16-inch high white letters on a red background as follows:

DANGER - EXTERNAL VOLTAGE SOURCE

Safety color coding for identification of warning signs shall conform to ANSI Z535.1.

Provide field markings of proper warning labels for arc flash and shock hazard protection on all switchgears, switchboards, panelboards, in accordance with CEC. Warning labels shall conform to applicable provisions of NFPA 70E and ANSI Z535.4, and subject to approval by the Contracting Officer.

## 2.10 ANCHOR BOLTS

Anchor bolts shall be provided for equipment placed on concrete equipment pads or slabs.

## 2.11 PAINTING

Enclosures of the following listed items shall be cleaned, primed, and factory-painted inside and outside in accordance with ASTM D 1535.

| ITEM | FINISH COLOR |
|---|---|
| Switches / Switchgear | No. 61 gray |
| Transformers | No. 61 gray |

# PART 3 EXECUTION

## 3.1 INSTALLATION

Installation shall be accomplished by workers skilled in this type of work. Installation shall be made so that there is no degradation of the designed fire rating of walls, partitions, ceilings, and floors. Except as otherwise indicated, emergency switches and alarms shall be installed in conspicuous locations.

Electrical equipment and feeders shall be supported and/or anchored in accordance with California Building Code Zone 4 Seismic Requirements.

3.2 IDENTIFICATION PLATES

Identification plates shall be fastened by means of corrosion-resistant steel or nonferrous metal screws on all newly installed electrical equipment and nylon tiewraps at all cables.

a. Medium voltage circuit breakers

b. Transformers

c. Power metering devices

d. Relays

e. Low voltage switchgears, switchboards and panels

f. Cable in every manhole

g. Medium voltage and low voltage pullboxes (as indicated on drawings)

h. Deadbreak junctions

Hand lettering, marking, or embossed self-adhesive tapes are not acceptable.

Identification plates shall be furnished for all line voltage enclosed circuit breakers, identifying the equipment served, voltage, phase (s) and power source. Circuits 480 volts and above shall have conspicuously located warning signs in accordance with OSHA requirements.

3.3 EQUIPMENT PADS

Equipment pads shall be provided where indicated on the drawings and shall be the dimensions shown, or, if not shown, shall conform to the shape of each piece of equipment served with a minimum 3" margin around the equipment and supports. Also rubber vibration isolation pads shall be provided with every piece of equipment.

3.4 CUTTING AND PATCHING

Contractor shall install his work in such a manner and at such time as will require a minimum of cutting and patching on the building structure.

Holes in or through existing masonry walls and floors in exposed locations shall be drilled and smoothed by sanding. Use of a jackhammer will be permitted only where specifically approved.

3.5 DAMAGE TO WORK

Required repairs and replacement of damage work shall be done as directed by and subject to the approval of the Contracting Officer, and at no additional cost to the Government.

3.6 CLEANING

Exposed surfaces of wireways, conduit systems, and equipment that have become covered with dirt, plaster, or other material during handling and

construction shall be thoroughly cleaned.

Before final acceptance, electrical equipment shall be clean and free from dirt, grease, and fingermarks.

## 3.7 CONCRETE ENCASED DUCTBANK

Contractor shall install red dye concrete for all underground electrical conduit (duct) as shown on the drawings. Ductbank shall be buried at least 24 below grade and 36" under the roadway.

## 3.8 CONDUITS, RACEWAYS, AND FITTINGS

Conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting must not contain more than the equivalent or three 90-degree bends, including those bends located immediately at the outlet or fitting.

Do not install crushed or deformed conduit. Avoid trapped conduit runs where possible. Care must be taken to prevent the lodgment of foreign material in the conduit, boxes, fittings, and equipment during the course of construction. Clogged conduit must be cleared of obstructions or be replaced.

Conduit and raceway runs concealed in or behind walls, above ceilings, or exposed on walls and ceilings 5 feet or more above finished floors and not subject to mechanical damage may be electrical metallic tubing (EMT).

Power, control power, and power metering system wires shall be enclosed in separate conduit systems. Conduit and fittings shall be installed in accordance with CEC and as specified herein.

Conduit and raceway runs in or under concrete, in damp, corrosive, or outdoor locations, in hazardous areas, where subject to mechanical damage, or intended for conductors rated over 600 volts, shall be rigid steel conduit. Conduit joints in corrosive areas shall be painted with corrosion- or acid-inhibiting compounds.

Any run of EMT, intermediate, or rigid conduit between fitting and fitting, or between outlet and fitting shall conform to the latest version of the California Electrical Code, including those bends located immediately at the outlet or fitting. Installed conduit and fittings shall be free of dirt and trash and shall not be deformed or crushed.

Conduit shall be installed with a minimum of 6" of free air space separation from mechanical piping.

Conduit in finished areas shall be installed concealed. Conduit passing through walls shall be installed in sleeves.

Expansion fittings with flexible ground strap shall be provided in conduit runs crossing building expansion joints.

Exposed ends of conduit without conductors shall be sealed with watertight caps or plugs. Bushings shall be provided on the open ends of conduit containing conductors. Insulated bushings shall be provided for conduits containing conductors No. 4 or larger with an insulating ring as integral part of the bushing.

A nylon or polypropylene pull rope with a tensile strength not less than 130 pounds shall be installed in all empty conduits.

Couplings, boxes, and conduit fittings on fire alarm systems shall be painted red.

### 3.8.1 Support of Conduit

Conduit shall be securely clamped and supported at least every 10 feet vertically and 8 feet horizontally unless otherwise noted. Conduit in high vibration areas shall be supported every 3 feet; and, in medium vibration areas every 5 feet. Unless noted on construction documents, the Contracting Officer shall be contacted for final verification of high and medium vibration areas. Galvanized pipe straps shall be fastened to structure with bolts, screws, and/or anchors. Wooden masonry plugs shall not be used.

Neither conduits nor boxes shall be supported from T-bar ceiling wires.

Conduit connections to boxes and fittings shall be supported not more than 3 feet from the connection point. Conduit bends shall be supported not more than 3 feet from each change in direction. Conduit shall be installed in neat symmetrical lines parallel to the centerlines of the building construction and the building outline. Multiple runs shall be parallel and grouped whenever possible on common supports.

The ends of conduit extending from the interior to the exterior of the building and portions of interior conduit exposed to widely varying temperatures shall be sealed to prevent the passage of air within the conduit. Conduit shall be sloped to drain and shall be provided with drainage fittings at the lower end of the run. The curved portion of conduit bends shall not be visible above the finished floor. Underground service entrance and feeder conduit entering or leaving the building above the ground floor shall be terminated in a pull box.

### 3.8.2 Flexible Conduit

Electrical connections to vibration-isolated equipment shall be made with flexible metallic conduit in a manner that will not impair the function of the equipment.

Flexible metallic conduit shall be used to connect recessed fixtures from outlet boxes in ceilings, metallic transformers, and other approved assemblies.

Liquidtight flexible metallic conduits shall be used in wet and oily locations.

Sections of flexible steel conduit shall be not more than 6'long and shall be installed only in exposed or accessible locations. Interior surface of conduit shall be free from burrs and sharp edges which might cause abrasion of wire and cable coverings. Ends of flexible steel conduit shall be provided with grounding bushings and approved fittings.

Ground wires shall be used in flexible conduit for all circuits. Flexible conduit shall not be considered a ground conductor.

3.8.3 Rigid steel Conduit

Ends of conduit shall be cut square, reamed and threaded, and joints shall be brought butt-to-butt in the couplings. Joints shall be mechanically tight. Conduit shall be protected against damage and the entrance of water or foreign material during construction.

Ninety degree bends of conduit larger than 2" shall be made with factory-made elbows. Conduit elbows larger than 3" shall be 24" long radius. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Changes in directions of runs shall be made with symmetrical bends or cast-metal fittings.

At connections to sheet metal enclosures and boxes, a sufficient number of threads shall project through to permit the bushing to be drawn tight against the end of the conduit, after which the locknut shall be pulled up sufficiently tight to draw the bushing to firm electrical contact with the box. Conduit shall be fastened to sheet metal boxes and cabinets with two locknuts where required by the National Electric Code, where insulating bushings are used, where bushings cannot be brought into firm contact with the box, and where indicated.

Conduit joints shall be made with tapered threads set firmly. Each length of conduit cut in the field shall be reamed before installation. Where conduit is threaded in the field, each threaded end shall consist of at least five full threads. Corrosive-inhibitive compound shall be used on conduit threads in exterior areas.

Conduit stubbed up through concrete floors for connections to free-standing equipment (except motor-control centers, cubicles, and other such items of equipment) shall be provided with a flush coupling if the floor slab is of sufficient thickness; if not, a floor box shall be provided and set flush with the finished floor. Conduits installed for future use shall be terminated with a coupling and plug set flush with the floor, unless otherwise indicated.

3.8.4 Rigid PVC Conduit

Rigid PVC conduit for underground work shall be encased in a red-dyed concrete envelope or direct buried as specified for underground ducts.

A continuous, bare, soft-draw copper ground wire shall be run in conduit with all power cable 600 volts or less and shall be solidly connected to ground at each end. Ground wires shall be sized per CEC.

Rigid PVC conduit shall be stored on a flat surface and shall be protected from the direct rays of the sun.

3.8.5 Electrical Metallic Tubing (EMT)

EMT shall be cut square with a hacksaw or three-wheel pipe cutter and reamed to remove burrs and rough surfaces.

EMT must be grounded in accordance with CEC, using pressure grounding connectors especially designed for EMT.

Field-made bends and offsets shall be avoided where possible but, where necessary, shall be made with an approved hickey or conduit-bending machine. Changes in direction of runs shall be made with symmetrical bends

or approved metal fittings.

3.8.6 Flexible Metallic Conduit

Flexible metallic conduit shall be installed only in exposed, accessible locations in accordance with CEC. A grounding conductor (green) shall be installed in all runs. Connections to motors and vibrating equipment shall be made with flexible metallic conduit.

3.9 INSTALLATION OF WIRING

Raceways shall be completely installed, with interior clean, dry, and protected from the weather, before proceeding with the installation of wires and cables. Conductors of special-service systems and emergency light and power systems shall not occupy the same enclosure with light and power conductors or the same enclosure with each other. Conductors shall be continuous with splices and connections made in outlet, junction, or pull boxes only. All control wiring must be continuous between components and/or terminal boards.

Conductors 600 volts and below shall be color coded in accordance with the following:

| CONDUCTOR | 120/208/240V | 277/480V |
|---|---|---|
| Phase A | Black | Brown |
| Phase B | Red | Orange |
| Phase C | Blue | Yellow |
| Neutral | White | White |
| Equipment Grounds | Green | Green |

Control/metering wires shall be manufactured with colored insulation. Conductors up to and including No. 6 shall be manufactured with colored insulating materials. Conductors larger than No. 2 must have ends identified with colored plastic tape in outlet, pull, or junction boxes. Control circuit conductors shall be identified at each connection point.

Connectors and splices shall conform to UL and CEC and shall be made in approved enclosures utilizing solderless pressure connectors and adequate insulation with vinyl-plastic electrical insulating tape. Conductors and materials used in a splice, tap, or connection shall be thoroughly cleaned prior to makeup to ensure good electrical and mechanical connections. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made at the equipment terminal of each conductor. Terminal and conductor identification shall match that shown on approved shop drawings. Hand lettering or marking is not acceptable. Control-circuit terminals of equipment shall be properly identified by color-coded insulated conductors, number-coded plastic self-sticking printed markers, or permanently attached metal-foil markers. Cable fittings and insulating tape shall be UL labeled.

Phase conductors and the neutral conductor of each branch or feeder circuit must be contained in a single enclosure or paralleled in separate enclosures to avoid overheating the raceway by electromagnetic induction. Conductors and conduit in parallel must be the same length and size, must have conductors of the same type of insulation, must be terminated at both ends in a manner to ensure equal division of the total current among conductors, and must have a separate neutral conductor in each conduit.

Where several feeders pass through a common pullbox, the feeders shall be tagged to clearly indicate the electrical characteristics, circuit number, and panel designation. Tags shall be oriented in a way so as to be easily read.

All control devices, contacts, metering units alarms and other devices shall be completely connected using closed ring-type terminals for connections to device terminals and to terminal blocks located in the cabinet. Terminal blocks shall be plainly marked to identify all connections, and at least 20 percent spare terminal points shall be provided. All terminal blocks shall have stainless steel hardware and screws. Terminal blocks shall accommodate No. 8 wire. All wires shall be identified at terminal blocks by sleeve in plastic with wire number.

## 3.10 BOXES AND FITTINGS

Junction, pull, and outlet boxes shall be installed where required and where indicated.

Pullboxes shall be furnished and installed where necessary in the conduit system to facilitate conductor installation. Conduit runs longer than 100 feet or with more than three right angle bends shall have a pullbox installed at a convenient intermediate location.

Boxes and enclosures shall be securely mounted to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

Bonding jumpers shall be used around concentric or eccentric knockouts.

An identification plate marked "DANGER: 480 VOLTS" shall be provided on the outside of 480-volt enclosures. The identification plate shall use white lettering on a red laminated plastic.

## 3.11 PANELBOARDS

Mount panelboards so that the top operating handle does not exceed 72 inches above the finished floor. Do not mount equipment within 36 inches of the front of the panel. Directory card information must be complete and legible.

## 3.12 PAINTING

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks must be thoroughly cleaned and painted as specified in Section 09 90 00.00 40 PAINTING AND COATING.

## 3.13 GROUNDING

Ground rods shall be driven so that the top of the rod is 6" above grade.

Metallic raceway systems shall have electrical continuity with equipment individually and directly connected to the building ground, independent of the raceway system, as herein specified. All raceways shall contain an appropriately sized green grounding conductor.

Enclosures for panelboards shall be individually and directly connected to the building ground. The grounding conductor shall be not less than No. 2 and shall be connected from the building ground to a copper ground-bus

terminal strip located in each panelboard.

Equipment enclosures shall be grounded with an identified (green color) insulated conductor, not smaller than No. 12, connected to the branch circuit ground-bus terminal strip. The ground-bus terminal strip in each panelboard enclosure shall be isolated and independent of the system neutral terminal strip.

Building and equipment grounding shall be accomplished in accordance with CEC.

## 3.14 FIELD TESTS

All testing shall be accomplished in accordance with NETA ATS-2007 and shall be performed by a certified testing firm.

### 3.14.1 Wiring System Tests

After completion of the installation and splicing, and prior to energizing the conductors, perform wire and cable continuity and insulation tests as herein specified before the conductors are energized.

The Contractor must provide all necessary test equipment, labor, and personnel to perform the tests, as herein specified.

Isolate completely all wire and cable from all extraneous electrical connections at cable terminations and joints. Substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panelboards, and other disconnecting devices must be used to isolate the circuits under test.

Perform Insulation-Resistance Test on each field-installed conductor with respect to ground and adjacent conductors. Applied potential must be 500 volts DC for 300 volt rated cable and 1000 volts DC for 600 volt rated cable. Take readings after 1 minute and until the reading is consistent for 15 seconds. Minimum insulation-resistance values must not be less than 25 Megohms for 300 volt rated cable and 100 Megohms for 600 volt rated cable. For circuits with conductor sizes 8 AWG and smaller, insulation-resistance testing is not required.

Perform Continuity Test to insure correct cable connection (i.e., correct phase conductor, grounded conductor, and grounding conductor wiring) end-to-end. Any damages to existing or new electrical equipment resulting from contractor miswiring, will be repaired and reverified at contractor's expense. All repairs must be approved by the CO prior to acceptance of the repair.

Conduct Phase-Rotation Tests on all three-phase circuits using a phase-rotation indicating instrument. Perform phase-rotation of electrical connections to connected equipment clockwise, facing the source.

Final acceptance will depend upon the successful performance of wire and cable under test. Do not energize any conductor until the final test reports are reviewed and approved by the CO.

### 3.14.2 Grounding System Tests

The Contractor shall test grounding systems for ground resistance.

Ground resistance tests shall be made during dry weather and in no case sooner than 48 hours after rainfall. Tests shall be conducted using the ratio method that measures the ratio of the resistance to earth of an auxiliary test electrode to the series resistance of the electrode under test and a second auxiliary electrode. Measurements shall be performed in accordance with IEEE 81, by the ratio ohmmeter, and as herein specified.

The auxiliary grounding electrodes shall be placed in accordance with instrument manufacturer's recommendations but not less than 30' apart, in accordance with IEEE 81.

3.14.3 Records

Test readings, including the method of testing and the environmental conditions of the test, shall be recorded and submitted to the Contracting Officer.

A certified record of ground-resistance tests on each driven ground-rod assembly, and other grounding electrode shall be submitted, including the number of rods driven and their depth at each location to meet the required resistance-to-ground measurements specified. A statement shall be included describing the condition of the soil at the time of measurement. The location of each ground-rod assembly and other grounding electrodes shall be identified by letter in alphabetical order and keyed to the record of ground-resistance tests.

