SECTION 6 - ELECTRICAL

PART 1 - GENERAL

6-01 GENERAL PROVISIONS

This section supplements the applicable requirements of other sections.

6-01.01 DEFINITIONS

For the purposes of Section 6, the following definitions apply:

A. PROVIDE: Furnish and install.
B. INDICATED: As shown on the drawings or specified herein.
C. CIRCUIT DESIGNATION: Panel designation and circuit number (i.e., LA-13).
D. SHALL: Mandatory requirements.

6-01.02 SCOPE OF WORK

A. The Specifications for Work of Section 6 include, but are not limited to the following sections:

6-01 - General Provisions
6-02 - Temporary Construction Facilities
6-03 - Conduits
6-04 - Underground Ductbanks
6-05 - Conductors
6-06 - Boxes
6-07 - Wiring Devices
6-08 - Branch Circuit Panelboard
6-09 - Disconnects
6-10 - Overcurrent Protective Devices
6-11 - Support Devices
6-12 – Diesel Standby Generator
6-13 - Transfer Switch
6-14 – Solid State Reduced Voltage Starters
6-15 - Switchboards
6-16 - Grounding, Ground Electrode
6-17 - Transformer
6-18 - Lighting Fixtures
6-19 - General Control Devices
6-20 - Motor Control

B. Work Included: All labor, materials, appliances, tools, equipment, facilities, instruments, transportation, and services necessary for and incidental to performing all operations in connection with furnishing, delivery, and installation of the work of this section, complete, as shown on the drawings and/or specified herein. The installation shall include all material, devices, and apparatus not specifically mentioned herein or noted on the drawings, but which are necessary to make a complete working installation of all electrical system shown on the plans or described herein. Work includes, but is not necessarily limited to the following:

1. Examine all sections for related work to be included as work under this section.
2. General provisions for electrical work.

C. RELATED WORK SPECIFIED ELSEWHERE:

1. Motors and their installation.
2. Generator installation is as shown on Mechanical drawings.

D. WORK NOT IN CONTRACT (N.I.C.):

1. Telephone instruments.

6-01.03 REFERENCE STANDARDS

A. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI).

B. ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC).

C. ELECTRICAL TESTING LABORATORIES (ETL).

D. ILLUMINATING ENGINEERING SOCIETY (IES).

E. INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE).

F. INSULATED CABLE ENGINEERS ASSOCIATION (ICEA).

G. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA).

H. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA).

I. UNDERWRITERS LABORATORIES, INC. (UL).

J. CALIFORNIA STATE FIRE MARSHALL (CSFM).

K. ELECTRIC UTILITY SERVICE EQUIPMENT REQUIREMENTS COMMITTEE (EUSERC).

6-01.04 QUALITY ASSURANCE

A. Regulations: All the electrical equipment and materials, including their installations, shall conform to the following applicable latest codes and standards:

1. National Electric Code, Latest Adopted Edition (NEC).
2. Local and State Fire Marshal.
3. Occupational Safety and Health Act (OSHA).
4. Requirements of the Serving Utility Company.
5. Local Codes and Ordinances.
6. Requirements of the Office of the California State Architect (OSA).
7. California Administrative Code, Title 8, Chapter 4, Industrial Safety Orders.
8. California Administrative Code, Title 24.
9. Stationary Combustion Engines and Gas Turbines NFPA - 37.

B. Variances: In instances where two or more codes are at variance, the most restrictive requirement shall apply. All work, materials, equipment, and devices shall be provided in accordance with the governing codes and regulations. When the drawings and/or Specifications call for sizes or class different than that required by the applicable codes, the Contractor shall provide the larger or higher class called by the codes. Nothing on the drawings or in these Specifications is

to be construed to permit work and/or equipment in violation of the governing or applicable codes.

C. Contractor's Expense: Obtain and pay for all required bonds, insurance, licenses, and pay for all taxes, fees, and utility charges required for the electrical work.

D. Testing and Adjustment:

1. Perform all necessary tests required to ascertain that the security, central controller, instruments, telemetry system, and electrical system has been properly installed, and that the power supply to each item of equipment is correct, and that the system is free of grounds, ground faults, and open circuits, that all motors are rotating in the proper directions, and such other tests and adjustments as may be required for the proper completion and operation of the electrical system. Insulation resistance between phase conductors and ground shall not be less than 250,000 ohms.

2. Test the input and output voltage of each transformer prior to operation under load, and adjust the output voltage by resetting taps, to achieve the specified values. After the system has been placed under load, test transformers under normal operation. Record the measurement of primary and secondary voltages. Reset taps to within 1/2 percent if necessary to adjust secondary voltage. Submit a report indicating the final result of such tests, and reporting specific current and voltage measurements.

3. If, during the course of testing, it is found that system imbalance is in excess of 20 percent, rearrange single-pole branch circuits in lighting and receptacle panels to bring system balance to within 20 percent on all phases. Record all such

changes on the panelboard schedule and submit a summary of changes on the record drawings.

6-01.05 SUBMITTALS

A. Submit the following in accordance with Section 1.

1. Detailed shop drawings for:

a. Panelboard
b. Motor Control Centers
c. Transformers
d. Cabinets

2. Detailed manufacturer's product data for:

a. Lighting Fixtures and Associated Equipment
b. Transformer
c. Cabinets
d. Transfer Switch
e. Telemetry System
f. Instruments
g. Service Entrance Switchboards
h. Motor Control Centers

3. Submit calculations for:

a. Power system studies

4. Submit seismic calculations and anchorage details by a California licensed Professional Structural Engineer for:

a. Generator
b. Service Entrance Switchboards
c. Motor Control Centers

5. Submit certified test results for:

a. Transformer
b. Protective Device and Ground Fault System Coordination
c. Grounding

d. Motor Control Center and Service Entrance Equipment for Proper Wiring and Operation.
e. Copies of Certified Test Results for Items a through e Shall be Provided Prior to Utility Co. Providing Electrical Power to Main Switchboard.

6. Submit operating, maintenance, and instructional data for:

a. Service Entrance Switchboards
b. Instruments
c. Transfer Switch
d. Motor Control Centers
e. Solid State Reduced Voltage Starters

7. Instruction Materials:

a. Provide at the time of the personnel instruction period, instruction manuals for the systems as listed under operating maintenance, and instructional data.

b. Include the following (minimum) information in each copy of the instruction manual:

1) Manufacturers' names and addresses.
2) Serial numbers of items furnished.
3) Catalog cuts, exploded views, and brochures, complete with technical and performance data for all equipment, marked to indicate actual items furnished and the intended use.
4) Wiring diagrams and schematic diagrams.
5) Recommended maintenance procedures.
6) Trouble shooting.

6-01.06 SBMWD'S PERSONNEL INSTRUCTIONS

Prior to completion of the contract, and at the SBMWD's convenience, instruct verbally, and demonstrate to the SBMWD's personnel, the

operation of the systems as listed under operating, maintenance, and instructional data.

6-01.07 CLEANING

Clean exterior surfaces of equipment and remove all dirt, cement, plaster, and other debris. Protect interior of equipment from dirt during construction and clean thoroughly before energizing.

Clean out cracks, corners, and surfaces on equipment to be painted. Remove grease and oil spots so that paint may be applied without further preparation.

6-01.08 PROJECT RECORD DOCUMENTS

Mark Project Record Documents daily to indicate all changes made in the field.

In addition to general requirements of Project Record Drawings, indicate on drawings, changes of equipment locations and ratings, trip sizes, and settings of circuit breakers, alterations in raceway runs and sizes, changes in wire sizes, circuit designations, installation details, one-line diagrams, control diagrams, and schedules.

Use green to indicate deletions and red to indicate additions.

Use the same symbols and follow, as much as possible, the same drafting procedures used on the Contract Drawings.

Locate underground conduit stubbed-out for future use, underground feeder conduits, and feeder pull box locations using building lines by indicating on the Project Record Drawings.

6-01.09 ELECTRICAL SERVICE

Coordinate with the utility company all work associated with power and service entrance equipment.

6-01.10 MINIMUM SPECIFICATION REQUIREMENTS (ALL WORK OF SECTION 6)

As a minimum Specification requirement, all materials and methods shall comply with applicable governing codes.

6-01.11 PENETRATION SEALING

Seal penetrations through exterior walls and fire rated walls, floors, and roofs.

6-01.12 PLACING EQUIPMENT IN SERVICE

Do not energize or place electrical equipment in service until all interested parties have been duly notified and are present or have waived their rights to be present. Where equipment to be placed in service involves service or connection from another contractor of the SBMWD, notify the SBMWD in writing when the equipment will be ready. Notify the SBMWD weeks in advance of the date the various items of equipment will be complete.

6-01.13 ELECTRIC ITEM LOCATION

Electrical drawings are generally diagrammatic. Verify equipment sizes with shop drawings and manufacturers' data and coordinate location layout with other trades. Notify the SBMWD of any changes of location requirements prior to installation.

6-01.14 DESIGN CHANGES AFTER AWARD OF BID

When a change in the quantity or size of conductors is made, the conduit size will remain in accordance with that indicated in the original contract drawings rather than the drawing symbol conduit table. When code permits, provide conductor insulation "THWN" where required to maintain conduit fill conformance with the National Electrical Code.

6-01.15 CREDITS AND EXTRAS

Material prices shall be in accordance with the latest issue of Trade Service Publication Inc.'s "Electrical Trade Book", less Contractor's discount, or submitted manufacturer's or supplier's quotes, plus tax and 5 percent cartage.

Labor rates shall be based on local union scale and shall include only benefits required by the union.

The maximum charged for the Foreman or General Foreman shall be the minimum required by the local union.

The amount of labor charged to accomplish the required work shall be based on NECA's "Manual of Labor Rates".

The amount of added direct labor cost shall not exceed 30 percent of the actual labor cost and shall include insurance, taxes, small tools, payroll expenses, office supervision, management development, training, etc.