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# MEDIUM-VOLTAGE CABLES

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

| | |
|---|---|
| AEIC CS8 | (2007e3) Specification for Extruded Dielectric Shielded Power Cables Rated 5 through 46kV |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B 3 | (2007) Standard Specification for Soft or Annealed Copper Wire |
| ASTM D 746 | (2007) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE Std 383 | (2003) Standard for Qualifying Class 1E Electric Cables and, Field Splices for Nuclear Power Generating Stations 2004 |
| IEEE Std 386 | (2006) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V |
| IEEE Std 400.2 | (2004; R 2005) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF) |
| IEEE Std 404 | (2006) Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500V Through 500,000V |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA WC 27500 | (2005) Standard for Aerospace and Industrial Electrical Cable |
| NEMA WC 70 | (1999 Errata 2001) Standard for Non-Shielded Power Cable 2000 V or Less for the Distribution of Electrical Energy |
| NEMA WC 71 | (1999) Standard for Nonshielded Cables Rated 2001-5000 Volts for the Distribution |

of Electrical Energy

NEMA WC 74 (2006) Standard for 5-46 kV Shielded Power Cable for use in the Transmission and Distribution of Electrical Energy

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS (2007) Acceptance Testing Specifications

CALIFORNIA CODE OF REGULATIONS (CCR)

CEC (2007) California Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 510 (2005 Rev. thru August 2005) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape

UL 1072 (2007) Medium-Voltage Cables

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD 228 (2000) Cable and Wire, Insulated; Methods of Testing

## 1.2 DEFINITIONS

Medium voltage power cables shall mean all cables rated above 600 to 35,000 volts.

## 1.3 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Certificates shall be provided for the following showing that the cable manufacturer has made factory-conducted tests on each shipping length of cable. Certified copies of test data shall show conformance with the referenced standards and shall be approved prior to delivery of cable.

## 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment and performance data and manufacturer's catalog data shall be provided for the following items:

Single-Conductor Shielded Cables

SD-06 Test Reports

Test reports for the following shall be in accordance with the paragraph entitled, "Field Testing," of this section.

Dielectric Absorption Tests
High-Voltage Tests
Radiographic Tests
Corona Discharge

SD-07 Statements

Listing of products installed shall be provided showing qualifications of Cable Splicers to the Contracting Officer prior to specified work.

SD-08 Certificates

Conductor Resistance
Ionization
High-Voltage
Flammability
Mechanical Integrity
Bending Test
High-Voltage Time Test
Dielectric Power Loss
Power-Factor Tests
Qualifications of Cable Splicers

SD-09 Manufacturer's Instructions

Manufacturer's instructions shall be provided showing the recommended sequence and method of installation for the following:

Medium-Voltage Power Cables
Elbow Terminations
Deadbreak Junctions

## 1.5 QUALIFICATIONS

Cable splicers performing splicing shall have 5 years experience in cable splicing and terminations. Once a termination or splice has been started by a worker, the same person shall complete that particular splice. Each termination and splice shall be started and completed in one continuous work period.

## 1.6 CABLE VOLTAGE RATINGS

Medium-voltage power cables shall include multiple- and single-conductor cables rated as follows, phase-to-phase, for grounded and ungrounded neutral systems:

Cables rated 15,000 volts, ungrounded neutral, shall be used on 7,200 volts and 13,800 volts, three-phase, 60-hertz distribution systems.

## 1.7 SHIPMENT

Cable shall be shipped on reels such that the cable will be protected from mechanical injury. Each end of each length of cable shall be hermetically sealed and securely attached to the reel.

Minimum reel drum diameter shall be 14 times the overall diameter of the cable. A pulling eye shall be installed by the manufacturer for each length of cable supplied for installation in ducts, manholes, and utility

tunnels.

PART 2 PRODUCTS

2.1 CONDUCTORS

Conductors shall be uncoated soft solid copper conforming to ASTM B 3.

2.2 CABLE IDENTIFICATION

Cables shall have a tape placed immediately on the outer jacket showing the name of the manufacturer, the year in which the cable was manufactured, and a unique number for identification purposes. Information shall be closely grouped on the tape at 1-foot intervals to permit complete identification.

2.3 CONDUCTOR SHIELD

Extruded layer of the semiconducting EPR thermo-setting compound.

2.4 FLAMMABILITY

Cables not to be enclosed in metallic conduit shall be tested for flammability in accordance with IEEE Std 383, 70,000 Btu per hour vertical tray flame test.

2.5 SINGLE-CONDUCTOR SHIELDED CABLES

2.5.1 Ethylene-Propylene-Rubber-Insulated with Hypalon Jacket

Single conductor 15 KV cable assemblies shall consist of: Class B stranded copper conductors, an extruded semiconducting shield over the conductors, 133% insulation( 220 mils) of ethylene propylene rubber insulation, an extruded or other approved semiconducting shield, a 5 mil minimum copper tape shield wrapped helically with a minimum 25 percent overlap and a hypalon jacket.

The cable shall be suitable for use in wet or dry locations, in underground ducts or the direct burial applications. The cable shall be rated for 90°C or 105°C continuous load and 130°C or 140°C emergency overload and 250°C short circuit conditions as indicated on the drawings. Emergency overload operation may occur for periods up to 1500 hours during the life of the cable. The cable shall meet or exceed recognized industry standards UL 1072, AEIC CS8, NEMA WC 70, NEMA WC 71, and NEMA WC 74.

2.6 TERMINATIONS

Terminations shall be provided in a kit, including: skirts, stress control terminator, ground clamp, connectors, lugs, and complete instructions for assembly and installation. Terminations shall be the product of one manufacturer, suitable for the type, diameter, insulation class and level, and materials of the cable terminated. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

2.6.1 Cold-Shrink Type

Terminator shall be a one-piece design, utilizing the manufacturer's latest technology, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber. Termination

shall not require heat or flame for installation. Termination kit shall contain all necessary materials (except for the lugs). Termination shall be designed for installation in low or highly contaminated indoor and outdoor locations and shall resist ultraviolet rays and oxidative decomposition.

2.6.2 Heat Shrinkable Type

Terminator shall consist of a uniform cross section heat shrinkable polymeric construction stress relief tubing and environmentally sealed outer covering that is nontracking, resists heavy atmospheric contaminants, ultraviolet rays and oxidative decomposition. Provide heat shrinkable sheds or skirts of the same material. Termination shall be designed for installation in low or highly contaminated indoor or outdoor locations.

2.6.3 Separable Insulated Connector Type

IEEE Std 386. Provide connector with steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material. Provide connectors of deadbreak type as indicated, of suitable construction for the application and the type of cable connected, and that include cable shield adaptors. Provide external clamping points and test points.

900A loadbreak connector rating: voltage 15/25kV class. Short time rating 40,000A RMS symmetrical. Copper submersible deadbreak junction assembly with adjustable stainless steel bracket.

2.7 MEDIUM VOLTAGE CABLE JOINTS

Provide joints (splices) in accordance with IEEE Std 404 suitable for the rated voltage, insulation level, insulation type, and construction of the cable. Joints shall be certified by the manufacturer for waterproof, submersible applications. Upon request, supply manufacturer's design qualification test report in accordance with IEEE Std 404. Connectors for joint shall be tin-plated electrolytic copper, having ends tapered and having center stops to equalize cable insertion.

2.7.1 Heat-Shrinkable Joint

Consists of a uniform cross-section heat-shrinkable polymeric construction with a linear stress relief system, a high dielectric strength insulating material, and an integrally bonded outer conductor layer for shielding. Replace original cable jacket with a heavy-wall heat-shrinkable sleeve with hot-melt adhesive coating.

2.7.2 Cold-Shrink Rubber-Type Joint

Joint shall be of a cold shrink design that does not require any heat source for its installation. Splice insulation and jacket shall be of a one-piece factory formed cold shrink sleeve made of black EPDM rubber. Splice shall be packaged three splices per kit, including complete installation instructions.

2.8 TAPE

2.8.1 Insulating Tape

UL 510, plastic insulating tape, capable of performing in a continuous temperature environment of 80$^{\circ}$C.

### 2.8.2 Buried Warning and Identification Tape

Provide detectable metallic foil bright yellow warning tape in accordance with CEC.

### 2.8.3 Fireproofing Tape

The fireproofing tape shall consist of a flexible conformable fabric having one side coated with flame retardant, flexible, polymeric coating and/or a chlorinated elastomer not less than 0.05 inch thick and shall weight not less than 0.28 pounds per square foot. The tape shall be noncorrosive to the cable sheath, shall be self-extinguishing, and shall not support combustion. The tape shall not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.

## 2.9 PULL ROPE

Shall be plastic or flat pull line (bull line)having a minimum tensile strength of 200 pounds.

## 2.10 CABLE SUPPORTS (RACKS, ARMS, AND INSULATORS)

The metal portion of racks and arms shall be zinc-coated after fabrication.

### 2.10.1 Wall Bracket/Stanchion

The wall bracket shall be 4 inches by approximately 1-1/2 inches by 3/16 inch channel steel, 48 inches long (minimum) in manholes. Slots for mounting cable rack arms shall be spaced at 8 inch intervals. Heavy duty non-metallic cable rack stanchions shall be 36 inches long.

### 2.10.2 Rack Arms

Cable rack arms shall be steel or malleable iron or glass reinforced nylon and shall be of the removable type. Rack arm length shall be a minimum of 8 inches and a maximum of 20 inches.

### 2.10.3 Insulators

Insulators for metal rack arms shall be dry-process glazed porcelain. Insulators are not required for nylon arms.

## 2.11 CABLE TAGS IN MANHOLES

Provide polyethylene tags for each new power cable located in manholes. Do not provide handwritten letters. The first position on the power cable tag shall denote the voltage. The second through sixth positions on the tag shall identify the circuit. The next to last position shall denote the phase of the circuit and shall include the Greek "phi" symbol. The last positron shall denote the cable size. As an example, a tag could have the following designation: "13.8 VMS (Phase A) 1000", denoting that the tagged cable is on the 13.8kV system, circuit number VMS, underground, Phase A, sized at 1000 kcmil.

### 2.11.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 3250 pounds per square inch; that are 0.08 inch thick (minimum), non-corrosive

non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 170°F. Provide 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ties shall have a minimum loop tensile strength of 175 pounds. The cable tags shall have black block letters, numbers, and symbols, one inch high on a white background. Letters, numbers, and symbols shall not fall off or change positions regardless of the cable tag's orientation.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Medium-voltage cables shall be installed in accordance with CEC.

Cable shall be installed in underground duct banks; in conduit above and below grade; inside buildings; on racks; in wall and ceiling mounted cable trays; in manholes.

Cables shall be secured with heavy duty cable ties on racks inside manholes at a minimum of 10 feet intervals.

Cables shall be secured with non-metallic cable clamps, straps, hangers, or other approved supporting devices to manhole walls. Provide fireproofing tape on cable inside manholes.

When field cuts or other damage occurs to the PVC coating, a liquid PVC patch shall be applied to maintain the integrity of the coating. After the installation is complete, an inspection shall be performed to ensure the absence of voids, pinholes, or cuts.

Cable or conductors of a primary distribution system shall be rejected when installed openly in cable trays or openly racked along interior walls; in the same raceway or conduit with ac/dc control circuits or ac power circuits operating at less than 600 volts; or in a manner allowing cable to support its own weight.

### 3.1.1 Cable Supports and Fittings

Cable supports, related fittings, and accessories for use in corrosive underground locations, such as manholes, shall be sufficient to accommodate the cables. Racks in power manholes shall be spaced not more than 3 feet apart.

New rack arms and insulators shall be provided to accommodate the new cables under this contract. All new brackets shall be galvanized steel channel or glass reinforced nylon and new cable racks shall be of removable type. Insulators shall be dry-process porcelain.

### 3.1.2 Protection During Splicing Operations

Blowers shall be provided to force fresh air into manholes or confined areas where free movement or circulation of air is obstructed. Waterproof protective coverings shall be available on the work site to provide protection against moisture while a splice is being made. Pumps shall be used to keep manholes dry during splicing operations. Under no conditions shall a splice or termination be made with the interior of a cable exposed to moisture. Conductor insulation paper shall be moisture-tested before the splice is made. A manhole ring at least 6-inches above ground shall be

used around the manhole entrance to keep surface water from entering the manhole. Unused ducts shall be plugged and water seepage through ducts in use shall be stopped before the splice is started.

### 3.1.3 Duct Cleaning

Ducts shall be thoroughly cleaned before installation of power cables. A standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material in the line. Mandrel length shall be not less than 12-inches long and shall have a diameter 1/2 inch less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. Brush diameter shall be the same as or slightly larger than the diameter of the duct.

### 3.1.4 Pulling Cables in Ducts and Manholes

Medium-voltage cables shall be pulled into ducts and utility tunnels with equipment designed for this purpose, including power-driven winch, cable-feeding flexible tube guide, cable grips, and lubricants. A sufficient number of trained personnel and equipment shall be employed to ensure the careful and proper installation of the cable.

Cable reel shall be set up at the side of the manhole or tunnel hatch opening and above the duct or hatch level, allowing the cable to enter through the opening without reverse bending. Flexible tube guide shall be installed through the opening in a manner that will prevent the cable from rubbing on the edges of any structural member.

A dynamometer shall be used in the pulling line to ensure that the pulling force is not exceeded. Pulling force for a nonmetallic-sheathed cable shall not exceed the smaller of 1,000 pounds or a value computed from the following equation:

TM = 0.008 X N X CM

Where: TM = maximum allowable pulling tension in pounds

N = number of conductors in the cable

CM = cross-sectional area of each conductor in circular mils

Cable shall be unreeled from the top of the reel. Payout shall be carefully controlled. Cable to be pulled shall be attached through a swivel to the main pulling wire by means of a pulling eye.

Woven-wire cable grips shall be used to grip the cable end when pulling small cables and short straight lengths of heavier cables.

Pulling eyes shall be attached to the cable conductors to prevent damage to the cable structure.

Pulling eyes and cable grips shall be used together for nonmetallic sheathed cables to prevent damage to the cable structure.

Minimum bending radius shall be in accordance with the following:

| CABLE TYPE | MINIMUM BENDING RADIUS MULTIPLIER TIMES CABLE DIAMETER |
|---|---|
| RUBBER- AND PLASTIC-INSULATED CABLE WITH OR WITHOUT INTERLOCKED ARMOR | |
| Shielded cables with shielding tape | 12 |

Cables shall be liberally coated with a suitable cable-pulling lubricant as it enters the tube guide or duct. Grease and oil lubricants shall be used only on lead-sheathed cables. Nonmetallic sheathed cables shall be covered with wire-pulling compounds when required which have no deleterious effects on the cable. Rollers, sheaves, or tube guides around which the cable is pulled shall conform to the minimum bending radius of the cable.

Cables shall be pulled into ducts not in excess of maximum permissible pulling tension specified by the cable manufacturer. Cable pulling using a vehicle shall not be permitted. Pulling operations shall be stopped immediately with any indication of binding or obstruction and shall not be resumed until such difficulty is corrected. Sufficient slack shall be provided for free movement of cable due to expansion or contraction.

Cable splices made up in manholes or utility tunnels shall be firmly supported on cable racks as indicated. No cable splices shall be pulled in ducts. Cable ends shall overlap at the ends of a section to provide sufficient undamaged cable for splicing. Cables to be spliced in manholes or utility tunnels shall overlap the centerline of the proposed joint by not less than 2 feet.

Cables cut in the field shall have the cut ends immediately sealed to prevent entrance of moisture. Nonleaded cables shall be sealed with rubber tape wrapped down to 3 inches from the cable end. Rubber tape shall be cover-wrapped with polyvinylchloride tape.

### 3.1.5 Splices and Terminations

Splices shall be made in manholes except where cable terminations are specifically indicated. Splicing and terminating of cables shall be expedited to minimize exposure and cable deterioration.

Cables shall be terminated in a kit or elbows. Dry terminations with medium voltage pennants, preformed, and hand wrapped stress cones may be used for terminating cables. Elbow terminations shall be provided with adequate means for making external connections to the cable conductors of single-conductor cables; protecting the cable insulation against moisture, oil, or other contaminant; physically protecting and supporting cables, and maintaining the insulation level of the cable.

Elbow terminations shall be provided along with the deadbreak junctions and shall be installed in accordance with the deadbreak junction manufacturer's recommendations.

Installation shall include built-up or prefabricated heat or cold shrink stress-relief cones at the terminals of all shielded cables rated 15 kV and above, ungrounded.

Cable splices in manholes shall be located midway between cable racks on walls of manholes and supported with cable arms at approximately the same elevation as the enclosing duct.

All universal demountable splices shall be supported in such manner so as to minimize physical stress on the splice connections. Each cable end termination shall be supported using a pair of saddle type supports under the cable end termination and/or cable with a minimum 12 inches and a maximum 30 inches separation between the supports. Cable end termination and cable shall be secured to the supports in such a manner as to prevent movement of termination or cable at the support. Saddle type supports shall be installed on galvanized steel framing channel anchored to the wall.

Once a termination or splice has been started by a worker, the same person shall complete that particular termination or splice shall be started and completed in one continuous scheduled shutdown period.

Phase identification shall be provided at both ends of the cable termination by means of colored vinyl plastic electrical tape, Scotch No. 35 or equal, brown, orange and yellow.

Certification of the qualifications or the cable splicer/terminator from the testing firm shall be submitted, for approval, 30 days before splices or terminations are to be made in medium voltage cables. The certification shall include the training, and experience of the individual from the certified testing firm on the specific type and classification of cable to be provided under this contract. The certification shall include that the individual has had three or more years recent experience splicing a minimum of three splices/terminations that have been in operation for more than one year. In addition, the individual may be required to perform a dummy or practice splice/termination in the presence of the Contracting Officer, before being approved as a qualified cable splicer. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types.

Terminations of medium voltage power cables shall be accomplished in accordance with manufacturer's detailed instructions and requirements. Make terminations with materials and methods as designated by the written instructions of the cable manufacturer and termination kit manufacturer.

Terminations shall be accomplished as expeditiously as possible to minimize exposure of cable and possible cable deterioration.

### 3.1.6 Cable Tag Installation

Install cable tags in each manholes as specified, including each splice. Tag wire and cable provided by this contract. Install cable tags over the fireproofing, if any, and locate the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes.

### 3.1.7 Fireproofing Tape

Tightly wrap strips of fireproofing tape around each cable spirally in half-lapped wrapping. Install tape in accordance with manufacturer's instructions.

## 3.2 FIELD INSPECTION AND TESTING

Field Acceptance Checks and Tests shall be performed in accordance with the

manufacturer's recommendations and NETA ATS, and shall include the following visual and mechanical inspections and electrical tests.

Tests shall be performed after installation of cable, splices, and terminations and before terminating to equipment or splicing to existing circuits

1. Visual and Mechanical Inspection

    a. Inspect exposed cable sections for physical damage.

    b. Verify that cable is supplied and connected in accordance with contract plans and specifications.

    c. Inspect for proper shield grounding, cable support, and cable termination.

    d. Verify that cable bends are not less than ICEA or manufacturer's minimum allowable bending radius.

    e. Inspect for proper fireproofing.

    f. Visually inspect jacket and insulation condition.

    g. Inspect for proper phase identification and arrangement.

2. Electrical Tests

Each cable shall be subjected to dielectric-absorption, high-voltage and megger tests after the installation of medium-voltage power cables has been completed, including splices, joints, and terminations, and before the cable is energized.

Test equipment, labor, and technical personnel shall be provided as necessary to perform the electrical acceptance tests.

Arrangements shall be made to have tests witnessed and approved by the Contracting Officer.

Each power cable installation shall be completely isolated from extraneous electrical connections at cable terminations and joints. Safety precautions shall be observed.

Each power cable shall first be given a full dielectric-absorption test with 5,000-volt insulation-resistance test set. Test shall be applied for a long enough time to fully charge the cable. Readings shall be recorded every 15 seconds during the first 3 minutes of test and at 1 minute intervals thereafter. Test shall continue until three equal readings, 1 minute apart, are obtained. Minimum reading shall be 200 megohms at an ambient temperature of 68 degrees F. Readings taken at other than 68 degrees F ambient temperatures shall be corrected accordingly.

Upon successful completion of the dielectric absorption tests, the cable shall be subjected to a direct-current high-potential test for 5 minutes with test voltages applied in accordance with AEIC CS8 and IEEE Std 400.2 for ethylene propylene rubber-insulated cable. The test voltage shall not exceed 56kV for cables rated 15kV, and 36 kV for cables rated 8kV.

Leakage current readings shall be recorded every 30 seconds during the

first 2 minutes and every minute thereafter for the remainder of the test. When the leakage current continues to increase after the first minute, the test shall be immediately terminated and steps taken to find and correct the fault. When a second test becomes necessary, this test procedure shall be repeated.

Upon satisfactory completion of the high-potential test, the cable shall be given a second dielectric-absorption test as before.

Results of the second dielectric-absorption test shall agree with the first test and shall indicate no evidence of permanent injury to the cable caused by the high-potential test.

Test data shall be recorded and shall include identification of cable and location, megohm readings versus time, leakage current readings versus time, and cable temperature versus time.

Final acceptance shall depend upon the satisfactory performance of the cable under test. No cable shall be energized until recorded test data have been approved by the Contracting Officer Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Report - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

Radiographic tests shall be performed on all elbow terminations at the discretion of the Contracting Officer to determine if voids exist in the elbow. Unacceptable terminations shall be reworked at no additional expense to the Government.

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# OVERCURRENT PROTECTIVE DEVICES

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI C39.1 | (1981; R 1992) Electrical Analog Indicating Instruments |
| ANSI C63.2 | (1996) Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 KHz to 40 GHz - Specifications |
| ANSI C63.4 | (2003) Methods of Measurement of Radio - Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 KHz to 40 GHz |

ASTM INTERNATIONAL (ASTM)

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| ASTM A 167 | (2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| ASTM A 48/A 48M | (2003) Standard Specification for Gray Iron Castings |
| ASTM D 3487 | (2000) Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus |
| ASTM D 877 | (2002e1) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes |

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

| | |
|---|---|
| EIA 443 | (1979) Standard for Solid-State Relay Service, EIA/NARM (ANSI/EIA-443-79) |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C37.09 | (1999) IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis |
| IEEE C37.121 | (1989; R 1995) Standard for Switchgear-Unit Substation-Requirements |

| | |
|---|---|
| IEEE C37.13 | (1990; R 2005) Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures |
| IEEE C37.16 | (2000) Recommendations for Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors, - Preferred Ratings, Related Requirements, and Application |
| IEEE C37.17 | (1997) Standard for Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers |
| IEEE C37.90 | (1994) Standard for Relays and Relay Systems Associated With Electrical Power Apparatus |
| IEEE C57.13 | (1993, R 2003) Standard Requirements for Instrument Transformers |

IPI - ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)

| | |
|---|---|
| IPC D330 | (1992) Switches |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
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| NEMA 107 | (1998; R 1993) Methods of Measurement of Radio Influence Voltage (RIV) of High-Voltage Apparatus |
| NEMA 250 | (2003) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA AB 1 | (2002) Molded-Case Circuit Breakers and Molded Case Switches |
| NEMA AB 3 | (2006) Molded Case Circuit Breakers and Their Application |
| NEMA C12.1 | (2001) Electric Meters - Code for Electricity Metering |
| NEMA C78.23 | (1995; R 2003) Standard for Incandescent Lamps - Miscellaneous Types |
| NEMA FU 1 | (2002) Low Voltage Cartridge Fuses |
| NEMA ICS 1 | (2000; R 2005) Standard for Industrial Control and Systems General Requirements |
| NEMA ICS 2 | (2000; Errata 2002; R 2005, Errata 2006) Standard for Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment |
| NEMA ICS 3 | (2005) Standard for Industrial Control and |

| | |
|---|---|
| | Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC |
| NEMA ICS 6 | (2006) Standard for Industrial Controls and Systems Enclosures |
| NEMA SG 2 | (1993) Standard for High-Voltage Fuses |
| NEMA SG 5 | (1995) Standard for Power Switchgear Assemblies |

CALIFORNIA CODE OF REGULATIONS (CCR)

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| CEC | (2007) California Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
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| UL 20 | (2004) Standard for General-Use Snap Switches |
| UL 489 | (2004; Rev thru June 2006) Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |
| UL 50 | (2007) Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations |
| UL 508 | (2005) Safety Standard for Industrial Control Equipment |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION

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| NETA-ATS | (2007) Standard for Maintenance Testing Specifications |

## 1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

### SD-01 Preconstruction Submittals

No change in continuous-current rating, interrupting rating, and clearing or melting time of fuses shall be made unless written permission has first been secured from the Contracting Officer.

### SD-02 Shop Drawings

Connection Diagrams and Fabrication Drawings shall be submitted for the following items in accordance with paragraph entitled, "General Requirements," of this section.

Installation drawings shall also be submitted for the following items in accordance with the paragraph entitled, "Installation," of this section.

Control Devices

Protective Devices

SD-03 Product Data

Equipment and performance data shall be submitted for the following items including use life, system functional flows, safety features, and mechanical automated details.

Manufacturer's catalog data shall also be submitted for the following items:

Instrument Transformers
Enclosures
Circuit Breakers
Fuses
Control Devices
Time Switches
Protective Relays
Indicating Instruments
Indicating Lights

SD-06 Test Reports

Factory Test Reports shall be submitted for Power Circuit Breakers in accordance with IEEE C37.09.

Dielectric Tests
Timing Test
Insulation Power Factor Test

SD-07 Certificates

Certificates shall be submitted for Circuit Tests on similar motor-control or motor-circuit protector (MCP) units under actual conditions may be submitted in lieu of factory tests on the actual units provided.

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted for the following items, including special provisions required to install equipment components and system packages. Special notices shall detail resistance impedances, hazards and safety precautions.

Control Devices
Protective Devices

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for the following equipment:

Circuit Breakers
Time Switches
Protective Relays
Indicating Instruments

1.3 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Connection Diagrams shall be submitted showing the relations and connections of control devices and protective devices by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Fabrication Drawings shall be submitted for control devices and protective devices consisting of fabrication and assembly details to be performed in the factory.

PART 2 PRODUCTS

2.1 INSTRUMENT TRANSFORMERS

Instrument transformers shall comply with the interference requirements listed below, measured in accordance with ANSI C63.2, ANSI C63.4, and NEMA 107.

| Insulation Class, kV | Basic Insulation Level, kV | Preferred Nominal System Voltage, kV | Test Voltage for Potential Transformers, kV | Test Voltage for Current Transformers, kV | Radio Influence Voltage Level, Microvolts Dry Type | Radio Influence Voltage Level, Microvolts Oil Filled |
|---|---|---|---|---|---|---|
| 0.6 | 10 | ..... | ..... | 0.76 | 250 | 250 |
| 15L or 15H | 95-110 | 12.00<br>12.47<br>14.40 | 7.62<br>7.92<br>9.14 | 9.41 | 1000 | 250 |

2.1.1 Current Transformers

Current transformers shall conform to IEEE C57.13 for installation in metal-clad switchgear. Standard 5 Amp secondary transformers shall be used.

Transformers shall be window type.

Transformers shall have single secondary winding, multi-ratio, ANSI/IEEE C57.13, 5 terminals.

Transformers shall be complete with secondary short-circuiting device. Continuous thermal current rating factor shall be 2.0 at 30°C Ambient.

Window-type current transformers shall be indoor dry type construction with secondary current ratings as indicated. Burden, frequency, and accuracy shall be as specified.

2.1.2 Potential Transformers

Potential transformers shall conform to IEEE C57.13 for installation in metal-clad switchgear. Standard 120-volt secondary transformers shall be used.

Transformers shall have single secondary.

Burden and frequency shall be as required. Accuracy shall be 0.3 W through Z.

Potential transformers with integral mounted fuses and current-limiting fuses shall be indoor dry type two-winding construction with primary and secondary voltage ratings as required.

## 2.2 ENCLOSURES

### 2.2.1 Equipment Enclosures

Enclosures for equipment shall be in accordance with NEMA 250.

Equipment installed inside clean, dry locations shall be contained in NEMA Type 1, general-purpose sheet-steel enclosures.

Equipment installed in wet locations shall be contained in NEMA Type 4 watertight, corrosion-resistant sheet-steel enclosures, constructed to prevent entrance of water when tested in accordance with NEMA ICS 6 for Type 4 enclosures.

## 2.3 CIRCUIT BREAKERS

Circuit breakers shall conform to UL 489, NEMA AB 1, and NEMA AB 3.

### 2.3.1 Molded-Case Circuit Breakers

Circuit breakers shall be molded case, manually operated, trip-free, with inverse-time thermal-overload protection and instantaneous magnetic short-circuit protection as required. Circuit breakers shall be completely enclosed in a molded case, with the calibrated sensing element factory-sealed to prevent tampering.

Thermal-magnetic tripping elements shall be located in each pole of the circuit breaker and shall provide inverse-time-delay thermal overload protection and instantaneous magnetic short-circuit protection. Instantaneous magnetic tripping element shall be adjustable and accessible from the front of the breaker on frame sizes larger than 100 amperes.

Breaker size shall be as required for the continuous current rating of the circuit. Breaker class shall be as required.

Interrupting capacity of the panel and lighting branch circuit breakers shall be sufficient to successfully interrupt the maximum short-circuit current imposed on the circuit at the breaker terminals. Circuit breaker interrupting capacities shall be a minimum of 22,000 amperes and shall conform to NEMA AB 3.

Multipole circuit breakers shall be of the common-trip type having a single operating handle and shall have two-position on/off indication. Circuit breakers shall have temperature compensation for operation in an ambient temperature of 104 degrees F. Circuit breakers shall have root mean square (rms) symmetrical interrupting ratings sufficient to protect the circuit being supplied. Interrupting ratings may have selective type tripping (time delay, magnetic, thermal, or ground fault).

Breaker body shall be of phenolic composition. Breakers shall be capable of having such accessories as handle-extension, handle-locking, and

padlocking devices attached where required.

Circuit breakers used for motor-circuit disconnects shall meet the applicable requirements of CEC and shall be of the motor-circuit protector type.

Circuit breakers used for service disconnection shall be the enclosed circuit-breaker type with external handle for manual operation. Enclosures shall be sheet metal with a hinged cover suitable for surface mounting.

2.3.2 Low-Voltage Power Circuit Breakers (for breakers, 1,000 amperes and above)

The Contractor shall provide solid-state static-type trips for low-voltage power circuit breakers 1,000 amperes and above. Circuit breakers shall be in accordance with EIA 443, IEEE C37.17, and UL 489.

Breakers shall be listed for 100% rating.

Trip unit shall employ a combination of discrete components and integrated circuits to provide the time-current protection functions required in a selectively coordinated distribution system and undervoltage protection by Instantaneous Undervoltage Trip Device as indicated on the drawings.

Complete system selective coordination shall be provided by the Government and utilizing a combination of the following time-current curve-shaping adjustments: ampere setting; long-time delay; short-time pickup; short-time delay; instantaneous pickup; ground fault; and undervoltage setting.

Instantaneous and grounds fault trips shall be switchable or easily defeatable.

All adjustments shall be made using non-removable, discrete step highly reliable switching plugs for precise settings. A sealable, transparent cover shall be provided over the adjustments to prevent tampering.

Trip devices shall be furnished with three visual indicators to denote the automatic tripping mode of the breaker including: overload; short circuit; and ground fault.

Trip unit shall be wired to appropriate terminals whereby an optional remote automatic trip accessory can be utilized to provide the same indication.

A series of optional automatic trip relays shall be available for use with the trip unit to provide remote alarm and lockout circuits.

All trip units shall be provided with test jacks for in-service functional testing of the long-time instantaneous and ground fault circuits using a small handheld test kit.

The Contractor shall submit manufacturer's circuit breaker curves to the Government for review, approval and study.

Breakers shall have a removable operating handle, provision for padlocking, and position indicator.

Power Circuit Breakers shall be factory tested in accordance with

IEEE C37.09.

2.3.3 Vacuum Circuit Breakers (for breaker above 600 volts AC)

a. The circuit breakers shall be rated 15,000 volts, 60 Hz, with a continuous current rating or a maximum symmetrical interrupting rating of as specified on the drawings. Furnish circuit breakers with one vacuum interrupter per phase. Breakers of the same type and rating shall be completely interchangeable. The circuit breaker shall be operated by means of a stored energy mechanism which is normally charged by a universal motor but can also be charged by the manual handle supplied on each circuit breaker for manual emergency closing or testing. The closing speed of the moving contacts is to be independent of both the control voltage and the operator. Provide a full front shield on the breaker. Secondary control circuits shall be connected automatically with a self-aligning, self-engaging plug and receptacle arrangement when the circuit breaker is racked into the connected position. Provision shall be made for secondary control plug to be manually connected in the test position. A minimum of 4 auxiliary universal contacts shall be provided for external use. Provisions shall be made for 10 additional cell-mounted auxiliary contacts both MOC and TOC type for external use. The racking mechanism to move the breaker between positions shall be operable with the front door closed and position indication shall be visible with door close.

b. An interlocking system shall be provided to prevent racking a closed circuit breaker out from the connected position. An additional interlock shall automatically discharge the stored-energy operating mechanism springs upon removal of the breaker out of the compartment.

c. The circuit breaker control voltage shall be 120 volts AC - provide one capacitor trip unit for each circuit breaker.

2.4 FUSES

A complete set of fuses for all switchgears shall be provided. Fuses shall have a voltage rating not less than the circuit voltage.

Fuses rated 30 amperes, 125 volts or less shall be the nonrenewable cartridge type. Fuses rated above 30 amperes 600 volts or less shall be the renewable cartridge type with time-delay dual elements, except where otherwise indicated. Fuses shall conform to NEMA FU 1.

Special fuses such as extra-high interrupting-capacity fuses, fuses for welding machines, and capacitor fuses shall be installed where required. Plug fuses are not permitted.

Power fuses on ac systems above 600 volts shall be in accordance with NEMA SG 2.

Fuses shall be labeled showing UL class, interrupting rating, and time-delay characteristics, when applicable. Additionally, fuse information shall be clearly listed on equipment drawings.

Fuse holders field-mounted in a cabinet or box shall be porcelain. Field installation of fuse holders made of such materials as ebony asbestos, Bakelite, or pressed fiber is not permitted.