Rental cost or rates shall be based on the American Equipment Dealers rated manual, less Contractor's discount. Copies of the Equipment Rental Invoices shall be submitted to the Engineer.

The Contractor and the Engineer shall negotiate any cost item where it can be shown that the job conditions are beyond the scope of the above listed manuals. In this case, the burden of proof shall be the responsibility of the Contractor. He shall provide invoices, detailed breakdowns, confirmation by the resident inspector of existing conditions and etc., as may be required to justify his claim.

The fee for the prime electrical subcontractor shall be in accordance with the general and supplemental conditions of the specification, but shall not exceed 15 percent overhead and 10

percent profit. No additional overhead and profit shall be allowed for subcontractors to the prime subcontractor.

The Contractor shall submit detailed material and labor cost breakdown on all cost changes to the contract in the form directed by the Engineer.

For credit changes to the contract, the fee shall not be included, except where additions and deductions are made by a single change order, the cost shall be based on the net change in material and labor prior to determining the fee.

6-01.16 MATERIAL AND EQUIPMENT SUBSTITUTION

All material shall be new and free of defects. Where two or more trade names or manufacturers are mentioned, selection shall be made from the group listed for use in the base bid. The order in which names are listed is not intended to be any indication of preference.

Where a single manufacturer, product or trade name is stated, that manufacturer, product or trade name shall be used in the base bid. The use of other manufacturers, products or trade names will be considered (unless that product is indicated for no substitution) only if submitted 14 working days prior to the bid date. This will allow time for consideration of the substituted equipment and an addendum will be issued if the equipment is acceptable. The SBMWD reserves the right to review such submittals and to determine the acceptability for use. If substituted equipment is submitted at the time of bid without prior approval, that bid will not be accepted.

Equipment other than that specified will be accepted only when written approval is given by the SBMWD in accordance with Section 1.

The Contractor shall be held responsible for all physical changes in piping, equipment, etc. resulting from equipment substitution and likewise bear any increased cost of other trades in making said substitution.

6-01.17 MISCELLANEOUS

1. Provide the services of a factory trained technician for each set of equipment to inspect the installation, calibrate and adjust the control, protective devices, and instruments and to supervise all the required field test and start-up.

2. Contractor is responsible for proper final operation of the control systems. Modify, adjust, rewire, and provide additional relays, wiring, and control devices as necessary. The diagrams show the intended operation and shall be used as the overall guide. Contractor shall resolve any detail discrepancies encountered in using the diagrams and shall provide corrected (final) drawings and wiring diagrams.

6-02 TEMPORARY CONSTRUCTION FACILITIES

PART 1 - GENERAL

6-02.01 WORK INCLUDED

A. Work of this Section includes, but is not necessarily limited to, the following:

   1. Temporary lighting and power for all construction activities, including extension of temporary electrical service into building from temporary utility services outside building.

B. Provide all work under this Section in full accord with all authorities having jurisdiction, including, but not limited to OSHA.

C. Work of this Section for temporary construction facilities includes, but is not necessarily limited to the following:

   1. Maintenance of all temporary work and facilities.

2. Disconnecting and removing of all temporary work not part of permanent construction when and as directed.

PART 2 - PRODUCTS

6-02.02 MATERIAL AND FABRICATION

A. All equipment shall be free of defects and in good working order. Temporary equipment may have been used prior to use at this project.

PART 3 - EXECUTION

6-02.03 TEMPORARY LIGHTING AND POWER SERVICE

A. When required, provide a generator to obtain power required if utility services are unavailable.

B. Provide all required transformers, fused main switches, distribution boards, panels, cut-outs, wiring and grounding, spider boxes, sockets, lamps, fuses, and motor connections to suit all load requirements.

C. Provide and maintain all temporary service equipment as required until permanent service equipment is installed and activated. Switch-over from temporary to permanent service when the permanent service is ready.

D. Provide and maintain all required temporary lighting and temporary power systems for all areas of building as required for construction.

1. Provide all required lighting for ladders and access ways to meet requirements of all authorities having jurisdiction.
2. Provide all required power to within a 50 foot cord length when a cord may be utilized.

E. Provide all hardwired connections for all construction equipment requiring power.

F. Relocate temporary electric facilities as required to provide clearance for permanent installations of trades work to facilitate job progress.

1. When required, provide all step-up and step-down transformers for temporary and permanent equipment required to be connected to temporary power.

G. All equipment provided shall be sized to meet the requirements for connected lighting load, and power load demand.

H. Provide all required replacement fuses, replacement lamps, and all other appurtenances required for the duration of the construction period.

I. Provide adequate temporary lighting at all locations and beneath form work and scaffolds.

6-03 CONDUITS

PART 1 - GENERAL

6-03.01 WORK INCLUDED

A. CONDUITS; INCLUDING:
1. Rigid steel conduit.
2. Intermediate metal conduit (IMC).
3. Polyvinyl chloride conduit (PVC).
4. Liquid-tight flexible metal conduit.

6-03.02 DEFINITION

A. Conduit: This term shall be construed to mean conduit and conduit fittings.

6-03.03 RELATED WORK SPECIFIED ELSEWHERE

A. SUPPORT MATERIAL: Section 6-11

PART 2 - PRODUCTS

6-03.04 MATERIAL AND FABRICATION

A. Rigid Steel Conduit: Hot-dipped galvanized or sherardized including the threads, manufactured in accordance with ANSI C80.1 and UL6.

1. Threaded, hot-dipped galvanized or sherardized fittings manufactured in accordance with ANSI C80.4.

B. Intermediate Metal Conduit: Hot-dipped galvanized including the threads, manufactured in accordance with UL 1242.

C. Polyvinyl Chloride Conduit: Schedule 40, manufactured in accordance with ANSI C33.91, UL 651, and Nema TC-2.

1. Cemented type fittings of the same manufacturer as the conduit.

D. Polyvinyl Chloride Conduit: Type EB, heavy wall, manufactured in accordance with ANSI C33.91, UL651, and Nema TC-8.

1. Cemented fittings of the same manufacturer as the conduit.

E. Liquid-Tight Flexible Conduit: Hot-dipped galvanized with liquid-tight vinyl jacket.

1. Liquid-tight fittings.

PART 3 - EXECUTION

6-03.05 USE

A. Rigid steel conduit in areas where conduit is run exposed.

B. PVC CONDUIT:

1. Schedule 40 for runs below grade in direct contact with earth.

2. Schedule 40 in concrete floors, walls, or roofs.
3. Type EB when concrete encased for sizes 2 inches and larger.

C. FLEXIBLE CONDUIT:

1. For connection to equipment subject to vibration, maximum length 18 inches. In wet locations use liquid-tight flexible conduit.

D. Where 1/2-inch and 3/4-inch conduit runs are concealed in walls or ceilings and these runs are through studs and wood joists, flexible conduit may be used.

E. For utility company feeder and service conduits, provide the type specified by the serving utility.

F. In concrete or below grade use conduit not smaller than 3/4 inch. Maximum size in concrete slab: 1 inch. Run larger sizes under slab.

G. Use long sweep elbows with minimum radius 10 times nominal conduit diameter for shielded cable runs.

6-03.06 INSTALLATION

A. Provide conduit support and bracing in accordance with the latest published SMACNA guidelines.

B. Perform excavating, trenching, backfilling, and compacting. Refer to other sections for conformance.

C. Minimum cover for runs below finished grade outside buildings: 24 inches except where noted or required by the serving utility. Minimum cover for conduit in concrete floors, walls or roof: 1/3 thickness of slab.

D. Minimum separation from uninsulated hot water pipes, steam pipes, or vents: 6 inches. Avoid running conduit directly under water lines.

E. Protect inside of conduit from dirt and rubbish during construction by capping all openings with plastic caps intended for the purpose.

F. Provide conduit bodies for exposed conduit runs at junctions, bends or offsets where required. Do not use elbows or bends around outside corners of beams, walls or equipment. Make conduit body covers accessible.

G. Make conduit field cuts square with saw and ream out to full size. Shoulder conduits in couplings.

H. Make conduit projections from covered areas to areas exposed to the weather watertight by proper flashing. Extend flashing a minimum of 6 inches in all directions from conduit.

I. Where conduit is to remain empty, install polypropylene or nylon pull-line 3/16" minimum diameter) from end to end with tag at each end designating opposite terminations.

J. Run conduit parallel and at right angle to building lines, when visible in finished construction.

K. Cap conduits indicated to be stubbed-out underground using glued-on PVC caps intended for this purpose.

L. Install a coupling flush with the floor on all conduits stubbed up through floors on grade and plug flush with the floor.

M. Unless specifically indicated otherwise, no exterior horizontal roof supported conduit runs are permitted in lengths exceeding 6 feet.

N. Make no bends with a radius less than 12 times the diameter of the cable it contains nor more than 90 degrees. Make field bends with tools designed for conduit bending. Heating of metallic conduit to facilitate bending is not permitted.

O. Where conduit installed in concrete or masonry extends across building construction joints, provide expansion fittings as manufactured by O.Z., Crouse-Hinds, Appleton, or equal, with approved ground straps and clamps.

P. Concrete Wall or Slab Penetrations: All core drilling, sleeves, blockouts or other penetrations must be approved by the Structural Engineer prior to installation.

1. Space sleeves and core drills to insure a minimum dimension of 3 times the nominal trade diameter of the largest adjacent conduit between sleeves or core drills.
2. Use blockouts for concentrations of conduits in a confined area.

Q. Do not penetrate walls with flexible conduit where subject to physical damage. Use recessed box with extension ring for transition from interior to exterior of wall.

R. All homeruns shown shall be run to the panel indicated independently of all other homeruns. Provide pull points so as not to exceed total bends of 360 degree between them unless otherwise indicated.