## 2.5 CONTROL DEVICES

### 2.5.1 Switches

#### 2.5.1.1 Selector Switches

Selector switches for low-voltage control circuits shall be heavy-duty oiltight maintained-contact devices with the number of positions and the marking of identification plates in accordance with NEMA ICS 1 and NEMA ICS 2.

Selector switches in remote control stations shall be identified with engraved identification plates affixed to front cover in a prominent location. Identification plate shall carry the identification of the system being controlled.

#### 2.5.1.2 Ammeter Selector Switches

Ammeter selector switches for switchgear shall be rotary multistage snap-action type in accordance with UL 20 with silver-plated contacts rated for 600 volts ac or dc. Selector switch shall be a manually operated, four-position device rated for 600 volts, 20 amperes, minimum, and designed to permit current readings on each bus of the main bus from a single indicating instrument. Ammeter switch shall be mounted on the hinged front panel of the switchgear compartment and shall be completely isolated from high-voltage circuits, with engraved escutcheon plate.

Selector switch handle shall be oval type.

#### 2.5.1.3 Voltmeter Selector Switches

Voltmeter selector switches for switchgear shall be rotary snap-action type in accordance with UL 20 with silver-plated contacts rated for 600 volts ac or dc. Switch shall be a manually operated, four-position device designed to permit voltage readings on each phase of the main bus from a single indicating instrument. Voltmeter switch shall be mounted on the hinged front panel of the switchgear compartment and shall be completely isolated from high-voltage circuits, and with engraved escutcheon plate.

Selector switch handle shall be oval type.

## 2.6 PROTECTIVE RELAYS

### 2.6.1 Overcurrent Relays (GFE)

Overcurrent relays shall conform to IEEE C37.90.

Overcurrent relays for protection against phase and ground faults shall be three-phase nondirectional removable microprocessor-based type with built-in self-testing facilities and communications port furnished by the Government and to be installed by the Contractor. Relays shall be designed for operation on the dc or ac control circuit indicated.

Overcurrent relays shall have the following protection features:

a. Three phase (51) and ground/residual (51G/N) time overcurrent elements.

b. Three phase (50) and ground/residual (50G/N) instantaneous overcurrent elements.

c. Independent phase and ground curves; ANSI, IAC and/or IEC/BS142 curve shapes: definite time, moderately inverse, normal inverse, extremely inverse.

d. Adjustable current tap settings for time and instantaneous functions.

e. "Time dials" for phase and ground time overcurrent curves.

f. Separate pickup level and output relay for each protection element.

g. Three outputs: trip, auxiliary trip, and service.

h. Additional output relays shall be available as an option for individual protection elements.

i. Trip record: display of last five trips.

j. 86 lockout available.

The relays shall have front panel LED indications for cause of trip, pick up, relay in service and relay malfunction.

A clear key shall be available to clear the cause of trip indicators.

A phase current indicator will be provided on the front panel.

The relay shall be able to communicate via a RS232 and/or RS285 port using a non-proprietary protocol. Communication software shall be provided.

The information available over this port shall include:

a. Settings, phase and ground current as a % of CT, status

b. Simulation of trips

The relay shall comply with surge withstand capability (SWC) required by standards IEEE C37.90.

Case shall be semiflush-mounted to the instrument panel and shall have a matching cover. Relay shall be easily removable for repair or testing. The relay shall be mounted no more than 72" above the finished grade.

## 2.7 INDICATING INSTRUMENTS

### 2.7.1 Ammeters

Ammeters shall conform to ANSI C39.1.

Switchboard indicating ammeters shall be approximately 4-1/2 inches square with 250-degree scale and recessed cases suitable for flush mounting. Dials shall be white with black figures and black pointers. Instruments shall be mounted on the hinged front panel of the switchgear compartment and shall be completely isolated from high-voltage circuits. Meters shall be standard 5-ampere type for a zero to full-scale normal movement, 60 hertz.

2.7.2 Voltmeters

Voltmeters shall conform to ANSI C39.1.

Switchboard indicating voltmeters shall be approximately 4-1/2-inches square with 250-degree scale and recessed cases suitable for flush mounting. Dials shall be white with black figures and black pointers. Instruments shall be mounted on the hinged front panel of the switchgear compartment and shall be completely isolated from high-voltage circuits. Voltmeters shall be standard 120-volt type for a zero to full-scale normal movement, 60 hertz.

2.7.3 Digital Power Meter (GFE)

The meter shall be front panel, with local data display and basic setup. The display shall have eight digits and shall be easy-to-read LCD with back lighting and adjustable contrast. The display screen shall show the parameters of choice and scrolled manually or automatically through the communications ports.

The meter shall be fully bi-directional, four-quadrant (active, reactive, and apparent), revenue-accurate or revenue certified energy type.

The meter shall calculate the demand load on any instantaneous measurement (kW, kVAR, kVA, Amps, Volts, power factor, frequency, voltage and current unbalance) and record peak and minimum demand.

The meter shall have two-year internal calendar, fifteen daily tariff profiles, programmable triggers, separate energy and demand load accumulators.

2.8 FACTORY TESTING

Factory tests on control and low voltage protective devices shall be performed in accordance with the manufacturer's recommendations.

Short-circuit tests shall be in accordance with Section 2 of NEMA ICS 1.

Factory tests on power circuit breakers shall be in accordance with IEEE C37.09.

2.9 INDICATING LIGHTS

2.9.1 General-Purpose Type

Indicating lights shall be oiltight instrument devices with threaded base and collar for flush-mounting, translucent convex lens, candelabra screw-base lampholder, and 120-volt, 6-watt, Type S-6 incandescent lamp in accordance with NEMA C78.23. Color code for indicating lights shall be in accordance with NEMA ICS 6.

Indicating lights shall be provided in remote-control stations when pushbuttons and selector switches are out of sight of the controller.

2.9.2 Switchboard Indicating Lights

Switchboard indicating lights shall be the manufacturer's standard transformer type units 120-volt input utilizing low-voltage lamps and convex lenses of the colors indicated. Indicating lights shall be capable

of being relamped from the switchboard front. Indicating lights utilizing resistors in series with the lamps are not permitted except in direct-current control circuits. Lights shall have a press-to-test feature.

## 2.10 FINISH

Metallic materials shall be protected against corrosion. Equipment shall have the standard finish by the manufacturer when used for most indoor and outdoor installations.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Control devices and protective devices not factory installed in equipment shall be installed in accordance with the manufacturer's recommendations and shall be field adjusted and operation tested. Installations shall conform to CEC, NEMA ICS 1, NEMA ICS 2, and NEMA ICS 3 requirements for installation of control and protective devices.

## 3.2 FIELD TESTING

Control and protective devices not factory installed in equipment shall be demonstrated to operate as indicated.

Instrumentation, potential, and current transformers shall be ratio'd and tap settings verified.

Circuit breakers rated 15kV and above shall be given a timing test to verify proper contact speed, travel, bounce, and wipe.

The Government shall perform the relay coordination study and low voltage power circuit breaker settings (pickups, time dials and trip settings) and programming for the Contractor. The Contractor shall install, test and calibrate the relays in accordance with the Government settings.

The Contractor shall secure the services of a certified testing firm to provide a skilled relay technician actively engaged in the business of testing and calibrating power relays. The Contractor shall furnish all test equipment as required.

Two relay wiring tests shall be preformed:

a. Primary circuit polarity test, including a DC test from the current transformer to each terminal block and relay terminal.

b. Relay and circuit breaker operation test by application of power from a portable relay test set.

Relay testing shall be accomplished after completion of the circuit breakers installation, using standard portable test set equipment and the relay manufacturer's testing directions.

Relay testing shall include (1) zero set test, (2) pick-up test, (3) time-current characteristics (operation at currents 3 and 4 times the calculated tap settings, and instantaneous at the calculated tap settings), and (4) target and seal-in operation.

The Contractor shall provide the Contracting Officer with six (6) copies of

an attested certificate stating that the relays have been set, tested and adjusted in accordance with the data provided by a California certified Professional Electrical Engineer and indicating the relay settings as final. The tests shall be made for all new and existing circuit breaker relays and the wiring and relay operation of all circuit breakers whose control circuits may have been distributed in any way during construction or testing. Final field test information shall be reported on the "Electrical Distribution System Coordination" form provided by a certified testing firm. Test data and technician's initials shall be placed on a card in the relays window. Certification and test information shall be supplied to the Contracting Officer within fourteen (14) calendar days after completion of the testing.

Preliminary inspection of electrical equipment shall be conducted. Relay settings and tests shall be made only after the preliminary survey and system coordination survey have been completed by the Government. Preliminary inspection, relay settings, and tests shall be performed by the Contractor as follows:

Equipment shall be inspected for damage or maladjustment caused by shipment or installation. Wedges, ties, blocks, and other packing material installed by the manufacturer to prevent damage in shipment shall be removed.

Protective relays, auxiliary relays, trip coils, trip circuit seal-in and target coils, fuses, and instrument transformers shall be verified to be of the proper type and range.

Electrical continuity tests shall be performed on current, potential, and control circuits.

Ratio and polarity tests shall be performed on current and potential transformers.

Insulation tests shall be performed on relays, wiring, instrument-transformer secondary windings, and instruments.

With the relay disconnected and the main current transformer effectively open, a test current shall be applied to the remainder of the secondary circuits to detect any open or short-circuit connections.

Relays shall then be reinstalled and connected into their current-transformer secondary and control circuits.

Any defects in electrical equipment, protective devices, wiring, or other conditions that will prevent complete coordination and the successful operation of equipment shall be reported to the Contracting Officer before proceeding with the work.

Control and protective devices shall not be energized until recorded test data has been approved by the Contracting Officer. Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System Name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for Inclusion in the Maintenance Database."

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SECTION 26 08 00

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# SECTION 26 08 00

# APPARATUS INSPECTION AND TESTING

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS (2007) Acceptance Testing Specifications

### 1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to this section with additions and modifications specified herein.

### 1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Acceptance tests and inspections

SD-07 Certificates

Qualifications of organization, and lead engineering technician

Acceptance test and inspections procedure

### 1.4 QUALITY ASSURANCE

#### 1.4.1 Qualifications

Contractor shall engage the services of a qualified testing organization to provide inspection, testing, calibration, and adjustment of the electrical distribution system and generation equipment listed in paragraph entitled "Acceptance Tests and Inspections" herein. Organization shall be independent of the supplier, manufacturer, and installer of the equipment. The organization shall be a first tier subcontractor. No work required by this section of the specification shall be performed by a second tier subcontractor.

a. Submit name and qualifications of organization. Organization shall have been regularly engaged in the testing of electrical materials, devices, installations, and systems for a minimum of 5 years. The organization shall have a calibration program, and test instruments used shall be calibrated in accordance with NETA ATS.

b. Submit name and qualifications of the lead engineering technician performing the required testing services. Include a list of three comparable jobs performed by the technician with specific names and telephone numbers for reference. Testing, inspection, calibration, and adjustments shall be performed by an engineering technician, certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) with a minimum of 5 years' experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.

1.4.2 Acceptance Tests and Inspections Reports

Submit certified copies of inspection reports and test reports. Reports shall include certification of compliance with specified requirements, identified deficiencies, and recommended corrective action when appropriate. Type and neatly bind test reports to form a part of the final record. Submit test reports documenting the results of each test not more than 10 days after test is completed.

1.4.3 Acceptance Test and Inspections Procedure

Submit test procedure reports for each item of equipment to be field tested at least 45 days prior to planned testing date. Do not perform testing until after test procedure has been approved.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 ACCEPTANCE TESTS AND INSPECTIONS

Testing organization shall perform acceptance tests and inspections. Test methods, procedures, and test values shall be performed and evaluated in accordance with NETA ATS, the manufacturer's recommendations, and paragraph entitled "Field Quality Control" of each applicable specification section. Tests identified as optional in NETA ATS are not required unless otherwise specified. Equipment shall be placed in service only after completion of required tests and evaluation of the test results have been completed. Contractor shall supply to the testing organization complete sets of shop drawings, settings of adjustable devices, and other information necessary for an accurate test and inspection of the system prior to the performance of any final testing. Contracting Officer shall be notified at least 14 days in advance of when tests will be conducted by the testing organization. Perform acceptance tests and inspections on applicable equipment and systems specified in the following sections:

a. Section 26 05 13.00 40 MEDIUM VOLTAGE CABLES

b. Section 26 05 73.00 40 OVERCURRENT PROTECTIVE DEVICES

c. Section 26 11 16 SECONDARY UNIT SUBSTATIONS

d. Section 26 12 00.00 40 MEDIUM VOLTAGE TRANSFORMERS

e. Section 26 13 00.00 20 15KV VCB METAL-CLAD SWITCHGEAR

f. Section 26 23 00.00 40 SWITCHBOARDS

3.2 SYSTEM ACCEPTANCE

Final acceptance of the system is contingent upon satisfactory completion of acceptance tests and inspections.

3.3 PLACING EQUIPMENT IN SERVICE

A representative of the approved testing organization shall be present when equipment tested by the organization is initially energized and placed in service.

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# SECTION 26 11 16
# SECONDARY UNIT SUBSTATIONS

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ACI INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 318M | (2008) Metric Building Code Requirements for Structural Concrete and Commentary |

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI C37.121 | (1989) Switchgear-Unit Substations-Requirements |
| ANSI C39.1 | (1981; R 1992) Requirements for Electrical Analog Indicating Instruments |
| ANSI C57.12.13 | (1982) Conformance Requirements for Liquid-Filled Transformers |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 123/A 123M | (2008) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A 153/A 153M | (2005) Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A 167 | (2004) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| ASTM A 653/A 653M | (2008) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A 780 | (2006) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings |
| ASTM C 260 | (2006) Air-Entraining Admixtures for Concrete |
| ASTM D 117 | (2002) Sampling, Test Methods, Specifications for Electrical Insulating Oils of Petroleum Origin |
| ASTM D 1535 | (2008) Specifying Color by the Munsell System |

| | |
|---|---|
| ASTM D 3487 | (2000; R 2006) Mineral Insulating Oil Used in Electrical Apparatus |
| ASTM D 709 | (2001; R 2007) Laminated Thermosetting Materials |
| ASTM D 877 | (2002; R 2007) Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes |
| ASTM D 92 | (2005) Flash and Fire Points by Cleveland Open Cup Tester |
| ASTM D 97 | (2008) Pour Point of Petroleum Products |

CALIFORNIA CODE OF REGULATIONS (CCR)

| | |
|---|---|
| CEC | (2007) California Electrical Code |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C2 | (2007) National Electrical Safety Code |
| IEEE C37.20.1 | (2001; R 2006) Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear |
| IEEE C37.90.1 | (2002) Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus |
| IEEE C57.12.00 | (2006) General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers |
| IEEE C57.12.01 | (2005) General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin-Encapsulated Windings |
| IEEE C57.12.29 | (2005) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments |
| IEEE C57.12.50 | (1981; R 1998) Ventilated Dry-Type Distribution Transformers, 1 to 500 kVA, Single Phase, and 15 to 500 kVA, Three-Phase, with High-Voltage 601 to 34 500 Volts, Low-Voltage 120 to 600 Volts |
| IEEE C57.12.51 | (1981; R 1998) Ventilated Dry-Type Power Transformers, 501 kVA and Larger, Three-Phase, with High-Voltage 601 to 34 500 Volts, Low-Voltage 208Y/120 to 4160 Volts |
| IEEE C57.12.80 | (2002) Terminology for Power and Distribution Transformers |
| IEEE C57.12.90 | (2006) Standard Test Code for |

| | |
|---|---|
| | Liquid-Immersed Distribution, Power, and Regulating Transformers |
| IEEE C57.12.91 | (2001) Test Code for Dry-Type Distribution and Power Transformers |
| IEEE C57.13 | (2008) Standard Requirements for Instrument Transformers |
| IEEE C57.98 | (1994) Guide for Transformer Impulse Tests |
| IEEE C57.124 | (1991 R 2006) Recommended Practice for the Detection of Partial Discharge and the Measurement of Apparent Charge in Dry-Type Transformers |
| IEEE C62.11 | (2005) Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1KV) |
| IEEE Std 100 | (2000) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE Std 386 | (2006) Separable Insulated Connector Systems for Power Distribution Systems Above 600V |

FM GLOBAL (FM)

| | |
|---|---|
| FM P7825 | (2005) Approval Guide |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2007) Acceptance Testing Specifications |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA C12.1 | (2008) Code for Electricity Metering |
| NEMA C12.10 | (2004) Physical Aspects of Watthour Meters |
| NEMA ICS 6 | (1993; R 2006) Industrial Control and Systems: Enclosures |
| NEMA LI 1 | (1998) Industrial Laminated Thermosetting Products |
| NEMA ST 20 | (1992; R 1997) Dry-Type Transformers for General Applications |

ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

| | |
|---|---|
| OECD Test 203 | (1992) Fish Acute Toxicity Test |

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

| | |
|---|---|
| EPA 600/4-90/027F | (1993) Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms |

EPA 712-C-98-075 (1996) Fate, Transport and Transformation Test Guidelines - OPPTS 835.3100- "Aerobic Aquatic Biodegradation"

UNDERWRITERS LABORATORIES (UL)

UL 467 (2007) Grounding and Bonding Equipment

## 1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

## 1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

#### Unit Substation Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

### SD-03 Product Data

Incoming Sections
Transformer Sections
Outgoing Sections
Switchgear Components
Weatherproof Enclosures

Submittal shall include manufacturer's information for each component, device, and accessory provided with the transformer and switchgear.

### SD-06 Test Reports

#### Acceptance checks and tests

### SD-07 Certificates

#### Paint coating system

#### Transformer Losses

### SD-09 Manufacturer's Field Reports

Unit substation transformer design tests (liquid-filled)

Unit substation transformer routine and other tests (liquid-filled)

Unit substation transformer design tests (dry-type)

Unit substation transformer routine and other tests (dry-type)

SD-10 Operation and Maintenance Data

Unit substations, operation and maintenance manual

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals

## 1.4 QUALITY ASSURANCE

### 1.4.1 Drawing Requirements

#### 1.4.1.1 Unit Substation Drawings

Drawings shall include, but are not limited to the following:

a. An outline drawing, with front, top, and side views showing incoming, transformer, and outgoing sections. Include switchboard and switchgear information from Section 26 23 00 SWITCHBOARDS AND SWITCHGEAR as part of the total unit substation.

b. One-line diagram showing instrument transformers and ampere rating of bus bars.

c. Elementary diagrams and wiring diagrams with terminals identified, and indicating prewired interconnections between items of equipment and the interconnection between the items.

#### 1.4.1.2 Transformer Drawings

Drawings shall include, but are not limited to the following:

a. An outline drawing, with front, top, and side views.

b. ANSI nameplate data.

### 1.4.2 Paint Coating System

Submit IEEE C57.12.29 coating system performance requirement tests. When switchgear and transformer are provided by two different manufacturers, each one shall provide certification.

### 1.4.3 Transformer Losses

Submit certification from the manufacturer indicating conformance with the paragraph entitled "Specified Transformer Losses". If tests on transformers of "basically the same design" are not available, provide written certification by manufacturer that transformers will meet the specified losses, and state what the losses will be. Submit report with transformer shop drawings and product data.

1.4.4 Substation Product Data

Submittal shall include manufacturer's information for each component, device, and accessory provided with the equipment.

1.4.5 Test Reports

Submit report of acceptance test results as specified by paragraph entitled "Field Quality Control."

1.4.6 Regulatory Requirements

Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of CEC unless more stringent requirements are specified or indicated.

1.4.7 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section. Switchgear manufacturer shall provide UL label or 3rd party inspection label confirming design and construction are in accordance with applicable codes and standards.

1.4.7.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.7.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.5 MAINTENANCE

1.5.1 Assembled Operation and Maintenance Manuals

Manuals shall be assembled in durable, hard covered, water resistant binders. The manual shall be assembled and indexed in the order noted in a table of contents. The contents of the assembled operation and maintenance manuals shall be as follows:

a. Manufacturer's O&M information required by the paragraph entitled, "SD-10 Operation and Maintenance Data."

b. Catalog data required by the paragraph entitled, "SD-03 Product Data."

c. Drawing required by the paragraph entitled, "SD-02 Shop Drawings."

d. Price for spare parts and supply list

e. Routine and field acceptance test reports

1.6 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be secondary unit substations and related accessories are specified in Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

2.2 SECONDARY UNIT SUBSTATION

Secondary Unit substations shall comply with IEEE C37.121 regardless of the kVA rating specified. Substation shall consist of incoming section, transformer sections, and outgoing sections. Substation shall be designed for outdoor service for ALL buildings with ventilation openings and gasketing provided to ensure a weatherproof assembly under rain, snow, sleet, and hurricane conditions. Substations shall be subassembled and coordinated by one manufacturer and shall be shipped in complete sections ready for connection at the site. Where practicable, substation shall be shipped as one unit. External doors shall have provisions for padlocking.

2.2.1 Incoming Sections

The incoming section shall consist either of:

a. Full length terminal cabinet or an air-filled terminal chamber for connecting the incoming circuit directly to the transformer.

b. 15kV VCB metal clad switchgear specified in Section 26 13 00.00 20.

2.2.1.1 Incoming Section Enclosure

The incoming section enclosure shall be NEMA ICS 6 Type as indicated. Bases, frames and channels of enclosure shall be corrosion resistant and shall be fabricated of galvanized steel. Galvanized steel shall be ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable. Paint enclosure, including bases, ASTM D 1535 light gray No. 61. Paint coating system shall comply with IEEE C57.12.29. The enclosure of medium voltage circuit breaker is specified in Section 26 13 00.00 20.

2.2.1.2 Cable Terminations

Provide medium voltage cable terminations as specified in Section 26 05 13.00 40 MEDIUM VOLTAGE CABLES.

2.2.1.3 Primary Protective Device Connection

Connections between the primary protective device and transformer shall be bus mounted on porcelain insulators or cable in conduit, and sized and braced to withstand the specified short-circuit and short-time currents.

2.2.2 Transformer (Liquid-Filled) Sections

ANSI C57.12.13. Less-flammable liquid-filled. Transformer base shall be fabricated of ASTM A 167 type 304, 304L, or 316 stainless steel. Transformer base shall be 6 inches high. Paint coating system shall comply with IEEE C57.12.29.

Provide medium-voltage transformer as specified in Section 26 12 00.00 40.

2.2.3 Outgoing Section

The outgoing section shall consist of a secondary transition section for connecting to a low-voltage switchboard section. The switchboard shall be as specified in Section 26 23 00.00 40 SWITCHBOARDS. Connections between the transformer secondary bushings and the outgoing section transition bus shall be flexible braid bus. The secondary transition section shall have a hinged front panel.

2.2.3.1 Outgoing Section Enclosure

Provide outgoing section enclosure in accordance with the requirements in paragraph entitled, "Incoming Section Enclosure."

2.2.4 Digital Meters

Digital meters specified in Section 26 05 73.00 40 OVERCURRENT PROTECTIVE DEVICES.

2.2.5 Instruments

ANSI C39.1 for electrical indicating switchboard style instruments, with 2 percent accuracy. The ac ammeters and voltmeters shall be minimum of 2 inches square, with 250-degree scale. Provide single phase indicating instruments with flush-mounted transfer switches for reading three phases.

2.2.5.1 Ac Ammeters

Self-contained.

2.2.5.2 Ac Voltmeters

Self-contained.

2.2.5.3 Instrument Control Switches

Provide rotary cam-operated type with positive means of indicating contact positions. Switches shall have silver-to-silver contacts enclosed in a protective cover which can be removed to inspect the contacts.

2.2.6 Instrument Transformers

IEEE C57.13. Instrument transformers shall conform to the applicable requirements of Section 26 05 73.00 40 OVERCURRENT PROTECTIVE DEVICES.

### 2.2.7 Control Power Transformers

Control Power Transformers (CPT) for installation in medium voltage switchgear shall conform to NEMA ST-20. CPT shall be indoor, self-cooled, single-phase, dry-type, draw-out type transformers. Nominal primary and secondary voltages shall be as indicated on the drawings. CPT shall have 95kV BIL rating and be UL listed, shall have integral primary fuses and secondary fuses as indicated on the drawings.

### 2.2.8 Heaters

Each section of the secondary unit substation, including the primary switch, and the secondary switchgear assemblies, shall be equipped with space heaters. Heaters shall be rated at 240 volts for connection to 120 volts.

Heaters shall be located at the lowest portion of each space to be heated. Terminals shall be covered. Thermostats shall be used to regulate the temperature.

All heaters shall be installed and operable at the time of shipment so that the heaters can be operated immediately upon arrival at the site, during storage, or before installation. Connection locations shall be marked prominently on drawings and shipping covers and shall have temporary leads for storage operation. Leads shall be easily accessible without having to remove shipping protection.

### 2.2.9 Insulated Barriers

Where insulated barriers are required by reference standards, provide barriers in accordance with NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness.

### 2.2.10 Terminal Boards

Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Terminal boards associated with current transformers shall be short-circuiting type. Terminate conductors for current transformers with ring-tongue lugs. Terminal board identification shall be identical in similar units. External wiring shall be color coded consistently for similar terminal boards.

### 2.2.11 Wire Marking

Mark control and metering conductors at each end. Provide factory-installed, white, plastic tubing, heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Each sleeve shall contain a single letter or number, shall be elliptically shaped to securely grip the wire, and shall be keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Each wire marker shall indicate the device or equipment, including specific terminal number to which the remote end of the wire is attached.

2.2.12 Grounding and Bonding

Provide as specified in Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

2.2.13 Padlocks

Padlocks shall be provided for secondary unit substation equipment and for each fence gate. Padlocks shall be keyed as directed by the Contracting Officer.

2.2.14 Cast-in-Place Concrete

All concrete shall conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.3 MANUFACTURER'S NAMEPLATES

Each item of equipment shall have a nameplate bearing, as a minimum, the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. Include additional information as applicable to fully identify the equipment. Nameplates shall be made of noncorrosive metal. Equipment containing liquid dielectric shall include the type of dielectric on the nameplate. Sectionalizer switch nameplates shall have a schematic with all switch positions shown and labeled. As a minimum, provide nameplates for transformers, circuit breakers, meters, switches, and switchgear.

2.4 FIELD FABRICATED NAMEPLATES

ASTM D 709 and as specified in Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

2.5 WARNING SIGNS

Provide warning signs for the enclosures of secondary unit substations having a nominal rating exceeding 600 volts in accordance with Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

2.6 SOURCE QUALITY CONTROL

2.6.1 Equipment Test Schedule

The Government reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Test Instrument Calibration

1. The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.

3. Instrument calibration frequency schedule shall not exceed 12 months for both test floor instruments and leased specialty equipment.

4. Dated calibration labels shall be visible on all test equipment.

5. Calibrating standard shall be of higher accuracy than that of the instrument tested.

6. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

   (a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

   (b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

### 2.6.2 Transformer Tests (Liquid-Filled)

Transformer Design Test, routine and other tests shall be performed as specified in Section 26 12 00.00 40 MEDIUM-VOLTAGE TRANSFORMERS.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, CEC, and to the requirements specified herein.

### 3.2 GROUNDING

CEC and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

#### 3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL. Connect ground conductors to the upper end of the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

#### 3.2.2 Substation Grounding

Provide bare copper cable not smaller than No. 4/0 AWG not less than 30 inches below grade interconnecting the indicated ground rods. Surge arrester and neutrals shall be bonded directly to the transformer enclosure and then to the grounding electrode system with bare copper conductors, sized as shown. Lead lengths shall be kept as short as practicable with no kinks or sharp bends. Substation transformer neutral connections shall not be smaller than No. 1/0 AWG. When work in addition to that indicated or specified is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply. Fence and equipment connections shall not be smaller than No. 4 AWG. Ground fence at each gate post and cornerpost and at intervals not exceeding 10 feet. Bond each gate section to the fence post through a 1/8 by one inch flexible braided copper strap and clamps.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Exothermic welds and compression connectors shall be installed as specified in Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect unit substations furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Meters and Instrument Transformers

NEMA C12.1.

3.3.2 Field Applied Painting

Where field applied painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.3.3 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3.4 Warning Sign Mounting

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

3.3.5 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A 780, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

3.4.1 Exterior Location

Mount unit substation on concrete slab. Unless otherwise indicated, the slab shall be at least 8 inches thick, reinforced with a 6 x 6 - W2.9 x W2.9 mesh placed uniformly 4 inches from the top of the slab. Slab shall be placed on a 6 inch thick, well-compacted gravel base. Top of concrete slab shall be approximately 4 inches above the finished grade. Edges above grade shall have 1/2 inch chamfer. The slab shall be of adequate size to project at least 9 inches beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant

caulking or sealant. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter. Cut off and bush conduits 3 inches above slab surface.

3.4.2 Cast-in-Place Concrete

Cast-in-place concrete work shall conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5 Padlocks

Provide padlocks for secondary unit substation equipment and for each fence gate.

3.6 FIELD QUALITY CONTROL

3.6.1 Performance of Acceptance Checks and Tests

Transformers Acceptance Checks and Tests shall be performed in accordance with Section 26 12 00.00 40 MEDIUM-VOLTAGE TRANSFORMERS.

15kV Switchgear Acceptance Checks and Tests shall be performed in accordance with Section 26 13 00.00 20 15KV VCB METAL-CLAD SWITCHGEAR.

Low Voltage Switchboards Acceptance Checks and Tests shall be performed in accordance with Section 26 23 00.00 40 SWITCHBOARDS.

3.6.1.1 Current Transformers

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify correct connection.

4. Verify that adequate clearances exist between primary and secondary circuit.

5. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

6. Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

1. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

2. Perform insulation-resistance tests.

3. Perform polarity tests.

4. Perform ratio-verification tests.

3.6.1.2 Metering and Instrumentation

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify tightness of electrical connections.

b. Electrical Tests

1. Verify that current transformer and voltage transformer secondary circuits are intact.

3.6.1.3 Grounding System

a. Visual and Mechanical Inspection

1. Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

1. Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

2. Submit the measured ground resistance of each ground rod or grounding system, indicating the location of the rod or grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.6.2 Protective Relays

Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Relay settings shall be implemented as directed by the Contracting Officer. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers shall be field tested in accordance with IEEE C57.13.

3.6.3 Pre-Energization Services

Calibration, testing, adjustment, and placing into service of the

installation shall be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of 2 years of current product experience. The following services shall be performed subsequent to testing but prior to the initial energization. The equipment shall be inspected to ensure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation. If factory tests were not performed on completed assemblies, tests shall be performed after the installation of completed assemblies. Components shall be inspected for damage caused during installation or shipment to ensure packaging materials have been removed. Components capable of being both manually and electrically operated shall be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested shall be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer.

### 3.6.4 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days' advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

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DIVISION 26 - ELECTRICAL

SECTION 26 12 00.00 40

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# SECTION 26 12 00.00 40

# MEDIUM-VOLTAGE TRANSFORMERS

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI C57.12.13 | (1982) Conformance Requirements for Liquid-Filled Transformers |
| ANSI C57.12.50 | (1981) Requirements for Ventilated Dry-type Distribution Transformers, 1 to 500 kVA, Single Phase, and 15 to 500 kVA Three Phase, with High-Voltage 601 to 34,500 Volts, Low-voltage 2120 to 600 Volts |
| ANSI C57.12.91 | (2001) Test Code for Dry-Type Distribution and Power Transformers |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 167 | (2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip |
| ASTM D 877 | (2007) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes |
| ASTM D 924 | (2004) Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids |

CALIFORNIA CODE OF REGULATIONS (CCR)

| | |
|---|---|
| CEC | (2007) California Electrical Code |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C57.12.00 | (2006) Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers |
| IEEE C57.12.01 | (2005) General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin-Encapsulated Windings |

| | |
|---|---|
| IEEE C57.12.25 | (1990) Standard for Transformers-Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with Separable Insulated High-Voltage Connectors; High Voltage 34 500-Grd Y/19 920 Volts and Below; Low Voltage, 240/120 Volts; 167 kVA and Smaller - Requirements |
| IEEE C57.12.26 | (1992; Addenda 1993) Transformers - Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, (34 500 Grd Y/19 920 and Below; 2500 kVA and Smaller) |
| IEEE C57.12.29 | (2005) Pad-Mounted Equipment-Enclosure Integrity for Coastal Environments |
| IEEE C57.12.80 | (2002) Standard Terminology for Power and Distribution Transformers |
| IEEE C57.12.90 | (1999) Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers |
| IEEE Std 62 | (1995) Guide for Diagnostic Field Testing of Electric Power Apparatus-Part 1: Oil Filled Power Transformers, Regulators, and Reactors |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2007) Acceptance Testing Specifications |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA ST 1 | (1988; R 1997) Standard for Specialty Transformers (Except General Purpose Type) |
| NEMA ST 20 | (1992; R 1997) Standard for Dry-Type Transformers for General Applications |

U.S. DEPARTMENT OF ENERGY (DOE)

| | |
|---|---|
| DOE CI-2 | (2000) How to Buy an Energy-Efficient Distribution Transformer |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 506 | (2005) Standard for Specialty Transformers |

## 1.2 GENERAL REQUIREMENTS

Sections 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS and 26 11.16 SECONDARY UNIT SUBSTATIONS applies to work specified in this section.

## 1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

The following shall be submitted for distribution transformers:

Transformer Outline Drawing
Connection Diagrams
ANSI Nameplate Data

### SD-03 Product Data

Equipment and Performance data and Equipment Foundation Data shall be submitted for distribution transformers.

Manufacturer's catalog data shall be submitted for the following items:

Dry-Type Distribution Transformers
Liquid-Filled Distribution Transformers

Submittal shall include manufacturer's information for each component device, and accessories provided wit the transformer.

### SD-06 Test Reports

Test reports shall be submitted for the following tests on distribution transformers in accordance with the paragraph entitled, "Field Testing," of this section.