S. At switchboards, manholes, and floor standing distribution panelboards, provide insulated throat bushings or bell ends on all non-metallic conduit entries and bushings on all metallic conduit entries.

T. Provide bushings on all conduit terminations sized 1-1/2" and larger.

6-04 UNDERGROUND DUCTBANK

PART 1 - GENERAL

6-04.01 WORK INCLUDED

A. Concrete encased ductbanks where indicated.

6-04.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals: Section 6-01

B. Conduit: Section 6-03

C. Conductors: Section 6-05

D. Excavation and Backfill: Section 3

6-04.03 QUALITY ASSURANCE

A. TEST MANDREL:

1. Swab and pull mandrel, one size smaller than the conduit, through the entire length, after backfilling and before restoration of any paving or landscaping.
2. If any obstructions are encountered, locate and replace the obstructed area. Then retest the raceway system as described.

PART 2 - PRODUCTS

6-04.04 ACCEPTABLE MANUFACTURERS

A. DUCT SPACERS:

1. Carlon, An Indian Head Company
2. Queen City Plastics, Inc.
3. R & G Sloane Manufacturing Company, Inc.

6-04.05 MATERIAL AND FABRICATION

A. DUCT SPACERS:

1. Vertical and horizontal interlocking duct spacers for concrete encasement: High-impact styrene.

PART 3 - EXECUTION

6-04.06 INSTALLATION

A. Exercise care in excavating, trenching, and working near existing utilities.

B. INSTALLATION OF DUCTBANKS:

1. Locate spacers no greater than 5 ft.-0 in. center to center along entire length of ductbank.

2. Duct couplings may be placed side by side horizontally, but staggered at least 6 in. vertically.

3. Make conduit joints in accordance with manufacturer's recommendations. In the absence of specific recommendations, make the joints as follows:

   a. Brush a plastic solvent cement on the inside of the coupling and on the outside of the duct ends.
   b. Slip duct and fitting together with a quick one-quarter turn to set the joints.

4. Follow ductbank sections on drawings for size, arrangement and spacing of ducts.

5. Secure ducts and spacers to prevent movement during placement of concrete.

6. At connection to existing manhole, dowel concrete encasement with one #4 reinforcing bar 36 in. long per duct. (minimum of two required.)

7. Provide 1#1/0 soft bare copper ground conductor throughout the continuous length of ductbanks containing conductors having more than 150 volts to ground.

8. Concrete; in accordance with requirements of Section 201 of the Greenbook, latest edition and the following:

   a. Encase duct in 2500 psi concrete.

   b. Encase ducts in concrete having a mixture of three pounds of Class B red tint per cubic yard of concrete where ductbank contains conductors having more than 150 volts to ground, or where indicated per engineer's drawings.

   c. Make ductbank construction monolithic top to bottom and side to side.

   d. Do not exceed the outside dimension of the completed ductbank by more than 1 inch in the vertical or 4 inches in the horizontal from dimensions indicated.

   e. Where the length is poured in phases, provide a minimum of four #4 reinforcing bars 36 inches long with 18 inches extending into the next phase pour.

9. Do not backfill for a period of at least 24 hours after pouring concrete.

10. Survey slope of trenches and ducts between terminations to provide drainage. No pockets shall be permitted.

11. Ductbank concrete may be poured without forming, provided trench walls are firm and will not cave in during installation. Unless noted otherwise, encase the raceway on all sides with a minimum of 3 inches of concrete.

12. Where conduits are stubbed out for future connection, stop concrete 12 inches from end of conduit. Provide a waterproof cap on the end of the conduit.

13. The top of the concrete ductbank shall be as shown on the drawings, or as otherwise required by code and as required to coordinate with other underground obstructions.

6-05 CONDUCTORS

PART 1 - GENERAL

6-05.01 WORK INCLUDED

Conductors; for power, lighting, telemetering, and control, including conductors for general wiring, flexible cords and cables, and ground conductors.

6-05.02 RELATED WORK SPECIFIED ELSEWHERE

A. SUBMITTALS: Section 6-01

PART 2 - PRODUCTS

6-05.03 MATERIAL AND FABRICATION

A. Conductors for General Wiring: Thermoplastic insulated rated for 600V manufactured in accordance with UL 83 and listed by an acceptable independent testing laboratory.

1. Provide 3/4 hard drawn copper conductors. Provide solid conductor for #10 AWG and smaller. Provide stranded conductors for #8 AWG and larger.

B. Flexible Cords and Cables. Jacketed Type SO, suitable for use outdoors with thermoplastic insulated conductors rated for 600V and manufactured in accordance with UL 62 and listed by an acceptable independent testing laboratory.

C. CABLE FOR INSTRUMENTATION: Solid and stranded annealed, bare copper in 18, 19, 22, and 24 AWG insulated conductors, twisted into pairs of specified color combinations to provide pair identification and low noise pickup. Each pair shielded, filled with compound to prevent moisture entry, complete with outer jacket. Cable jacket shall be marked at two-foot intervals with cable type, year manufactured, pair count, size, and manufacturer. Cable shall be manufactured in accordance with UL and listed by an acceptable independent testing laboratory.

D. Conductor Connectors for General Wiring:

1. Sizes No. 14 to No. 8: Splice with insulated spring wire connectors.

a. Ideal No. 451, 455, and 453.
b. Minnesota Mining: Types Y, R, G, and B.
c. Buchanan No. B1, B2, and B4.

2. Sizes No. 6 or Larger, Copper: Splice and terminate with compression or pressure type connectors and terminal lugs.

E. Provide connector sealing packs for splices that require complete protection from dampness and water where indicated.

1. Scotchlok Nos. 3576, 3577, and 3578 by 3M Company.

PART 3 - EXECUTION

6-05.04 USE

A. CONDUCTORS FOR GENERAL WIRING:

1. Minimum 75°C temperature rated insulation on conductors, except use minimum 90°C temperature rated insulation on conductors in conduits exposed on roof, or where required due to ambient temperature.

2. Stranded conductors at motors and other applications where subject to vibration.

3. Minimum size conductors for power and lighting #12 AWG, except where noted.

4. Minimum size conductors for control circuits #14 AWG stranded with THHN/THWN insulation.

B. Use flexible cords and cables for connection of special equipment as indicated. Length not to exceed 72 inches.

C. GROUND CONDUCTORS:

1. Provide an insulated green ground conductor for all branch circuit wiring where indicated.

2. Bare copper conductor may be used.

a. Install ground conductors in all non-metallic conduits as required by code. Install ground conductors in all motor branch circuits and all feeders. Where ground conductor size is not indicated, provide size as required for an equipment ground conductor by the National Electrical Code.

b. Install ground conductors in all flexible metal conduits exceeding 72 inches in length.

D. INSTRUMENTATION CONDUCTORS:

1. Provide an insulated, shielded and jacketed cable for all devices and instruments where required by the manufacturer or as recommended by the equipment instruction manual.

6-05.05 INSPECTION

Check conduit system for damage and loose connections, replace damaged sections.

Check for caps at conduit openings. Make sure that inside of conduit is free of dirt and moisture.

Pull mandrel, one size smaller than the conduit, through entire length of all underground conduits prior to conductor installation.

6-05.06 INSTALLATION

A. CONDUCTORS FOR GENERAL WIRING:

1. Color code conductors insulation as follows:

SYSTEM VOLTAGE CONDUCTOR	240/120	480V,3Ø
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	See NEC Article 200	

2. For conductors #6 AWG or larger, permanent plastic colored tape may be used to mark conductor in lieu of coded insulation. Tape shall cover not less than 2 inches of conductor insulation within enclosure.

   a. Provide color tape on each end and all terminal points and splices on wire enclosed in conduit.

   b. Provide color tape every 4 feet on wire not enclosed in a listed wireway.

3. When pulling conductors do not exceed manufacturer's recommended values.

4. Use polypropylene or nylon ropes for pulling conductors.

B. Insulate splices with plastic electrical tape: Scotch No. 33+, Tomic No. 1T, or equal.

C. Terminate all control wires with terminal lugs on terminal boards not designed with pressure plates. If splices are needed, use same procedure, installing a terminal board in a junction box for protection.

D. Vertical cable supports shall be 0.Z. Gedney, Type M or equal.

6-05.07 IDENTIFICATION

A. Feeders: Identify with the corresponding circuit designation at over-current device and load ends, at all splices and in pull boxes.

B. Branch Circuits: Identify with the corresponding circuit designation at the over-current device and at all splices and devices.

C. Control Wires: Identify with the indicated number and/or letter designation at all terminal points and connections.

D. Alarm and Detection Wires: Identify with the indicated wire and zone numbers at all connections, terminal points, and coiled conductors within cabinets.

E. For identification of conductors use plastic coated self-sticking markers such as Thomas & Betts E-Z Code.

F. Circuit designation is construed to mean panel designation and circuit number (i.e., L-A-13).

6-06 BOXES

PART 1 - GENERAL

6-06.01 WORK INCLUDED

A. BOXES; INCLUDING:

1. Outlet boxes
2. Pull and junction boxes
3. Cabinets.

6-06.02 RELATED WORK SPECIFIED ELSEWHERE

A. SUBMITTALS: Section 6-01
B. SUPPORT MATERIAL: Section 6-11

PART 2 - PRODUCTS

6-06.03 MATERIAL AND FABRICATION

A. OUTLET BOXES:

1. Pressed Steel Boxes: Knockout type hot-dipped or electro-plate galvanized.
2. Cast Iron Boxes: Hot-dipped or electro-plate galvanized with threaded hubs.
3. Cast Iron Conduit Bodies: Hot-dipped or electro-plate galvanized with threaded hubs.
4. Cast copper free aluminum conduit bodies with threaded hubs.
5. Covers for Pressed Steel Boxes: Hot-dipped or electro-plate galvanized.
6. Outlet boxes manufactured in accordance with UL 514.