Insulating Liquid Tests
Power Factor Tests
Insulation Resistance Tests
Insulation Power Factor (Doble) Tests
Acceptance Checks

### SD-07 Certificates

Certification of previous tests on similar units (type-testing) under actual conditions may be submitted for impulse tests, efficiencies, temperature-rise tests, sound tests, power-factor tests, bushing tests, and short-circuit tests in lieu of factory tests on actual units furnished.

### SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for the following equipment:

Dry-Type Distribution Transformers
Liquid-Filled Distribution Transformers

## 1.4 QUALITY ASSURANCE

### 1.4.1 Transformer Tests

Tests on transformers shall comprise the manufacturer's standard tests including resistance measurements of all windings; ratio tests; polarity and phase-relation tests; no-load loss at rated voltage; impedance; voltage and load loss at rated current; insulation power factor (Doble) tests, insulation oil tests, and dielectric tests. For oil-filled units manufacturer shall certify that the oil contains no PCB's and shall affix a label to that effect on the transformer tank and on each oil drum containing the insulating oil.

### 1.4.2 Transformer Drawings

Drawings shall include, but are not limited to, the following:

a. An outline drawing with front, top, and side views.

b. Transformer base drawing.

c. ANSI nameplate data.

d. Connection diagrams.

### 1.4.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar mean, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of CEC unless more stringent requirements are specified or indicated.

### 1.4.4 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers catalogs, or brochures during the 2-year period. Where 2 or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

#### 1.4.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6,000 hours, exclusive of the manufacturers factory or laboratory tests, is furnished.

1.4.4.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than 3 years prior to date of delivery to site, unless specified otherwise.

PART 2 PRODUCTS

2.1 LIQUID-FILLED TRANSFORMER

2.1.1 Transformer Rating and Equipment

a. Continuous Full Load Ratings: as indicated on the drawing

b. Cooling Class: KNAN/KNAF, Liquid-filled, self-cooled/forced air cooled

c. Frequency: 60 Hz

d. Phases: Three phase

e. Voltage Rating: as indicated on the drawings

f. Impedance: as indicated on the drawings

g. Insulation Level: 95 kV BIL primary and 30 kV BIL secondary

h. Temperature Rise: 65°C average winding temperature rise above a 30°C ambient

i. Audible Sound Levels: Audible sound levels shall comply with the following:

| kVA Range | DECIBELS (MAX) |
|---|---|
| 225-300 | 55 |
| 301-500 | 56 |
| 501-700 | 57 |
| 701-1000 | 58 |
| 1001-1500 | 60 |
| 1501-2000 | 61 |

j. Short-Circuit Withstand: Transformers shall be capable of withstanding, without injury, the mechanical and thermal stresses caused by short circuits on the external terminals of the low-voltage windings for 2.0 seconds and in accordance with IEEE C57.12.90.

2.1.2 Transformer Accessories

The transformer shall have the following accessories:

a. Four 2.5 percent full capacity taps, two above and two below rated primary voltage.

b. Tap changer, with external, pad-lockable, manual type operating handle, for changing tap setting when transformer is de-energized.

c. Side wall medium-voltage bushings; IEEE Std 386. 15 kV, 95 kV BIL.

d. Insulated low-voltage neutral bushing with lugs for ground cable and removable ground strap.

e. Two ground pads complete with clamp-type terminals for connecting a 4/0 AWG copper ground cable. The pads shall be welded on the base or on the tank wall near the base.

f. Liquid-level indicator.

g. Pressure-vacuum gage.

h. Liquid temperature indicator with 65-70$^{\circ}$ alarm and 85$^{\circ}$ trip function.

i. Drain and filter valves.

j. Pressure relief device, top mounted.

k. Diagrammatic stainless steel or laser-etched anodized aluminum nameplate in accordance with IEEE C57.12.00 and as modified or supplemented by this section.

l. Transformer base with provisions for jacking and for rolling in either direction. Transformer base shall be 6" high and fabricated of ASTM A 167 type 316 stainless steel.

m. Lifting provisions.

n. Bolted transformer top or welded top with bolted handhole access.

o. Auxiliary cooling equipment and controls.

   1. Transformer shall be forced-air-cooled. Forced-air-cooling fans shall have automatic temperature control relay. Power supply for cooling fans shall be provided from control power transformer installed in the control cabinet.

### 2.1.3 Insulating Liquid

Less-flammable transformer liquids: CEC and FM P7825 for less-flammable liquids having a fire point not less than 300$^{\circ}$C tested per ASTM D 92 and a dielectric strength not less than 33 kV tested per ASTM D 877. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid" on the nameplate. The fluid shall be a biodegradable electrical insulating and cooling liquid classified by UL and approved by FM as "less flammable" fluids.

The fluid shall meet the following fluid properties:

a. Pour point: ASTM D 97, less than -15$^{\circ}$C

b. Aquatic biodegradation: EPA 712-C-98-075, 100%

c. Trout toxicity: OEDC Test 203, zero mortality of EPA 600/4-90/027F, pass

### 2.1.4 Seismic Requirements

The transformer equipment and anchorage shall resist the forces associated with seismic Zone 4 requirements.

2.1.5 Factory Finish

Transformers shall be provided with the manufacturer's standard paint finish, ASTM D 1535 light gray No. 61.

2.2 DRY-TYPE TRANSFORMER

IEEE C57.12.01 and NEMA C57.12.5 for dry-type transformers rated 50 kVA or larger. Transformer, including the enclosure, flanges, base, lifting provisions, and hardware, shall be fabricated of ASTM A 167 type 304 or 304L stainless steel. Transformer base shall include any part of the transformer that is within 3 inches of the concrete pad. Paint coating system shall comply with NEMA C57.12.29.

2.2.1 Transformer Ratings and Equipment

a. Transformer shall have continuous full load as indicated on the drawings.

b. Transformer voltage ratings: as indicated on the drawings.

c. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Locate tap adjustments on the face of the high voltage coil. Adjustments shall be accessible by removing the front panel and shall be made when the transformer is de-energized.

d. Minimum tested impedance shall be not less than indicated on the drawings.

e. Cooling system: Class AA, air cooled.

f. Insulation class: 200°C

g. Diagrammatic stainless steel or laser-etched anodized aluminum nameplate.

h. Transformer shall include grounds pads, lifting lugs and provisions for jacking under the base. The transformer base construction shall be suitable for using rollers or skidding in any direction. The transformer shall have an insulated low-voltage neutral bushing with lugs for ground cable, and with removable ground strap.

i. Dry-type transformer shall have the following accessories:

Winding Temperature Indicator

2.3 SOURCE QUALITY CONTROL

2.3.1 Equipment Test Schedule

The Government reserves the right to witness tests. Provide equipment test schedules for test to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

2.3.1.1 Test Instrument Calibration

a. The manufacturer shall have a calibration program which assures that

all applicable test instruments are maintained within rated accuracy.

b. The accuracy shall be directly traceable to the National Institute of Standards and Technology.

c. Instrument calibration frequency schedule shall not exceed 12 months for both test floor instruments and leased specialty equipment.

d. Dated calibration labels shall be visible on all test equipment.

e. Calibrating standard shall be of higher accuracy than that of the instrument tested.

f. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

1. Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

2. Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.3.2 Transformer Design Tests (Liquid-Filled)

In accordance with IEEE C57.12.00 and IEEE C57.12.90. Additionally, IEEE C57.12.80 section 5.1.2 states that "design tests are made only on representative apparatus of basically the same design". Submit design test reports (complete with test data, explanations, formulas, and results), in the same submittal package as the product data and shop drawings for each of the specified transformers. Design tests shall have been performed prior to the award of this contract.

a. Tests shall be certified and signed by a registered professional engineer.

b. Temperature rise: "Basically the same design" for the temperature rise test means a unit-substation transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (KNAN/KNAF), the same temperature rise rating, and the same insulating liquid as the transformer specified.

c. Lightning impulse: "Basically the same design" for the lightning impulse dielectric test means a unit-substation transformer with the same BIL, the same coil construction (such as wire wound primary and sheet wound secondary), and a tap changer, if specified. Design lightning impulse tests shall include both the primary and secondary windings of that transformer.

1. IEEE C57.12.90 paragraph 10.3 entitled "Lightning Impulse Test Procedures", and IEEE C57.98.

2. State test voltage levels.

3. Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

d. Lifting and moving devices: "Basically the same design" for the lifting and moving devices test means a transformer in the same weight range as the transformer specified.

e. Pressure: "Basically the same design" for the pressure test means a unit-substation transformer with a tank volume within 30 percent of the tank volume of the transformer specified.

2.3.3 Transformer Routine and Other Tests (Liquid-Filled)

In accordance with IEEE C57.12.00 and IEEE C57.12.90. Routine and other tests shall be performed by the manufacturer on each of the actual transformers prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence shall be as follows:

a. Cold resistance measurements (provide reference temperature).

b. Phase relation.

c. Ratio.

d. Insulation power-factor by manufacturer's recommended test method.

e. No-load losses (NLL) and excitation current.

f. Load losses (LL) and impedance voltage.

g. Dielectric.

1. Impulse: Per IEEE C57.12.90 paragraph 10.3 entitled "Lightning Impulse Test Procedures", and IEEE C57.98. Test the primary winding only.

(a) State test voltage levels.

(b) Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test reports.

2. Applied voltage.

3. Induced voltage.

h. Leak.

i. Sample insulating liquid. Sample shall be tested for:

1. Dielectric breakdown voltage.

2. Acid neutralization number.

3. Specific gravity.

4. Interfacial tension.

5. Color.

6. Visual condition.

7. Water in insulating liquid.

8. Measure dissipation factor or power factor.

j. Perform dissolved gas analysis (DGA).

2.3.4 Transformer Design Tests (Dry-Type)

In accordance with IEEE C57.12.01 and IEEE C57.12.91. Additionally, IEEE C57.12.80 section 5.1.2 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports in the same submittal package as the product data, shop drawings, and certificates of transformer losses for each of the specified transformers. Design tests shall have been performed prior to the award of this contract.

a. Provide required submittals in a hard-covered binder with index and tabs.

b. Tests shall be certified and signed by a registered professional engineer. Engineer's stamp and signature shall appear on at least the first page of the factory test reports.

c. Temperature rise:

1. "Basically the same design" for the temperature rise test means a unit-substation transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (AA), the same temperature rise rating, the same insulating class and the same insulating medium as the transformer specified.

2. Provide temperature rise readings, formulas, calculations of average temperature rise, and description of test method.

d. Lightning impulse:

1. "Basically the same design" for the lightning impulse dielectric test means a unit-substation transformer with the same BIL and the same coil construction (such as wire wound primary and sheet wound secondary).

2. IEEE C57.12.91 and IEEE C57.98. Provide design lightning impulse tests consisting of a reduced full-wave, two-chopped waves, and one full wave test for each phase of the primary and secondary windings of the same transformer.

3. State test voltage levels.

4. Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

5. Partial Discharge Test per IEEE C57.124. Provide transformer ratings, description and diagram of test method used, test readings and final results.

2.3.5 Transformer Routine and Other Tests (Dry-Type)

In accordance with IEEE C57.12.01 and IEEE C57.12.91. Routine and other tests shall be performed by the manufacturer on each of the actual transformers prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence shall be as follows:

a. Resistance measurements.

b. Phase relation.

c. Ratio.

d. Insulation power-factor by manufacturer's recommended test method.

e. No-load losses (NLL) and excitation current.

f. Load losses (LL) and impedance voltage.

g. Lightning impulse: Perform the complete design type impulse tests on the transformer primary winding only.

   1. IEEE C57.12.91 and IEEE C57.98.

   2. State test voltage levels.

   3. Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test reports.

h. Low frequency dielectric.

   1. Applied voltage.

   2. Induced voltage.

PART 3 EXECUTION

3.1 INSTALLATION

Distribution transformers shall be installed on poured-in-place concrete pads and shall be grounded to a ground grid.

Dry-type transformers shall be installed on resilient vibration-isolating mountings and connected with flexible metallic conduit to prevent transmission and amplification of sound.

Each distribution transformer shall have its kVA rating conspicuously displayed in 3-inch high yellow letters on its tank or enclosure in addition to the complete manufacturer's standard identification plate.

3.2 FIELD TESTING

Transformers shall be tested in accordance with IEEE Std 62 and ANSI C57.12.91.

### 3.2.1 Transformers (Liquid-Filled)

a. Visual and mechanical inspection.

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition. Check for damaged or cracked insulators and leaks.

3. Verify correct liquid level in transformer tank.

4. Perform specific inspections and mechanical tests as recommended by manufacturer.

b. Electrical Tests

1. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

2. Perform oil dissolved gas analysis (DGA).

3. Liquid filled transformers shall have the insulating liquid dielectrically tested after installation and before being energized. Insulating liquid shall be tested in accordance with ASTM D 877, and breakdown voltage shall be not less than 33,000 volts.

4. Liquid filled transformers shall have the oil power factored at 20 degrees C, per ASTM D 924 prior to being energized. Results shall not be greater than 0.5 percent at 20 degrees C.

5. Transformer windings shall be given an insulation-resistance test using 5000-volt test set (primary).

   Readings shall be recorded every 15 seconds for the first minute and every minute thereafter for 10 minutes. Resistance between phase conductors and ground shall be no less than 125 megohms.

6. Transformer windings shall be given an insulation power factor test and winding excitation test in accordance with ANSI IEEE C57.12.90. Insulation power factor shall not exceed 0.5 percent for new liquid filled units. New dry type units can have power factors up to 5.0 percent and still be acceptable.

7. Verify that cooling fans operate correctly and that fan motors have correct overcurrent protection.

8. Verify operation of all alarm, control, and trip circuits from temperature and level indicators, pressure relief device, and fault pressure relay.

9. Inspection all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

10. Verify correct equipment grounding.

3.2.2 Transformers (Dry-Type)

a. Visual and Mechanical Inspection

1. Compare equipment nameplate information with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify that control and alarm settings on temperature indicators are as specified.

4. Verify that cooling fans operate correctly and that fan motors have correct overcurrent protection.

5. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

6. Perform specific inspections and mechanical tests as recommended by manufacturer.

7. Verify that resilient mounts are free and shipping brackets have been removed.

8. Verify that winding core, frame, and enclosure groundings are correct.

9. Verify that as-left tap connections are as specified.

b. Electrical Tests

1. Perform insulation-resistance tests.

2. Perform power-factor tests or dissipation-factor tests in accordance with the test equipment manufacturer's instructions.

3. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

4. Perform turns-ratio tests.

5. Perform overpotential test on all high- and low-voltage windings-to-ground.

6. Verify correct secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

3.2.3 Acceptance

Final acceptance shall depend upon the successful performance of the equipment under test. Transformers shall not be energized until recorded test data have been approved by the Contracting Officer. Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

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DIVISION 26 - ELECTRICAL

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15KV VCB METAL CLAD SWITCHGEAR

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# SECTION 26 13 00.00 20

# 15KV VCB METAL CLAD SWITCHGEAR

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI C37.06 | (2000) Switchgear - AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities (includes supplement ANSI C37.06a) |
| ANSI/IEEE C37.04 | (1999; R2005) Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (includes supplements C37.04C, C37.04G, C37.04H, C37.041) |
| ANSI/IEEE C57.13 | (1993) Instrument Transformers, Requirements for |

CALIFORNIA CODE OF REGULATIONS (CCR)

| | |
|---|---|
| CEC | (2007) California Electrical Code |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1008/A1008M-07A | (2000) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened and Bake Hardenable |
| ASTM D 1535 | (2008) Specifying Color by the Munsell System |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C2 | (2007) National Electrical Safety Code |
| IEEE C37.09 | (1999; R2007) Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis |
| IEEE C37.20.2 | (1999) Standard for Metal-Clad Switchgear |
| IEEE C37.90 | (2003) Standard for Relays and Relay Systems Associated with Electric Power |

| | |
|---|---|
| | Apparatus |
| IEEE C57.12.29 | (1999) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments |
| IEEE Std 4 | (1995) Standard Techniques for High Voltage Testing |
| IEEE Std 48 | (1990) Standard Test Procedures and Requirements for Alternating Current Cable Terminations 2.5kV through 765kV |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2007) Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA SG 2 | (2008) High Voltage Fuses |
| NEMA SG 4 | (2000) Alternating-Current High Voltage Circuit Breakers |
| NEMA SG 5 | (1995) Power Switchgear Assemblies |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70B | (2006) Electrical Equipment Maintenance |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 467 | (2007) Grounding and Bonding Equipment |
| UL 1062 | (2006) UL Standard for Safety Unit Substations |

## 1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC MATERIALS AND METHODS and Section 26 08 00 APPARATUS INSPECTION AND TESTING, apply to this section, with the additions and modifications specified herein.

## 1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchgear Drawings;

Include switchgear plan and elevation, wiring diagrams and installation details of equipment, control equipment and accessories.

SD-03 Product Data

Product Data shall be submitted for the following items including use life, system functional flows, safety features, and mechanical details:

Switchgear Components
Weatherproof Enclosures

Each submittal shall include data on circuit breakers and associated accessories. Each submittal shall include manufacturer's information for each component, device and accessory provided with the equipment.

SD-06 Test Reports

Test Reports shall be submitted for the following tests on the switchgear in accordance with the paragraphs entitled, "Factory Testing" and "Relay Settings and Tests" of this section.