B. PULL AND JUNCTION BOXES:

1. Sheet steel, hot-dipped or electro-plate galvanized, or prime coated and a final coat of manufacturer's standard enamel or lacquer finish. Manufactured in accordance with UL 50.

   a. Where exposed to weather, provide raintight hubs for conduits entering the boxes, top and sides only.

2. Pre-Cast Concrete Pull Boxes: As manufactured by Brooks or Associated Concrete Products and shown on drawings.

3. High Impact Resistant PVC Boxes: As manufactured by Carlon, Sedco, or R & G Sloan.

C. CABINETS: Sheet metal, prime coat, and final coat of manufacturer's standard enamel or lacquer finish, Manufactured in accordance with UL 50.

1. Control Cabinet: NEMA 1 enclosure, door with butt hinges, and flush handle latches.

a. Provide with removable steel back panel.

2. Terminal Cabinets: NEMA 1 enclosure, door with concealed hinges, and spring catch type flush cylinder locks. Key locks alike, provide two keys with each lock. Provide terminal blocks with adequate number of terminals.

3. Provide engraved plastic nameplates with 1/4" minimum height letters indicating designation of control and terminal cabinets as shown on the drawings.

a. Secure nameplates with at least two screws or rivets. Cementing and adhesive installation not acceptable.

PART 3 - EXECUTION

6-06.04 USE

A. OUTLET BOXES:

1. Aboveground boxes shall be cast iron or cast aluminum device boxes and conduit bodies with metal covers for exposed conduit installation. Provide gasket for covers in wet areas.

B. PULL AND JUNCTION BOXES:

1. Use sheet steel boxes NEMA Type 1 for indoor and NEMA Type 3R for outdoor installation, except as follows:

2. Use cast iron boxes for boxes above grade.

6-06.05 INSTALLATION

Provide 3/8" fixture studs in wall bracket and ceiling boxes.

Provide covers suitable for the fixtures or devices used.

Make outlet box covers flush with finished surfaces.

Close unused open knockouts with knockout seals.

Where boxes are concealed in exposed concrete unit masonry, use square cornered types or boxes fitted with rings of sufficient depth for the box to be recessed completely within cavity of block or tile. Install box to insure that ring fits an opening sawed out of the masonry, so that no mortar is required to fill between ring and construction.

Provide a 6" base of compacted crushed rock under pre-cast concrete pull boxes.

Adjust floor boxes so they are level with top of finished floors.

Provide pull boxes and junction boxes in all branch circuit and feeder runs as indicated. Do not provide pull boxes unless they are indicated or required by the Electrical Code.

6-07 WIRING DEVICES

PART 1 - GENERAL

6-07.01 WORK INCLUDED

A. Wiring devices and plates as indicated.

6-07.02 RELATED WORK SPECIFIED ELSEWHERE

A. BOXES: Section 6-06

6-07.03 DEFINITION

A. WIRING DEVICES: This term includes all wall switches, push buttons, receptacles, and plates used for general purpose installation.

PART 2 - PRODUCTS

6-07.04 MATERIAL AND INSTALLATION

A. WALL SWITCHES:

1. Quiet toggle type, 20A-120/277V, AC rated, with terminal screws to take up to #10 AWG conductors, color brown except where noted otherwise:

	SPST	**DPST**	**3-WAY**	**SPST KEY SWITCH**
Arrow-Hart	1991-	1992-	1993-	1991-L
Bryant	4901-	4902-	4903-	4901-L
General Electric	GE5951-G	GE5952-G	GE5953-G	GE5951-OLG
Hubbell	1221-	1222-	1223-	1221-L
Leviton	1221-2I	1222-2I	1223-2I	1221-2IL
Pass & Seymour	20AC1-	20AC2-	20AC3-	20AC1-L

2. Momentary contact type, 20A-120/277V, 2 circuits, 3 positions, center off, color brown except where noted otherwise:

Arrow-Hart	1995-
Bryant	4921-
General Electric	GE5935-G
Hubbell	1557-
Leviton	1257-I
Pass & Seymour	1250-

B. RECEPTACLES:

1. NEMA 5-20, 20A-125V, straight blade, grounding type, color brown except where noted otherwise.

	SINGLE	**DUPLEX**	**GFCI**	**SURGE SUPPRESSION**
Arrow-Hart	5361-	5362-	GF5342-	
Bryant	5361-	5362-	GFR53FT-	
General Electric	GE4102-	GE4108-	---	
Hubbell	5361-	5362-	GF5362-	6352-IS
Leviton	5361-I	5362-I	6899-I	5380-I
Pass & Seymour	5361-	5362-A	2091-F	

	RECEPTACLE
Arrow-Hart	6200
Bryant	70520-FR
General Electric	GL0520
Hubbell	2310
Leviton	2310
Pass & Seymour	L520-R

3. NEMA 6-20, 20A-250V, 2 pole, 3 wire, straight blade grounding type:

	RECEPTACLE
Arrow-Hart	5861
Bryant	5461
General Electric	GE4182
Hubbell	5461
Leviton	5461-I
Pass & Seymour	5871

4. NEMA L6-20, 20A-250V, 2 pole, 3 wire, locking and grounding type:

	RECEPTACLE
Arrow-Hart	6210
Bryant	70620FR
General Electric	GL0620
Hubbell	2320
Leviton	2320
Pass & Seymour	L620-R

C. PLATES:

1. Interior Plates: Provide stainless steel for receptacles and switches.

2. Exterior Plates: Weatherproof, gasketed, or die cast aluminum with self-closing, hinged cover. It shall be listed as weatherproof in the open position. Hubbell Cat. No. 5206W0 or equal for duplex receptacles, Hubbell Cat. No. 7420 or equal for switches. NEMA 3R polycarbonate plates as manufactured by "TayMac Corporation" for GFCI receptacles.

PART 3 - EXECUTION

6-07.05 INSTALLATION

A. Mount switches and receptacles in vertical position, unless otherwise noted.

B. Mount receptacles with weatherproof plates in horizontal position.

C. Install receptacles mounted vertically so that the ground contact falls on the top position, and horizontally mounted receptacles with neutral pole in top position.

6-08 BRANCH CIRCUIT PANELBOARDS

PART 1 - GENERAL

6-08.01 WORK INCLUDED

A. Branch circuit panelboards.

6-08.02 RELATED WORK SPECIFIED ELSEWHERE

A. SUBMITTALS: Section 6-01
B. OVERCURRENT PROTECTIVE DEVICES: Section 6-10
C. CONTROL DEVICES: Section 6-19

PART 2 - PRODUCTS

6-08.03 MATERIAL AND FABRICATION

A. Provide factory assembled, enclosed panelboards in dead front cabinets, with doors, surface mounted or recessed as indicated, not less than 20" wide and 5-3/4" deep. Height will depend on the number of breakers and spaces.

B. Provide feeder terminal lugs for main breakers rated for use with copper conductors.

C. Provide full length bussing including areas indicated as space only.

D. Provide full size neutral bus where neutral bus is indicated. Provide equipment ground bus and bolt-on circuit breakers.

E. 120/240V, 1 Phase, 3 Wire Panelboards: General Electric Co. Type A-Series, Square-D Co. Type NQOD, or Westinghouse Type B10B.

F. All equipment shall be listed to meet or exceed the available fault current.

PART 3 - EXECUTION

6-08.04 INSTALLATION

A. Secure panelboards to building structure (where shown on drawings) to withstand wire pulling strains. Mount panelboards in switchboards where shown or indicated on the drawings.

B. Do not use toggle bolts.

6-08.05 LABELING AND IDENTIFICATION

A. Provide engraved plastic nameplates on all branch circuit panelboards shown on the single line diagram.

B. Provide panelboard and source feed designation on nameplates with 3/8" minimum height lettering for the panel name and 1/4" height lettering for the source feed designation.

EXAMPLE: 'LA'
FED FROM: MCC-

C. Secure nameplates with at least two screws or rivets. Cementing and adhesive installation not acceptable.

D. Provide a typewritten directory for each branch circuit panelboard, showing each circuits and its use. Provide metal directory frame with plastic window.

6-09 DISCONNECTS

PART 1 - GENERAL

6-09.01 WORK INCLUDED

A. DISCONNECTS: Switches, fused or unfused.

6-09.02 RELATED WORK SPECIFIED ELSEWHERE

A. SUBMITTALS: Section 6-01
B. FUSES: Section 6-10

PART 2 - PRODUCTS

6-09.03 ACCEPTABLE MANUFACTURERS

A. General Electric Company
B. Square D. Company

6-09.04 MATERIAL AND FABRICATION

Provide heavy duty type, quick-make, quick-break disconnects with cover interlocks.

Provide NEMA Type 1 enclosure for dry locations, provide the proper enclosure for other locations as indicated. Provide NEMA Type 3R for outdoor locations. Provide NEMA Type 4X for corrosive locations.

Provide motor rated toggle switches where indicated.

PART 3 - EXECUTION

6-09.05 INSTALLATION

Securely fasten disconnects to structure to withstand wire pulling strains.

6-09.06 LABELING AND IDENTIFICATION

Provide engraved plastic nameplates on individually mounted disconnects with minimum 1/4" height lettering indicating the load served and the source feed designation.

EXAMPLE:

LOAD: EF-1
FED FROM: MCC-3

Secure nameplates with at least two screws or rivets. Cementing and adhesive installation not acceptable.

6-10 OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

6-10.01 WORK INCLUDED

A. Overcurrent protective devices such as circuit breakers and fuses.

6-10.02 SUBMITTALS

A. Submit in accordance with Section 6-01.

PART 2 - PRODUCTS

6-10.03 ACCEPTABLE MANUFACTURERS

A. CIRCUIT BREAKERS:

1. General Electric Co.
2. Square D. Co.

B. FUSES:

1. Bussman Mfg. Div.
2. General Electric Co.
3. The Gould/Shawmut Co.
4. Littlefuse

6-10.04 MATERIAL AND FABRICATION

A. CIRCUIT BREAKERS: Molded case, quick-make, quick-break, thermal- magnetic, trip-free with individual inverse time tripping mechanism on each pole. Terminal lugs rated for copper and aluminum conductors. Minimum 10,000 amperes interrupting capacity, RMS symmetrical.

1. Use thermal magnetic circuit breakers for motor applications.

2. Provide Class A (5 ma sensitivity) breakers where GFI type breakers are required.

3. Ratings shall be as indicated on the drawings.

PART 3 - EXECUTION

6-10.05 INSTALLATION

A. Set adjustable circuit breakers with trips as indicated.

B. Provide separate neutral conductors for circuits protected by GFI breakers.

C. Install fuses in disconnects sized as indicated.

6-10.06 LABELING AND IDENTIFICATION

A. Provide engraved plastic nameplates with 1/4-inch minimum height letters indicating:

1. Circuit designation at branch overcurrent devices in panelboards, switchgear, and motor control centers.

2. Circuit designation of panel or device controlled on circuit breakers, individually enclosed.

B. Secure nameplates with at least two screws or rivets. Cementing and adhesive installation not acceptable.

6-11 SUPPORT DEVICES

PART 1 - GENERAL

6-11.01 WORK INCLUDED

A. Support devices for conduit, boxes, lighting fixtures, and equipment.

PART 2 - PRODUCTS

6-11.02 ACCEPTABLE MANUFACTURERS

A. HANGERS, STRAPS, AND BEAM CLAMPS:

1. Efcor.
2. Raco, Inc.
3. Steel City.
4. O.Z./Gedney Co.
5. Caddy Fastening System by ERICO Products, Inc.

B. CHANNELS AND FITTINGS:

1. Kindorf.
2. Unistrut Corp.

C. ANCHORS:

1. Acherman-Johnson Corp.
2. Phillips Drill Co.
3. Rawl Products Co.

6-11.03 MATERIAL AND FABRICATION

A. HANGERS: Steel cadmium plated.

B. STRAPS: One-hole and two-hole malleable iron, hot-dipped galvanized or steel, cadmium or zinc plated.

C. BEAM CLAMPS: Malleable iron, hot-dipped galvanized or cadmium plated.

D. CHANNELS AND FITTINGS:

1. Channels: Hot-dipped galvanized.
2. Fittings: Galvanized.

E. ANCHORS: Self drilling and expansion bolt types. No wood or fiber plugs or concrete nails are acceptable.

PART 3 - EXECUTION

6-11.04 USE

A. Use one-hole or two-hole straps for single conduit runs on walls or ceilings.

B. Use hangers with solid steel rods for hanging single conduits.

C. Use formed channel trapezes for groups of two or more conduits.

D. To fasten boxes and supports to:

1. Wood: Use wood screws or screw type nails of equal holding power.
2. Brick and Concrete: Use bolts and expansion shields.
3. Hallow Masonry Units: Use toggle bolts.

E. Support sheet metal boxes from building structure directly or by bar hangers.

F. Do not penetrate reinforced concrete beams with fastenings more than 1-1/2" or reinforced concrete joists with more than 3/4" fastenings to prevent contact with reinforcing steel.

6-12 DIESEL STANDBY GENERATORS

PART 1 - GENERAL

6-12.01 WORK INCLUDED

A. Standby generator set and associated controls and panels.

B. Start-up and field test.

6-12.02 SUBMITTALS

A. Submit in accordance with Section 6-01.

1. Shop Drawings including:

a. Outline dimensions.

b. Control and annunciator wiring diagrams.

c. Accessory data.

d. Generator sets KW and voltage output rating at 0.8 P.F., including the manufacturer's horsepower-speed curves

e. Size and configuration of unit mounted fuel tank showing all tank openings (filler, vents, gages, etc.).

f. Calculations verifying the unit submitted is sized to provide power for the loads indicated and meet the performance criteria specified for the unit installation location.

g. Location of the fuel tank level monitoring device for three hour remaining fuel supply level indication.

h. Control panel elevation (Rear mounted).

i. Installation details and calculations for anchorage of the generator unit, fuel tank, and battery rack, certified by a California licensed structural engineer, indicating conformance to seismic criteria for the appropriate zone location as defined by the California Administrative Code, Title 24.

j. Block diagram clearly indicating the quantity and size of conductors and conduits and types of conductors between control and/or annunciator enclosures mounted remote of the generator unit.

k. Calculations used to size the battery charger. Include the following:

   1. Anticipated input current at rated output voltage.

   2. Make and model of battery charger including performance data.

l. Make of engine.

m. Number of cylinders.

n. Bore and stroke, inches.

o. Piston displacement, cubic inches.

p. Piston speed, feet per minute at rated RPM.

q. BMEP at rated KW output.

r. Number and type of bearings.

s. Exciter type.

t. Generator insulation class and temperature rise.

u. Engine BHP curve and fuel consumption curve.

v. Fuel delivery rate required and fuel consumption at full load.

w. List of recommended spare parts with prices.

x. Double wall stainless steel plate type heat exchanger sized accordingly, by Polaris or approved equal.

y. Silencer and support, flex connector, heat shield.

z. Crankcase fumes filter.

2. Operation and Maintenance Manuals including:

a. Factory and Field test results.

b. Instructional Material: Provide complete instructions covering the operation of the engine-generator set and associated equipment for the plant, together with a manual covering engine operation and maintenance. Include any minor adjustments necessary to obtain optimum operation of the set, complete troubleshooting and diagnostic information, disassembly instructions, assembly instructions, preventative maintenance schedule, recommended lubricants, and all necessary service checks.

3. Certified letter stating the exhaust system, when previously designed, has been reviewed and found acceptable for the unit provided or stating proposed modifications for engineering review.

4. The Contractor shall on behalf of the SBMWD, prepare and submit application forms to obtain a permit from the South Coast Air Quality Management District (SCAQMD) required to operate proposed

standby emergency generator. The completed forms shall be submitted to the SBMWD for review, and the SBMWD will make submittal to the SCAQMD.

6-12.03 RELATED WORK NOT INCLUDED IN THIS SECTION

Transfer Switch: Section 6-13

6-12.04 QUALITY ASSURANCE

A. REFERENCES:

1. Except as otherwise noted herein, the latest edition of applicable rules, regulations, and paragraphs of the following standards apply:

   a. National Fire Protection Association (NFPA) Standards.
   b. Flammable and Combustible Code (NFPA 30).
   c. Stationary Combustible Engines and Gas Turbine Code (NFPA 37).
   d. National Electrical Manufacturers Association (NEMA).
   e. Motors and Generators, NEMA #MG-1.1.
   f. South Coast Air Quality Management District (SCAQMD).

B. FACTORY TESTS:

1. Perform all tests after assembly is complete.
2. Provide certified test results in duplicate.
3. Test shall include, but not be limited to, manufacturer's standard test plus one hour test at rated power factor. Test shall be for:

   a. 1/2 hour at 75 percent rated load, and
   b. 1 hour at 100 percent rated load.

4. Determine compliance with the performance criteria specified.

C. FIELD TESTS:

1. Generator set supplier shall provide a factory trained mechanic along with all tools, test equipment, and resistive or inductive load banks required to perform tests. The SBMWD or his representative shall be notified a minimum of two weeks prior to the following testing and may, at his discretion, have the testing witnessed by him or his representative.

2. Record data every 15 minutes and at the beginning and end of every separate test. Include all electrical and temperature information. Testing shall be accomplished in the following sequence:

   a. Check all engine and generator mounting bolts. Check alignment of engine generator and realign if not within manufacturer's limits.

   b. Perform engine manufacturer's recommended pre-starting checks. Include a check of water and lube-oil levels within the engine.

   c. Start engine from a cold start and record the following:

      1) The time delay on start shall be observed and recorded.

      2) The cranking time until the prime mover starts and runs shall be observed and recorded.

      3) The time required to reach operating speed shall be observed and recorded.

      4) The voltage and frequency overshoot shall be recorded.

5) The time required to achieve a steady-state condition at each load change shall be observed and recorded.

6) The voltage frequency and amperes shall be recorded.

7) The prime mover oil pressure and water temperature shall be recorded, where applicable, and the battery charge rate shall be recorded at 5-minute intervals for the first 15 minutes, and at 15-minute intervals thereafter.

d. Operate generator set for 1/2 hour at 50 percent of rated load.

e. Operate generator set for 1/2 hour at 75 percent of rated load.

f. Operate generator set for two hours at 100 percent of rated load.

g. Within 5 minutes of the two hours 100 percent test, perform a 100 percent block load test for a minimum running period of 120 minutes.

h. Demonstrate functioning of high temperature coolant circuit by restricting air flow through the radiator, or by shutting down the radiator fan motor, or by operating the overheat switch gauge.

i. Verify the engine shut down for low oil pressure. Removing the lead conductors or using the manufacturer's test circuits are acceptable methods.

j. Perform a battery starting test, with the charger disconnected, consisting of the minimum cycle cranking period

indicated hereafter or more cycle cranking period when recommended by the manufacturer.

k. Demonstrate operation of the engine over speed circuit by increasing engine speed or by utilizing the manufacturer's pre-engineered test circuit. Record the speed at which the trip operates.

l. Demonstrate the ground fault alarm circuit and note the ground fault current flowing in accordance with the ground fault manufacturer's test procedures.

3. If safety conditions of Safety System are not met during the test, the necessary readjustments shall be made and the step repeated until satisfactory results are obtained.

4. If generator set fails to operate at the loads required, repair or replace the set and repeat the entire test.

5. Checks to be made during on-site testing:

   a. Proper operation of all controls.

   b. Proper operation of all gauges, indicator lights, and instruments throughout operation at all control and annunciator panels.

   c. Proper operation of all auxiliary and accessory equipment. Check all valves, including pilot valves, and injection pump(s) during the tests to assure proper operation.