Pressure Tests
Ratio Tests
Rotation Tests
Dielectric Tests
Operational Tests
Continuity Tests
Insulation Resistance Tests
Acceptance Checks and Tests

SD-07 Certificates

Certificates of Compliance shall be submitted for switchgear.

SD-09 Manufacturer's Field Reports

Switchgear design and production tests

SD-10 Operation and Maintenance Data

Switchgear Operation and Maintenance Manual

## 1.4 QUALITY ASSURANCE

### 1.4.1 Switchgear Drawings

Furnish drawings that include, but are not limited to, the following:

a. Overall dimensions, weights, plan view, and front view

b. ANSI nameplate data.

c. Single-line diagram.

### 1.4.2 Paint Coating System

Submit ANSI C57.12.29 paint coating system performance requirement tests.

## 1.5 DELIVERY, STORAGE AND HANDLING

Subassemblies of the switchgear shall be delivered, stored, handled, and installed in a manner that will not damage the equipment. Equipment shall

be stored in the original unbroken protective covering and shipping container, indoors, in a clean, dry, and ventilated location.

During installation, equipment shall be protected from damages due to the weather conditions,.

## 1.6 MAINTENANCE

### 1.6.1 Operation and Maintenance Manuals

Metal-Clad Switchgear Operation and Maintenance Data shall be submitted. Manuals shall be assembled and bound securely in durable, hard covered, water resistant binders.

# PART 2 PRODUCTS

## 2.1 METAL-CLAD SWITCHGEAR

IEEE C37.20.2

### 2.1.1 Ratings and Test Requirements

The voltage rating of the switchgear shall be 15 kV. The corresponding ratings associated with the required switchgear voltage rating shall be as follows:

| | |
|---|---|
| Rated Maximum Voltage, kV | 15 |
| Rated Withstand Impulse Voltage, kV BIL | 95 |
| Continuous and Load Interrupting Current, A | 1200 |
| Short-Circuit Interruption Capacity, MVA | 500 |

## 2.2 SWITCHGEAR EQUIPMENT

### 2.2.1 Switchgear and Auxiliary Equipment Compartments

Switchgear and auxiliary equipment shall be metal-clad switchgear assembly in an enclosed self-contained, self-supporting, indoor or outdoor ventilated unit with sheet metal compartments joined together to form a continuous structure with front-hinged panels and hinged rear covers. Outdoor units shall be enclosed in a weather proof NEMA 3R enclosure with pad lockable front and rear hinged doors.

Barriers between adjacent compartments and the major components of each circuit within a compartment shall be sheet steel not less than 11 gage. Other covers, barriers, panels, and doors shall be not less than 14 gage.

Sheet metal barriers and enclosures shall be constructed from cold-rolled carbon-steel sheets of commercial quality with stretcher-level flatness conforming to ASTM A1008/A1008M-07A. Each compartment shall be reinforced with structural members and welded together. Welds shall be ground to a smooth flat surface before painting.

Removable elements of the same type and rating in the switchgear assembly shall be physically and electrically interchangeable in corresponding compartments.

Front-hinged panel shall be suitable for mounting instruments, relays, control switches, and indicating lamps.

Compartments shall be completely bused with insulated rigid copper solid bus bar of rectangular cross section. Main buses and bus-tap connections shall be uniformly positioned and phase sequenced in accordance with IEEE C37.20.1.

Buses shall be supported and braced to withstand the maximum short-circuit stresses that would be incurred under the most severe fault conditions. Contact surfaces of all main bus and tap connections shall be silver plated and bolted together to ensure maximum conductivity.

Main bus shall be readily accessible for connection of future switchgear assemblies at either end.

Voltage rating and insulation level of switchgear assemblies shall conform to IEEE C37.20.1.

Temperature limits for insulating materials used in switchgear assemblies shall conform to IEEE C37.20.1.

Temperature limits for buses and bus-tap connections in switchgear assemblies shall be in accordance with IEEE C37.20.1.

A continuous rigid copper ground bus shall extend throughout the entire switchgear section and shall ground the stationary structure and equipment. Ground bus shall be capable of carrying the maximum rated short-circuit current of the protective device in the switchgear assembly for a minimum period of 1.0 second.

Compartments shall be provided with indicating lights identifying the breaker positron, "OPEN/CLOSED". Indicating lights shall be supplied from the switchgear control bus at 120 volts ac and shall be the LED type.

Low-voltage wiring for controls and accessories shall be run to terminal blocks having numbered points to identify all circuits. Low-voltage wiring shall be run in conduit, sheet metal compartments, or wireways to isolate the wiring from high-voltage circuits.

Each compartment of the switchgear assembly shall be identified with the manufacturer's standard identification plate engraved with circuit and functions designations. Compartments shall be completely wired with cable terminals, cable clamps, control bus, control power switch, and terminal blocks. Terminal blocks shall be readily accessible for the external connections of metal-clad switchgear.

### 2.2.2 Switchgear Assemblies

General arrangement of the switchgear, the number of compartments, and each compartment's components shall be as shown on the drawings. Switchgear compartments shall include the following:

Vacuum circuit breakers, control switches with pistol grip handle and indicating lights

Current transformers

Microprocessor bused overcurrent/ground-fault relays (Government furnished)

Digital power meter (Government furnished)

Draw-out type voltage transformers with primary and secondary fuse protection

Draw-out type control power transformers with primary and secondary fuse protection

Provision for terminating cables

Space heaters

Convenience receptacle

Incoming line bus entrance compartment shall include an insulated rigid copper bus for direct connection of the incoming line to the main bus, with provision for terminating cables. Rigid copper bus shall be supported to withstand a 23,000-ampere rms short circuit and shall be rated for 65 degrees C temperature rise.

Auxiliary transition compartment shall include an insulated rigid copper bus for direct connection of adjacent auxiliary or switchgear compartments or to the throat of the transformer section. Rigid copper bus shall be supported to withstand a 23,000-ampere rms short circuit.

## 2.3 SWITCHGEAR COMPONENTS

### 2.3.1 Vacuum Circuit Breakers

Shall be of the stored-energy-operated type and shall conform to the applicable requirements of Section 26 05 73.00 40 OVERCURRENT PROTECTIVE DEVICES.

### 2.3.2 Instruments and Instrument Transformers

Indicating instruments, protective relays, current and voltage transformers, instrument transfer switches, and the like shall conform to the applicable requirements of Section 26 05 73.00 40 OVERCURRENT PROTECTIVE DEVICES.

### 2.3.3 Service and Maintenance Devices

The following service and maintenance devices shall be included as a part of the switchgear:

A manual handle for racking the vacuum circuit breaker.

Facilities for operating vacuum circuit breakers in the test or removed position.

Test plugs and cables for meters and relays.

### 2.3.4 Space Heaters

Each section of the switchgear, shall be equipped with space heaters. Heaters shall be rated at 240 volts for connection to 120 volts.

Heaters shall be located at the lowest portion of each space to be heated. Terminals shall be covered. Thermostats shall be used to regulate the temperature.

All heaters shall be installed and operable at the time of shipment so that the heaters can be operated immediately upon arrival at the site, during storage, or before installation. Connection locations shall be marked prominently on drawings and shipping covers and shall have temporary leads for storage operation. Leads shall be easily accessible without having to remove shipping protection.

### 2.3.5 Protective Relays and Devices

See drawings and Section 26 05 73.00 40 for protective relays.

## 2.4 WEATHERPROOF ENCLOSURES WITHOUT MAINTENANCE AISLES

Weatherproof protection for switchgear assemblies without enclosed maintenance aisles shall consist of switchgear and auxiliary equipment compartments, as herein specified, protected with weatherproof ventilated front and rear hinged doors, base and roof sections, roof seamcovers, finishing strips, and end trims.

Front and rear access doors shall be flanged and shall close against rubber or similar weatherproof gasketing material. Ventilated openings shall be provided with filtered louvers and screened vents. Doors shall be equipped with latch, stops, and door-locking mechanisms.

Roof section shall be unit construction with a removable sloping cover and overhanging roof drip edges. Base section shall be unit construction and shall support switchgear assemblies of 6 inches above the concrete foundation.

Each switchgear compartment shall include a removable steel floor plate which shall be drilled for conduit and cable during installation. Floor of the switchgear assembly shall be undercoated with a heavy rubberized protective sealing material at least 0.03 inch thick.

Each compartment shall be equipped with electric space heaters to minimize condensation, interior lighting outlets, utility outlets, and circuit overload protection.

## 2.5 PAINTING

### 2.5.1 Paint Coating System

After fabrication, all exposed ferrous-metal surfaces of the switchgear and component equipment shall be cleaned, primed, and factory-painted inside and outside in accordance with ASTM D 1535. Color shall be No. 61 gray.

## 2.6 SOURCE QUALITY CONTROL

### 2.6.1 Switchgear Design and Production Tests

Furnish reports which include results of design and production tests performed according to IEEE Std 4. Production tests shall be performed by the manufacturer on each switchgear assembly to ensure that design performance is maintained in production.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, CEC, and to the requirements specified herein.

## 3.2 GROUNDING

CEC and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

### 3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 26 11 16 SECONDARY UNIT SUBSTATIONS, as indicated.

### 3.2.2 Switchgear Grounding

Connect #4/0 bare copper conductor ground loop, not less than 30 inches below grade, to the upper end of the ground rods by exothermic welds or compression connectors. Provide #4/0 bare copper conductors connecting the switchgear grounding provisions to two different ground rods.

### 3.2.3 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

## 3.3 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount switch on concrete slab. Slab shall be at least 12 inches thick, reinforced with a 6 x 6 - W2.9 x W2.9 mesh, placed uniformly 4 inches from the top of the slab. Slab shall be placed on a 6 inch thick, well-compacted gravel base. Top of concrete slab shall be approximately 4 inches above finished grade. Edges above grade shall have 1/2 inch chamfer. Slab shall be of adequate size to project at least 8 inches beyond equipment.

Stub up conduits, with bushings, 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with switch cable training areas. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

## 3.4 FIELD QUALITY CONTROL

### 3.4.1 Performance of Acceptance Checks and Tests

Circuit breakers, control and protective devices not factory installed in equipment shall be demonstrated to operate as indicated.

Circuit breakers, control and protective devices shall be field tested in accordance with NETA ATS requirements before the breakers are energized.

## 3.5 RELAY SETTINGS AND TESTS

For relay settings and tests, refer to Section 26 05 73.00 40 OVERCURRENT PROTECTIVE DEVICES.

After the installation has been thoroughly tests and certified to be in

satisfactory condition, with relays calibrated and adjusted to the proper current tap and time dial setting, the Contractor shall request permission to energize the equipment at system voltage for final testing.

3.5.1 Grounding System

a. Visual and Mechanical Inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod, perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.6 ENERGIZING THE SWITCHGEAR

The switchgear shall not be energized until it is completely installed and ready for operation. Field testing shall have been conducted and approved by the Contracting Officer.

Using an ammeter, voltmeter, and wattmeter or phase-angle meter, the values and polarities of voltage and current shall be measured and compared with those expected in the various relay circuits. Contact positions of directional elements and voltage relays shall be inspected as noted.

After inspection and satisfactory tests have been completed on all active relay circuits under a no-load condition, each relay shall be given an operational test with diverted load currents or simulated ground faults.

Following successful operation of all relays and equipment under normal and simulated fault conditions, circuits shall be restored to the normal operating condition and left ready for service.

A report shall be prepared with records of connections, electrical constants, settings, test values, operating performance, and failures or weaknesses found on test.

Tests and procedures for testing shall be in accordance with the manufacturer's recommendations, as approved by the Contracting Office.

-- End of Section --

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# SECTION 26 23 00.00 40

# SWITCHBOARDS

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI C39.1 | (1981; R 1992) Requirements for Electrical Analog Indicating Instruments |
| ANSI C57.12.29 | (1999) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 123/A 123M | (2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A 153/A 153M | (2005) Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A 167 | (2004) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| ASTM A 653/A 653M | (2004a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A 780 | (2001) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings |
| ASTM D 149 | (1997a; R 2004) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies |
| ASTM D 1535 | (2001) Specifying Color by the Munsell System |
| ASTM D 709 | (2001) Laminated Thermosetting Materials |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C12.16 | (1991) Solid-State Electricity Meters |
| IEEE C2 | (2007) National Electrical Safety Code |
| IEEE C37.13 | (1990; R 2005) Low-Voltage AC Power |

| | |
|---|---|
| | Circuit Breakers Used in Enclosures |
| IEEE C37.20.1 | (2006) Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear |
| IEEE C37.90.1 | (2002) Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems Associated with Electric Power Apparatus |
| IEEE C57.12.28 | (2005) Standard for Pad-Mounted Equipment - Enclosure Integrity |
| IEEE C57.12.29 | (2005) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments |
| IEEE C57.13 | (2008) Standard Requirements for Instrument Transformers |
| IEEE Std 100 | (2000) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE Std 81 | (1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)Normal Measurements |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2007) Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA C12.1 | (2001) Code for Electricity Metering |
| NEMA C12.10 | (2004) Physical Aspects of Watthour Meters |
| NEMA C57.12.28 | (1999) Pad-Mounted Equipment - Enclosure Integrity |
| NEMA ICS 6 | (1993; R 2001) Industrial Control and Systems: Enclosures |
| NEMA LI 1 | (1998) Industrial Laminated Thermosetting Products |
| NEMA PB 2 | (2006) Deadfront Distribution Switchboards |
| NEMA PB 2.1 | (2007) General Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less |
| NEMA ST 20 | (1992; R 1997) Dry-Type Transformers for General Applications |

CALIFORNIA CODE OF REGULATIONS (CCR)

| | |
|---|---|
| CEC | (2007) California Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1558 | (1999) Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear |
| UL 198C | (1986; Rev thru Feb 1998)High-Interrupting-Capacity Fuses, Current-Limiting Types |
| UL 198E | (1988; Rev Jul 1988) Class R Fuses |
| UL 467 | (2007) Grounding and Bonding Equipment |
| UL 489 | (2002; Rev thru May 2003) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures |
| UL 512 | (1993; Rev thru Mar 1999) Fuseholders |
| UL 891 | (2005) Safety Switchboards |

## 1.2 RELATED REQUIREMENTS

Section 26 00 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL applies to this section, with the additions and modifications specified herein.

## 1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

## 1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

#### Switchboard Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, industry, and technical society publication references.

### SD-03 Product Data

Switchboard

SD-06 Test Reports

Switchboard design tests

Switchboard production tests

Acceptance checks and tests

SD-10 Operation and Maintenance Data

Switchboard Operation and Maintenance Manuals

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals

Equipment Test Schedule

Request for Settings

## 1.5 QUALITY ASSURANCE

### 1.5.1 Switchboard Product Data

Each submittal shall include manufacturer's information for each component, device and accessory provided with the switchboard and switchgear including:

a. Circuit breaker type, interrupting rating, and trip devices, including available settings

b. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device.

### 1.5.2 Switchboard Drawings

Drawings shall include, but are not limited to the following:

a. One-line diagram including breakers current transformers, and meters

b. Outline drawings including front elevation, section views, footprint, and overall dimensions

c. Bus configuration including dimensions and ampere ratings of bus bars

d. Markings and NEMA nameplate data, including fuse information manufacturer's name, catalog number, and ratings

e. Circuit breaker type, interrupting rating, and trip devices, including available settings

f. Three-line diagrams and elementary diagrams and wiring diagrams with terminals identified, and indicating prewired interconnections between items of equipment and the interconnection between the items.

g. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and

largest secondary feeder device. These shall be used by the designer of record to provide breaker settings that will ensure protection and coordination are achieved.

1.5.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of CEC unless more stringent requirements are specified or indicated.

1.5.4 Standard Products

Provide materials and equipment that are products of manufacturers (such as Square D, RSE Sierra or similar) regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 MAINTENANCE

1.6.1 Assembled Operation and Maintenance Manuals

Submit Operation and Maintenance Manuals. Manuals shall be assembled and bound securely in durable, hard covered, water resistant binders. The manuals shall be assembled and indexed in the following order with a table of contents. The contents of the assembled operation and maintenance manuals shall be as follows:

a. Manufacturer's O&M information required by the paragraph entitled "SD-10, Operation and Maintenance Data".

b. Catalog data required by the paragraph entitled, "SD-03, Product Data".

c. Drawings required by the paragraph entitled, "SD-02, Shop Drawings".

d. Prices for spare parts and supply list.

e. Design test reports

f. Production test reports

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be switchboards and related accessories are specified in Sections 26 11 13 SECONDARY UNIT SUBSTATIONS.

2.2 SWITCHBOARD

NEMA PB 2 and UL 891 or IEEE C37.20.1 and UL 1558.

2.2.1 Ratings

The voltage rating of the switchboard shall be 480Y/277 or 208Y/120 volts AC, 4-wire 3 phase. The continuous current rating of the main bus shall be as indicated. The short-circuit current rating shall be equal to or greater than the integrated equipment rating shown on the drawings. The switchboards shall be UL listed and labeled for its intended use.