6. Provide and record other tests as outlined in NFPA 110.

7. Upon completion of the on-site tests, make a general inspection for the following defects:

   a. Leaks in the engine, piping system, etc.
   b. Excessive blow by.
   c. Crankcase contamination.
   d. Any other deficiency which may impair proper operation.

8. Should equipment fail to function properly during operational testing, the defect shall be repaired or the unit replaced and the entire operational test may be repeated at the sole discretion of the engineer.

9. Final acceptance shall be made when the generator set has successfully completed the on-site tests and after all defects in material or operation have been corrected.

D. PERFORMANCE:

1. Upon full load application from no load, the unit shall re-establish stable nominal voltage and frequency operating conditions within 9 seconds with zero droop regulation setting of the governor. This shall also apply for removal of full load to a no load condition.

   The maximum transient frequency drop shall not exceed 5 percent of rated frequency upon full load application for greater than 2 seconds as indicated on an Esterline Angus recording meter, Model AW, operating at 12 inches per minute chart speed, or equal.

2. The first cycle RMS voltage drop as indicated by an oscillograph when 70 percent full rated load is applied from no load in a single step at unity power factor shall not exceed 7 percent with

recovery to nominal voltage within five (5) seconds.

3. The largest motor may be started with all other coincidental loads operating and the voltage drop shall not exceed 30 percent.

4. The generator set shall be capable of reaching rated frequency and voltage within 8 seconds from a cold start under no load.

PART 2 - PRODUCTS

6-12.05 ACCEPTABLE MANUFACTURERS

A. STANDBY GENERATOR:

1. Caterpillar
2. SBMWD Approved Equal

B. The engine-generator set shall be the product of a company with a record of successful and authorized factory representation, or a manufacturer of such units during, at least, the preceding ten (10) years. The supplier shall certify, subject to verification by the SBMWD, that he maintains adequate service and parts facilities within a radius of 100 miles from the site. In addition, it shall be a product of an authorized factory representative of either the generator or the engine manufacturer.

6-12.06 MATERIAL AND FABRICATION

A. Standby Emergency Generator Set: The set consists of a diesel engine driven alternator, an engine mounted control panel. The set shall be mounted on a welded steel base, anchored to the concrete slab with Type RP-1 Neoprene Ribbed Base Pads, suitable to be mounted on a level surface.

B. As a minimum, provide engine with the following characteristics and/or associated accessory items of equipment:

1. Diesel, four cycle, water cooled radiator type (or heat exchanger if so indicated), size adequate for generator load test specified, at the altitude where the unit is to be installed. Minimum horsepower 1-1/2 BHP per rated KW. Engine shall be sized according to the loads indicated on the Contract single line diagrams. Careful consideration must be given to engine sizing in order to meet the performance criteria specified.

2. Operating speed 1800 RPM, piston speed at 2250 (FPM) maximum.

3. Starting system per manufacturer's standard, but not less than 12 volt DC; starting motor with Bendix type drive. Provide dual starters and batteries as required to meet the performance criteria specified.

4. On units where fuel is utilized for injector cooling and the fuel delivery rate is greater than two times the fuel consumption rate, provide a fuel aftercooler. It shall be mounted on the genset to cool the fuel prior to return to the fuel storage system when unit mounted radiators are utilized.

5. Provide a dual walled day tank mounted beneath the genset between the genset skids and the concrete foundation as indicated. The base tank length shall not exceed the overall length of the specified genset and concrete foundation. Size the tank to provide a minimum of 12 hours running time at rated load, unless otherwise indicated.

a. Fuel level gauge, including electric fuel level monitoring device for "3 hour remaining fuel".

b. Mounted threaded couplings for vent, fill, and emergency tank and rupture basin vent lines in the top.

c. Single pole, double throw (SPDT), 10 amp, 120 volt minimum rated contacts, on a float switch signifying when the day tank level drops to approximately 30 minutes running time at rated load (low level alarm).

d. Rupture basin with single pole, double throw (SPDT), 10 amp, 120 volt minimum rated contacts on a float switch signifying when the tank has a fuel leak.

e. Provide a fan/cooler on the engine fuel return line on units where the fuel is used to cool the injectors and the fuel delivery rate is greater than two times the fuel consumption rate at full load where the engine set does not have a unit mounted radiator.

6. Lubricating oil filter of the full flow type with replaceable elements.

7. Breather/Filler pipe suitable for adding oil while the engine is running.

8. Heavy duty dry type air cleaner with replaceable elements.

9. Exhaust Silencer of critical grade, with a minimum 12 inch long flexible connector between exhaust piping or silencer and engine. Provide a rain cap to prevent moisture entering the exhaust system. Provide a moisture drain at the lowest point of the muffler or exhaust piping installation. The location, size, and

routing of exhaust system shall be as required for the engine furnished and as shown on the plans or as directed. Where this system is indicated, the sizes shown are based on a single manufacturer. Deviations required from this by the selected manufacturer shall be included. Exhaust system installation and connections shall be unit mounted unless shown otherwise on plans.

10. Exhaust manifolds, piping, and silencers, where not enclosed in engine housing or water cooled, shall have safety guard installed.

11. Centrifugal water pump with thermostat and by-pass.

12. Provide shutoff valves at the engine block on all water jacket heaters, at both inlet and outlet sides.

13. Immersion heater voltage shall be as indicated, with thermostat or a "Kim Hotstart" preheater. All water heaters shall be readily accessible. The electric heater supply shall be provided through a 3-wire locking type, grounding receptacle and matching plug. Heaters to maintain water temperature of the engine at 100°F with an ambient temperature of 40°F.

14. Engine Protective Devices: The following protective devices shall be provided as a minimum:

    a. A low water temperature sensing device with a visual warning to indicate that the engine water jacket temperature is below 70°F (21.1°C).

b. Sensing devices and a visual pre-alarm warning device shall be provided to indicate the following:

1) High engine temperature (above manufacturer's recommended safe operating temperature range).

2) Low lubricating oil pressure (below manufacturer's recommended safe operating range).

c. Automatic engine shutdown device featuring intake air shutoff plus individual visual devices to indicate that a shutdown took place for:

1) Overcrank (failed to start).
2) Overspeed (mechanically driven device activated at approximately 110 percent of unit operating RPM).
3) Low lubricating oil pressure.
4) Excessive engine temperature.

15. Governor: Unit-mounted with an isochronous electric speed sensing governor, including speed sensing modules of the solid state type to maintain a steady state condition of zero droop. The throttle shall permit speed adjustment within 1/4 cycle. Steady state speed regulation from no load to full load shall be ± .25 percent.

16. Starting bank of batteries shall be lead-acid type in hard rubber case, designed for diesel cranking, of ample capacity for the duty as recommended by the engine manufacturer. The batteries shall be at least 150 ampere-hour (20 hour rating) for sets up to and including 100 KW. For larger sets, the batteries shall be at least 205 ampere-hour. Provide a free-standing, corrosion-resistant, seismic restrained F.R.P., or steel rack for the

batteries. Provide a fiberglass cover for battery protection or one of a similar non-conductive material.

17. The cranking motor or motors shall be of a heavy duty type with adequate rating to crank the engine continuously for 90 seconds at 32°F without damage. Provide Crankcase fumes filter by Racor, Aircept or approved equal.

18. Battery hydrometer.

19. Replaceable element type secondary fuel oil filter.

20. Replaceable primary fuel oil filter in addition to the engine mounted fuel oil filter.

21. Provide "customer interface module" (CAT) or other appropriate dry contacts for connection to SBMWD's SCADA system.

22. Provide double wall stainless steel plate type heat exchanger sized accordingly, by Polaris or approved equal.

23. Provide a contact to close when generator starts to energize the remote heat exchanger solenoid valve (120V rating).

C. Provide generator of the ball bearing type, directly connected to engine with semi-flexible coupling. Directly connect exciter to the end of the generator shaft. Generator and exciter shall conform to USASI, IEEE, and NEMA standards for Class F insulation, 105°C rise by resistance. Class H insulation shall be provided. Nameplate ratings shall correspond to the manufacturer's published data from a period of not more than six months prior to bidding.

1. Continuous standby duty rating at 0.8 PF. KW, KVA, and volts as indicated.

2. External voltage regulator shall maintain regulation with ± 1% above and ± 1% below normal voltage. The instantaneous voltage drop when full load is applied shall not exceed the criteria indicated in the performance specification. Locate in control panel.

3. Excitation shall be provided by a series boost system or a permanent magnet so as to maintain a 3-phase symmetrical short circuit current of 3 times full load current for a period of at least 5 seconds.

4. The voltage waveform harmonic distortion shall not exceed 5 percent total RMS measured line to line and line to neutral where neutral is provided at rated load. Distortion in any one harmonic order shall not exceed 3 percent at rated load.

D. Provide control panel, unit mounted, with the following:

1. Water temperature gauge.

2. Oil pressure gauge.

3. 12 volt panel light with switch.

4. Voltmeter with 3-1/2" scale minimum or digital voltmeter with 3/4" minimum height readout. A selector switch shall be provided to connect any one phase to phase voltage across the meter, 0-600V for 480V systems and 0-300V for 208V systems.

5. Frequency meter of a type which will read true frequency relative to speed.

6. Ammeters with 3-1/2" scale minimum or digital ammeter with 3/4" minimum height readout. A selector switch shall be provided to select any one of the three phases.

7. Running time meter.

8. Voltage regulator and rheostat capable of a minimum of 10 percent adjustment.

9. Control switch with "Automatic", "Off/Reset", "Test", and "Manual" positions; the circuitry shall be such that the generator will be able to deliver emergency power at any time of a normal power failure during an exercise period or in the manual and test positions, providing the generator set has established normal voltage and frequency.

10. Necessary relays and time delay to permit automatic cranking of the engine for an adjustable period indicated, at which time the controls shall be disabled by an over crank position and provide an alarm.

11. Controls to automatically run engine at no load and governed speed for an adjustable period of 0 to 10 minutes after load is transferred from emergency back to normal source. This period to be called "cool-off".

12. Separate indicator lights and common audible alarm with necessary control for:

    a. Low engine water jacket temperature (amber).

    b. High engine water jacket temperature - pre-alarm (amber).

    c. Low lubricating oil pressure - pre-alarm (amber).

    d. Overcrank (failure to start) (red).

    e. Overspeed trip (red).

    f. High water jacket temperature - shutdown (red).

g. Low lubricating oil pressure - shutdown (red).

h. Low fuel (pre-alarm) monitors the fuel storage tank and indicates when less than a three hour supply exists (red).

i. Fuel tank leak detection (amber).

j. Control switch in "Off/Reset" position (red).

k. Generator fault alarm (required for units 650 KW and larger only) (amber).

Notes:

1) The common audible alarm shall consist of a unit battery operated DC horn on the panel. It shall energize when any of the above conditions exist. The panel will include an alarm silencing push-button and circuitry to allow subsequent malfunctions to resound the alarm if the horn had been previously silenced following an initial malfunction.

2) All indicator lights shall have either a "push-to-test" feature or an individual momentary push-button that will test all lights and the horn simultaneously.

13. Time delays and timers shall be either air dashpot, motor driven, or solid state types. Thermal or oil dashpot types will not be accepted. They shall maintain their repetitive operating characteristics in a temperature range of -20°C to 65°C.

14. All control components and overspeed reset shall be marked with engraved plastic nameplates.

15. Main circuit breakers rated as indicated, molded case construction, with ambient compensating thermal trip elements over a minimum range of 10°C to 50°C.

16. The engine starting controls shall provide for a minimum of five (5) adjustable timed cranking cycles of ten (10) seconds "on" and ten (10) seconds "off".

E. Provide alarm and status contacts for the telemetry system.

1. Individual visual signals shall indicate:

a. When the emergency or auxiliary power source is operating to supply power to load.

2. Individual contacts for future visual signals plus a common alarm contact for an audible signal to warn of an engine-generator alarm condition for:

a. Low water temperature (amber).
b. High engine temperature pre-alarm (red).
c. Low lubricating oil pressure pre-alarm (red).
d. Overcrank - failed to start (red).
e. Overspeed (red).
f. Low fuel tank pre-alarm (amber).
g. Low fuel tank emergency (red).
h. Fuel tank leak detection (amber).
i. When the battery charger is malfunctioning (red).
j. Control switch in "Off/Reset" position (red).
k. Ground fault (on units where required) (red).

F. Battery charger of the input voltage indicated, shall be of a solid state type or provide taper charging. The charger shall maintain rated output voltage within plus 1 percent from no load to full load with input

variations plus 10 percent. The charger shall have two ranges within a manual selector switch for selecting either float or equalize range with individual float/equalize adjustments. The charger shall contain a DC voltmeter, DC ammeter, AC and DC fuses, AC failure alarm relay and low DC voltage alarm relay. These relays shall have a minimum of 1PDT each for remote monitoring. The unit shall be listed by Underwriters Laboratories #UL1486.

G. Painting: All external non-working surfaces or metal parts of the generator set shall be painted after thorough cleaning and priming with at least two coats of suitable machinery paint.

PART 3 - EXECUTION

6-12.07 INSTALLATION

A. Mount engine-generator to concrete slab with Type RP-1 Neoprene Ribbed Base Pads, where the unit meets seismic restraint requirements as herein specified.

B. Install and connect batteries and fill with electrolyte.

C. Provide connection to a driven electrode ground from set frame sized as a minimum in accordance with the National Electrical Code, unless otherwise indicated.

D. Provide all oil and coolant required for testing. Upon final acceptance, all fluid levels shall again be filled.

E. Make all necessary control and power connections to the transfer switch.

F. Make necessary adjustments to voltage rheostat and time delay relays following manufacturer's recommendations. Manufacturer shall provide installation inspection and start-up service.

G. The entire installation shall be made in accordance with the recommendations of the manufacturer and within the regulations of the State Industrial Accident Commission and the Fire Prevention Bureau of the Fire Department having jurisdiction.

6-13 TRANSFER SWITCH

PART 1 - GENERAL

6-13.01 WORK INCLUDED

A. Automatic transfer switch.
B. Coordinate with generator equipment.

6-13.02 SUBMITTALS

A. Submit in accordance with Section 6-01.

6-13.03 RELATED WORK SPECIFIED ELSEWHERE

A. GENERATOR: Section 6-12

6-13.04 QUALITY ASSURANCE

A. Transfer switch must be U.L. listed and meet the requirements of U.L. 1008.

PART 2 - PRODUCTS

6-13.05 ACCEPTABLE MANUFACTURERS

A. ASCO; 940 Series
B. Russelectric; Type RMT
C. Zenith

6-13.06 MATERIAL AND FABRICATION

A. Automatic transfer switch, voltage, ampere rating, and number of poles as indicated and rated to withstand the available short circuit current with the overcurrent protective

device type indicated. Provide in a NEMA 1 enclosure. Unless otherwise noted, provide the following accessories and modifications:

1. Voltage and Frequency Sensing:

    a. Close differential voltage sensing on all phases of normal source. Pickup voltage adjustable from 85 percent to 100 percent of nominal, and the dropout adjustable from 75 percent to 98 percent of the pickup value.

    b. Voltage sensing of emergency source. Pickup adjustable from 85 percent to 100 percent of nominal.

    c. Frequency sensing of emergency source. Pickup adjustable from 90 percent to 100 percent of nominal.

2. Time Delays:

    a. Time delay to override momentary normal source outages to delay all transfer switch and engine starting signals. Adjustable from 0.5 to 6 seconds. Set at 0.5 seconds.

    b. Retransfer to normal time delay: Time delay is automatically bypassed if emergency source fails and normal source is available. Adjustable from 0 to 30 minutes. Set at 15 minutes.

    c. Unloaded running time delay for emergency engine generator cool down. Adjustable from 0 to 5 minutes. Set systems at 5 minutes minimum for independent generators or greater where recommended by the engine generator set manufacturer.

d. Transfer to emergency time delay. Adjustable from 0 to 1 minute (minimum) for controlled timing of load transfer to emergency. Set at 0 minutes, unless otherwise noted.

3. Engine Control Contacts:

   a. A contact that closes when normal source fails. Contacts designed for low voltage engine start signals or other customer use. Rated 10 amps, 32 volts DC.

   b. A contact that opens when normal source fails. Contacts designed for low voltage engine start signals or other customer use. Rated 10 amps, 32 volts DC.

4. Manual Controls: Test switch to momentarily simulate normal source failure. Installed and connected on enclosure door.

5. Indicators:

   a. All indicator light sources shall be light emitting diodes or lamps with a rated lamp life exceeding 4000 hours.

   b. One auxiliary contact closed when automatic transfer switch is connected to normal. (10 amps at 480 volts, 60 Hz, general use).

   c. One auxiliary contact closed when automatic transfer switch is connected to emergency. (10 amps at 480 volts, 60 Hz, general use.)

   d. Signal light (green) indicates when automatic transfer switch is connected to normal source. Installed and connected on enclosed types.

e. Signal light (red) indicates when automatic transfer switch is connected to emergency source. Installed and connected on enclosed types.

6. Provide a form C contact which will open at a field adjustable setting of 1 to 300 seconds (minimum) prior to transfer in either direction between two live sources and will close at a field adjustable setting of 1 to 20 seconds (minimum). This contact shall not create any additional transfer delay when transferring from a dead source to a live source.

7. Circuitry shall be provided to prevent transfer to the emergency source until voltage and frequency are within 90 percent of nominal valves.

6-13.07 LABELING AND IDENTIFICATION

A. Provide engraved plastic nameplate on transfer switch shown on the single line diagram.

B. Secure nameplate with at least two screws or rivets. Cementing and adhesive installation not acceptable.

PART 3 - EXECUTION

6-13.08 INSTALLATION

A. Make all necessary control and power connections for transfer switch.

B. Make necessary adjustments to voltage rheostat and time delay relay following manufacturer's recommendations. Manufacturer shall provide installation, inspection, and start-up service utilizing a factory trained mechanic.

6-14 SOLID STATE REDUCED VOLTAGE STARTERS

PART 1 - GENERAL

6-14.01 WORK INCLUDED

A. Floor standing, NEMA 1, Solid State Reduced voltage starters.
B. Motor Control Center installed soft starters.

6-14.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals: Section 6-01
B. Overcurrent Protective Devices: Section 6-10

PART 2 - PRODUCTS

6-14.03 ACCEPTABLE MANUFACTURERS

1. Square D Series ATS48
2. Allen/Bradley SMC Dialog Plus
3. Cutler/Hammer S801 series
4. No other manufacturers will be acceptable.
5. Acceptable manufacturers must meet SBMWD’s 16270 2.02 standard.

6-14.04 SOLID STATE REDUCED VOLTAGE STARTERS

A. The Solid State Reduced Voltage Soft Start Starter (RVSS) shall be the soft-start, soft-stop complete with but not limited to, the following equipment and features:

    1. Molded case circuit breaker with a frame size to be sized by the equipment manufacturer. The circuit breaker shall be provided with door mounted handle with ON, TRIP and OFF indicator and provision for locking in the ON or OFF position. The breaker shall be rated at 480V, 3-pole, complete with adjustable trip and shunt-trip option.

2. Bypass contactor automatically controlled by the RVSS control module to close and bypass the solid state power module only when motor reaches full rated speed and not before. The contactor shall be 3-pole, ampere rating based on NEMA or IEC standard.

3. Contactors shall be vacuum for 100HP and larger and shall be IEC horsepower rated for 75HP and smaller. Vacuum contactors shall be manufactured by Toshiba (no substitutions).