2.2.2 Construction

Switchboards shall consist of vertical sections bolted together to form a rigid assembly and shall be front and rear aligned. All circuit breakers shall be front accessible. Front and rear aligned switchboards shall have rear accessible load connections. Compartmentalized switchboards shall have vertical insulating barriers between the front device section, the main bus section, and the cable compartment. Where indicated, "space for future" or "space" shall mean to include bus, device supports, and connections. Provide insulating barriers in accordance with NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness. Apply moisture resistant coating to all rough-cut edges of barriers. Switchboards shall be completely factory engineered and assembled, including protective devices and equipment indicated with necessary interconnections, instrumentation, and control wiring.

2.2.2.1 Enclosure

The switchboard enclosures shall be an outdoor NEMA ICS 6 Type 3R or indoor Type 1 galvanized code-gage sheet steel without knockouts. Entire switchboard and switchgear front shall be hinged on one side with a piano hinge for the full height and shall also have captive screws opposite the hinged side. Enclosure shall be bolted together with removable bolt-on side and rear covers, and sloping roof downward toward rear. Front doors shall be provided with padlockable vault handles with a three point catch and corrosion-resistant steel pin-tumbler cylinder locks. Locks shall be keyed alike, and two keys shall be provided for each enclosure. Bases,

frames and channels of enclosure shall be corrosion resistant and shall be fabricated of galvanized steel. Base shall include any part of enclosure that is within 3 inches of concrete pad. Galvanized steel shall be ASTM A 123/A 123M, ASTM A 653/A 653M G90 coating, and ASTM A 153/A 153M, as applicable. Galvanize after fabrication. Paint enclosure, including bases, ASTM D 1535 light gray No. 61. Paint coating system shall comply with NEMA C57.12.28 for galvanized steel.

2.2.2.2 Bus Bars

Bus bars shall be copper with silver-plated contact surfaces. Plating shall be a minimum of 0.0002 inch thick. Make bus connections and joints with hardened steel bolts. The through-bus shall be rated at the full ampacity of the main throughout the switchboard. Provide minimum one-quarter by 2 inch copper ground bus secured to each vertical section along the entire length of the switchboard. The neutral bus shall be rated 100 percent of the main bus continuous current rating. Provide equipment ground bus.

2.2.2.3 Main Section

The main section shall consist of drawout power circuit breaker.

2.2.2.4 Distribution Sections

The distribution section shall consist of drawout type power or molded-case circuit breakers.

2.2.2.5 Handles

Handles for individually mounted devices shall be of the same design and method of external operation. Label handles prominently to indicate device ampere rating, color coded for device type. Provide ON-OFF indication by handle position and by prominent marking.

2.2.3 Protective Device

Provide main and branch protective devices as indicated.

2.2.3.1 Power Circuit Breaker

IEEE C37.13. Manually operated stationary or drawout, unfused, low-voltage power circuit breaker with a short-circuit current rating as indicated at 480 or 208 volts. Breaker frame size shall be as indicated.

2.2.3.2 Molded-Case Circuit Breaker

UL 489. UL listed and labeled, 100 percent rated, stationary, manually operated, low voltage molded-case circuit breaker, with a short-circuit current rating of 42,000 rms symmetrical amperes as indicated at 480 volts or 22,000 rms symmetrical amperes at 208 volts, unless otherwise noted on the drawings. Breaker frame size shall be as indicated. Series rated circuit breakers are unacceptable.

2.2.4 Drawout Breakers

Equip drawout breakers with disconnecting contacts, wheels, and interlocks for drawout application. The main, auxiliary, and control disconnecting contacts shall be silver-plated, multifinger, positive pressure,

self-aligning type. Each drawout breaker shall be provided with four-position operation. Each position shall be clearly identified by an indicator on the circuit breaker front panel.

a. Connected Position: Primary and secondary contacts are fully engaged. Breaker must be tripped before racking into or out of position.

b. Test Position: Primary contacts are disconnected but secondary contacts remain fully engaged. Position shall allow complete test and operation of the breaker without energizing the primary circuit.

c. Disconnected Position: Primary and secondary contacts are disconnected.

d. Withdrawn (Removed) Position: Places breaker completely out of compartment, ready for removal. Removal of the breaker shall actuate assembly that isolates the primary stabs.

2.2.5 Electronic Trip Units

Equip main and distribution breakers with a solid-state tripping system consisting of three current sensors and a microprocessor-based trip unit that will provide true rms sensing adjustable time-current circuit protection. The ampere rating of the current sensors shall be the same as the breaker frame rating. The trip unit ampere rating shall be as indicated. Ground fault protection shall be residual type sensing. The electronic trip units shall have the following features as indicated.

a. Main breakers shall have short delay pick-up, time settings, instantaneous settings and ground fault settings.

2.2.6 Instruments

ANSI C39.1 for electrical indicating switchboard instruments, with 2 percent accuracy. The ac ammeters and voltmeters shall be a minimum of 2 inches square, with 250-degree scale. Provide single phase indicating instruments with flush-mounted transfer switches for reading three phases.

2.2.6.1 Ac Ammeters

Self-contained.

2.2.6.2 Ac Voltmeters

Self-contained.

2.2.6.3 Instrument Control Switches

Provide rotary cam-operated type with positive means of indicating contact positions. Switches shall have silver-to-silver contacts enclosed in a protective cover which can be removed to inspect the contacts.

2.2.7 Meter Fusing

Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to voltage sensing meters. Size fuses as recommended by the meter manufacturer.

2.2.8 Terminal Boards

Provide plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Terminal boards associated with current transformers shall be short-circuiting type. Terminate conductors for current transformers with ring-tongue lugs. Terminal board identification shall be identical in similar units. External wiring shall be color coded consistently for similar terminal boards.

2.2.9 Heaters

Heaters are specified in Section 26 11 16 SECONDARY UNIT SUBSTATIONS.

2.2.10 Wire Marking

Mark control and metering conductors at each end. Provide factory-installed, white, plastic tubing, heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Each sleeve shall contain a single letter or number, shall be elliptically shaped to securely grip the wire, and shall be keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Each wire marker shall indicate the device or equipment, including specific terminal number to which the remote end of the wire is attached.

2.3 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

2.4 FIELD FABRICATED NAMEPLATES

ASTM D 709 and as specified in section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

2.5 SOURCE QUALITY CONTROL

2.5.1 Equipment Test Schedule

a. Test Instrument Calibration

1. The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.

3. Instrument calibration frequency schedule shall not exceed 12 months.

4. Dated calibration labels shall be visible on all test equipment.

5. Calibrating standard shall be of higher accuracy than that of the instrument tested.

2.5.2 Switchboard Design Tests

NEMA PB2 and UL 891 or IEEE C37.20.1 and UL 1558.

2.5.2.1 Design Tests

Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification.

a. Short-circuit current test

b. Enclosure tests

c. Dielectric test

2.5.3 Switchboard Production Tests

NEMA PB2 and UL 891 or IEEE C37.20.1 and UL 1558. Furnish reports which include results of production tests performed on the actual equipment for this project. These tests include:

a. 60-hertz dielectric tests

b. Mechanical operation tests

c. Electrical operation and control wiring tests

d. Ground fault sensing equipment test

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, CEC, and to the requirements specified herein.

3.2 GROUNDING

CEC and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL. Connect ground conductors to the upper end of the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Equipment Grounding

Provide bare copper cable not smaller than No. 4/0 AWG not less than 30 inches below grade connecting to the indicated ground rods. When work in addition to that indicated or specified is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Switchboard

NEMA PB 2.1.

3.3.2 Meters and Instrument Transformers

NEMA C12.1.

3.3.3 Field Applied Painting

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.3.4 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A 780, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

3.3.5 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount switchboard on concrete slab. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5 FIELD QUALITY CONTROL

Contractor shall submit request for settings of breakers to the Contracting Officer after approval of switchboard and at least 30 days in advance of their requirement.

3.5.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS-2007.

3.5.1.1 Switchboard Assemblies

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical, electrical, and mechanical condition.

3. Confirm correct application of manufacturer's recommended lubricants.

4. Verify appropriate anchorage, required area clearances, and correct alignment.

5. Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

6. Verify that circuit breaker sizes and types correspond to approved shop drawings.

7. Verify that current transformer ratios correspond to approved shop drawings.

8. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

9. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

10. Clean switchboard.

11. Inspect insulators for evidence of physical damage or contaminated surfaces.

12. Verify correct barrier and shutter installation and operation.

13. Exercise all active components.

14. Inspect all mechanical indicating devices for correct operation.

15. Verify that vents are clear.

16. Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.

17. Inspect control power transformers.

b. Electrical Tests

1. Perform insulation-resistance tests on each bus section.

2. Perform overpotential tests.

3. Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.

4. Perform control wiring performance test.

5. Perform primary current injection tests on the entire current

circuit in each section of assembly.

3.5.1.2 Circuit Breakers - Low Voltage - Power

a. Visual and Mechanical Inspection

1. Compare nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Confirm correct application of manufacturer's recommended lubricants.

4. Inspect anchorage, alignment, and grounding. Inspect arc chutes. Inspect moving and stationary contacts for condition, wear, and alignment.

5. Verify that all maintenance devices are available for servicing and operating the breaker.

6. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.

7. Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism.

8. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

9. Verify cell fit and element alignment.

10. Verify racking mechanism.

b. Electrical Tests

1. Perform contact-resistance tests on each breaker.

2. Perform insulation-resistance tests.

3. Adjust Breakers for final settings in accordance with Government provided settings.

4. Determine long-time minimum pickup current by primary current injection.

5. Determine long-time delay by primary current injection.

6. Determine short-time pickup and delay by primary current injection.

7. Determine ground-fault pickup and delay by primary current injection.

8. Determine instantaneous pickup value by primary current injection.

9. Verify correct operation of any auxiliary features such as trip and

pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.

10. Verify operation of charging mechanism.

3.5.1.3 Circuit Breakers

Low Voltage Molded Case with Solid State Trips

a. Visual and Mechanical Inspection

1. Compare nameplate data with specifications and approved shop drawings.

2. Inspect circuit breaker for correct mounting.

3. Operate circuit breaker to ensure smooth operation.

4. Inspect case for cracks or other defects.

5. Inspect all bolted electrical connections for high resistance using low resistance ohmmeter, verifying tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method, or performing thermographic survey.

6. Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

1. Perform contact-resistance tests.

2. Perform insulation-resistance tests.

3. Perform Breaker adjustments for final settings in accordance with Government provided settings.

4. Perform long-time delay time-current characteristic tests

5. Determine short-time pickup and delay by primary current injection.

3.5.1.4 Current Transformers

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify correct connection.

4. Verify that adequate clearances exist between primary and secondary circuit.

5. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

6. Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

1. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

2. Perform insulation-resistance tests.

3. Perform polarity tests.

4. Perform ratio-verification tests.

3.5.1.5 Grounding System

a. Visual and Mechanical Inspection

1. Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

1. IEEE Std 81. Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

2. Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.5.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Circuit breakers shall be tripped by operation of each protective device. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

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# SECTION 33 71 49.23 40

# UNDERGROUND MEDIUM VOLTAGE WIRING

## PART 1 GENERAL

### 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 1011/A 1011M | (2005) Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability |
| ASTM F 512 | (1995; R 2001e1) Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation |

CALIFORNIA CODE OF REGULATIONS (CCR)

| | |
|---|---|
| CEC | (2007) California Electrical Code |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FS TT-V-51 | (Rev F) Varnish: Asphalt |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 6 | (2004e13) Standard for Electrical Rigid Metal Conduit-Steel |

### 1.2 GENERAL REQUIREMENTS

Sections 26 05 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS, 26 05 13.00 40 MEDIUM-VOLTAGE CABLES, and 03 30 00 CAST-IN-PLACE CONCRETE apply to work specified in this section.

### 1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings shall be submitted for the following by the Contractor in accordance with paragraph entitled, "Drawings," of this section.

Conduit and Fittings

Separators
Grounding Conductor

Installation drawings shall be submitted for Underground Duct Systems in accordance with the paragraph entitled, "Installation," of this section.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Conduit and Fittings
Separators
Grounding Conductor

Material, Equipment, and Fixture Lists shall be submitted in accordance with paragraph entitled, "Underground Duct Systems," of this section.

SD-06 Test Reports

Test Reports shall be submitted in accordance with paragraph entitled,"Reports," of this section.

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted in accordance with paragraph entitled, "Underground Duct Systems," of this section.

1.4 DRAWINGS

Fabrication Drawings shall be submitted for Conduit and Fittings, Separators, and Grounding Conductor.

1.5 UNDERGROUND DUCT SYSTEMS

Material, Equipment, and Fixture Lists shall be submitted including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

Manufacturer's Instructions shall be submitted for the Underground Duct Systems including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

PART 2 PRODUCTS

2.1 CONDUIT AND FITTINGS

Conduit and fittings in underground duct banks shall be Schedule 40 polyvinyl-chloride conforming to ASTM F 512.

Aluminum conduit shall not be permitted.

2.2 SEPARATORS

Separators or spacing blocks shall be made of concrete, plastic, or other suitable nonmetallic nondecaying material.

## 2.3 GROUNDING CONDUCTOR

A grounding conductor shall be installed above the concrete encasement of the duct banks and shall be no smaller than a AWG No. 4/0 stranded bare copper conductor.

## 2.4 REPORTS

Test Reports for 2500-psi concrete shall be submitted to the Contracting Officer.

# PART 3 EXECUTION

## 3.1 INSTALLATION

### 3.1.1 Duct Banks

Duct banks shall consist of single or multiple conduit assemblies encased in red dye reinforced concrete and installed with top of duct or duct bank not less than 30 inches below established grade. Duct bank assemblies shall conform to the requirements indicated.

Conduit shall be thoroughly cleaned before using or installing. During construction and after the duct line is completed, the ends of the conduit shall be plugged to prevent water from washing mud into the conduit or manholes. Conduit shall be kept clean and free of concrete, dirt, and any other foreign substance during construction. All conduit runs should be installed so they will drain throughout the run (cable are safe in dry conduits).

Duct lines shall be laid to a minimum grade of 4 inches per 100 feet. Grade may be from one manhole to the next or both ways from a high point between manholes, depending on the contour of the finished grade.

Duct banks installed under or adjacent to roads or shoulders of roads shall be encased in reinforced concrete. Duct lines shall be installed so that the top of the concrete in encased ductlines is not less than 18 inches, or so that the duct in nonencased ductlines is not less than 24-inches below finished grade or finished paving at any point.

All polyvinylchloride conduits in ductbanks between the last manhole and the tunnel shall be pneumatically pressure tested at 5 psi for five minutes with a maximum 0.5 psi pressure drop. Test to be accomplished prior to concrete encasement. Test results to be submitted and approved by the Contracting Officer's Technical Representative prior to concrete encasement.

Changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long-sweep bends having a minimum radius of 25 feet, except that manufactured bends may be used at ends of short runs of 100 feet or less and then only at or close to the end of the run. Long-sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 18 inches for use with ducts of less than 3 inches in diameter and a minimum radius of 36 inches for ducts of 3 inches in diameter and larger.

After the duct line has been completed, a standard flexible mandrel not less than 12-inches long, with a diameter approximately 1/4 inch less than

the inside diameter of the conduit, shall be pulled through each conduit, after which a brush with stiff bristles shall be pulled through each conduit to make certain that no particles of earth, sand, or gravel have been left in the line.

Pneumatic rodding may be used to draw in the lead wire.

Conduit joints in concrete encasement may be placed side by side horizontally but shall be staggered at least 6 inches vertically.

Separators shall be placed not greater than 4 feet on center. Ducts shall be securely anchored to prevent movement during the placement of concrete. At least 3 inches of concrete shall be provided at bottom, top, and sides.

Both concrete bed and cover under paving shall be reinforced with two No. 4 reinforcing bars. Each single conduit of the duct bank shall be completely encased in concrete. Specified thickness of concrete encasement is minimum and may be increased to fit the actual shape of the trench.

Conduit joints shall be made up in accordance with the manufacturer's recommendations for the particular conduit and coupling selected.

A grounding conductor shall be installed above the concrete encasement. Grounding conductor shall extend along all electrical duct banks including stubs through each electrical distribution system manhole and to each transformer and switching-station installation.

#### 3.1.1.1 Connections to Manholes

Duct bank envelopes connecting to underground structures shall be flared to have enlarged cross-section at the manhole entrance to provide additional shear strength. Dimensions of the flared cross-section shall be larger than the corresponding manhole opening dimensions by no less than 12 inches in each direction. Perimeter of the duct bank opening in the underground structure shall be flared toward the inside or keyed to provide a positive interlock between the duct bank and the wall of the structure. Use vibrators when this portion of the encasement is poured to assure a seal between the envelope and the wall of the structure.

Conduit shall terminate in end bells where duct lines enter manholes.

#### 3.1.1.2 Connections to Existing Ducts

Where connections to existing duct banks are indicated, excavate the banks to the maximum depth necessary. Cut off the banks and remove loose concrete from the conduits before new concrete-encased ducts are installed. Provide a reinforced concrete collar, poured monolithically with the new duct bank, to take the shear at the joint of the duct banks. Remove existing cables which constitute interference with the work.

-- End of Section --