4. Symcom model 777 Motor Protector Relay (no substitutions) with correctly sized current transformers shall be used for added motor protection on 100HP or larger size motors or with a current rating of 100 amps or greater.

5. Unit shall be self-powered and shall not require a separate power supply module for the soft-starter’s control power.

6. The Solid State Reduced Voltage Starter shall be provided with the following devices and features as follows:

    a. A momentary power outage, a fault condition or device is turned off; the controller shall ramp down and shut off completely.

    b. Acceleration and deceleration ramp adjustable from 1-60 seconds. Factory set at 15 seconds.

    c. Initial torque limit adjustable from 0-100 percent nominal motor torque full load amperes (FLA). Factory set at 100 percent.

    d. Start current limit adjustable from 0-500 percent nominal FLA. Factory set at 400 percent.

e. Torque control shall be a selectable option for control operation.

f. Soft-starter operation keypad shall be mounted on the door with manufacture’s remote keypad option kit.

g. Voltage rating from 208V – 15% to 690V +10%, 50/60Hz.

h. SCR’s are rated for 1800V PIV.

i. Unit will have intergrated thermal protection (Class 2, 10, 10A, 15, 20, 25, 30 or no protection) and/or thermal protection with positive temperature (PTC) probes. Motor underload settings. Current overload settings. Phase reversal. Phase loss. Automatic restart. All programmable.

j. The bypass contactor must be mounted externally and the soft starter must not be dependent on the bypass contactor for continuous duty.

PART 3 - EXECUTION

6-14.05 INSTALLATION

A. The installation shall comply with manufacturer’s instructions, drawings, and recommendations.

B. Align starters with other motor control sections and equipment as shown on plans.

6-15 SWITCHBOARDS

PART 1 - GENERAL

6-15.01 WORK INCLUDED

A. Floor standing, NEMA 1 and 3R switchboard; including main and feeder overcurrent

protective devices, underground pull sections, disconnects, and metering equipment as required.

6-15.02 QUALITY ASSURANCE

A. REFERENCE SPECIFICATION AND STANDARDS:

1. Standard for Safety for Dead-Front Switchboards, UL 891.
2. Requirements of the serving utility company.

6-15.03 RELATED WORK SPECIFIED ELSEWHERE

A. SUBMITTALS: Section 6-01
B. OVERCURRENT PROTECTIVE DEVICES: Section 6-10

PART 2 - PRODUCTS

6-15.04 ACCEPTABLE MANUFACTURERS

A. Square-D Co. Type QED (No other manufacturers will be accepted)

6-15.05 MATERIAL AND FABRICATION

A. Provide switchboards with the voltage and ampere ratings for the main breaker or disconnect, the main bus and the feeder breakers, or disconnects and fuses as indicated on the one-line diagram. All equipment shall be listed to meet or exceed the available fault current.

1. Provide bus bars of silver plated copper.

2. Provide full length bussing including areas indicated as space only.

3. Provide circuit breakers or disconnects for the main and feeders, as indicated.

4. Provide full length copper ground bus.

5. Provisions for padlocking the circuit breakers or disconnect in the "on" and "off" positions.

6. Provide full rated bussing (no cascading).

7. All equipment shall be listed to meet or exceed the available fault current.

8. The switchboard shall be installed as shown on the plans.

B. Coordinate with the serving utility company and provide all required service components including, but not limited to, the incoming lugs, metering sockets, current transformers, test blocks, etc.

PART 3 - EXECUTION

6-15.06 INSTALLATION

A. Secure switchboard to concrete pad to withstand wire pulling strains.

B. Install switchboard sections plumb and in straight horizontal alignment (front and back) as indicated. Securely fasten to one another, and anchor to concrete pad floor slab with adequate concrete inserts and 5/8-inch bolts. As a minimum, four anchors per section are required.

6-15.07 LABELING AND IDENTIFICATION

A. Provide engraved plastic nameplate.

B. Provide switchboard designation on nameplate with 3/8" height minimum lettering.

C. Secure nameplates with at least two screws or rivets. Cementing and adhesive installation not acceptable.

6-16 GROUNDING, GROUND ELECTRODE

PART 1 - GENERAL

6-16.01 WORK INCLUDED

A. Grounding: Including conductors, ground rods, and fittings.

PART 2 - PRODUCTS

6-16.02 ACCEPTABLE MANUFACTURERS

A. Ground Rods and Clamps:
   1. Blackburn
   2. Joslyn
   3. Weaver

B. Bonding Fittings:
   1. Burndy Corp.
   2. Thomas & Betts Co.

C. Exothermic Welding:
   1. Cadweld, by Erico Products, Inc.

6-16.03 MATERIAL AND FABRICATION

Soft bare copper stranded conductor for ground cable.

3/4 inch, 10 foot copper clad steel ground rods.

Copper ground bus assembly, minimum 1/4 inch x 3 inch x 12 inch drilled and tapped every 2 inches on center for two hole lugs.

PART 3 - EXECUTION

6-16.04 INSTALLATION

A. Make all connections by exothermic welding process, except at ground bus assembly.

B. Make connections to the ground bus assembly in the following manner:

1. Bond cable to two hole lug using exothermic welding process.

2. Bolt two hole lug to ground bus assembly.

C. Follow the manufacturers' instructions of all exothermic welds. Do not alter molds in the field. The resulting weld shall be a clean, compact, solid connection.

D. Drive top of ground rods 12 inches below grade before connecting to the ground cable.

E. Mount ground bus assembly 18 inches above finished floor, with a minimum of two (2) supports.

F. Install ground conductor in PVC Schedule 80 conduit where exposed to physical damage or where the conductor is underground outside the building perimeter.

6-16.05 TEST

A. Provide certified earthing resistance testing to assure a maximum impedance to ground of 25 ohms.

B. Submit five (5) copies of the test results.

C. Provide additional grounding electrodes as necessary to achieve the impedance indicated.

6-17 TRANSFORMER

PART 1 - GENERAL

6-17.01 WORK INCLUDED

A. Transformers; dry type, for general use.

6-17.02 QUALITY ASSURANCE

A. Reference Standards:

1. General Purpose Transformers, ANSI C89.2, UL 1561.

2. Non-Linear Load Transformers, ANSI C57.110, UL 1561 with K factor listing by UL.

6-17.03 RELATED WORK SPECIFIED ELSEWHERE

A. SUBMITTALS: Section 6-01

PART 2 - PRODUCTS

6-17.04 ACCEPTABLE MANUFACTURERS

A. Line Voltage Transformers:

1. General Electric Co.
2. Acme.
3. Square D Co.

6-17.05 MATERIAL AND FABRICATION

A. Provide line voltage transformers with the following:

1. Insulation temperature rise above 40oC. ambient not to exceed 115oC. for 185oC. insulation system in transformers 25 KVA or smaller.

2. Insulation temperature rise above 40oC. ambient not to exceed 150oC for 220oC insulation system, in transformers 30 KVA or larger.

3. Aluminum or copper windings.

PART 3 - EXECUTION

6-17.06 INSTALLATION

A. Transformer to be wall mounted unless shown otherwise of document drawings.

6-17.07 LABELING AND IDENTIFICATION

A. Provide engraved nameplate on transformer shown on the single line diagram.

B. Provide transformer and source feed designation on nameplate with 3/8" minimum height lettering for the transformer name and 1/4" height lettering for the source feed designation.

EXAMPLE: T-1
FED FROM: PANEL HA MCC-1

C. Secure nameplate with at least two screws or rivets. Cementing and adhesive installation not acceptable.

6-18 LIGHTING FIXTURES

PART 1 - GENERAL

6-18.01 WORK INCLUDED

Lighting fixtures, including lamps, accessories, and support materials.

6-18.02 RELATED WORK SPECIFIED ELSEWHERE

A. SUBMITTALS: Section 6-01

B. OUTLET AND JUNCTION BOXES: Section 6-06

C. SUPPORTING DEVICES: Section 6-11

D. CONTACTERS, RELAYS, TIME SWITCHES, PHOTOCONTROLS, ETC.: Section 6-19

PART 2 - PRODUCTS

6-18.03 MATERIAL AND FABRICATION

A. Fixture schedule lists one or more acceptable manufacturers for each fixture type.

B. Provide all lighting fixtures of each type from the same manufacturer.

C. Provide sockets for screw base lamps of plated steel, brass or bronze.

D. Lamps - Acceptable Manufacturers:

1. General Electric.
2. Phillips.
3. Sylvania.
4. As indicated for specialty lamps.

PART 3 - EXECUTION

6-18.04 INSTALLATION

A. Provide a lighting fixture for each lighting outlet indicated.

B. Align rows of suspended and surface mounted fluorescent fixtures to form straight lines at uniform elevations.

C. Support pendant mounted fluorescent fixtures as follows:

1. Single fixtures not over 12 inches wide, a minimum of two single pendants.

2. Single fixtures over 12 inches wide, a minimum of two single pendants at each end or one double pendant at each end.

3. Continuous rows of fixtures not over 12 inches wide, a minimum of one single pendant for each fixture plus one for each row.

4. Continuous rows of fixtures over 12 inches wide, a minimum of two single pendants or one double pendant for each fixture plus one for each row.

5. Locate pendants for continuous row fixtures at each joint and each end of row.

6. Rigidly fasten continuous row fixtures together with fixture manufacturer supplied joiner.

D. Provide each lighting fixture with the lamps indicated on the fixture schedule.

E. EMT shall not be used to support suspended fixtures of any type. Suspension shall be by means of standard hangers, where available and applicable, by rigid threaded conduit and fittings, or by rods.

F. Where fixtures are to be mounted on, or suspended from, concrete ceiling, provided cast-in-place inserts.

G. Fixtures shall not be supported by outlet box cover screws alone; provide a fixture stud or "hickey" for added support.

H. Provide a junction box at each bracket light fixture indicated.

6-19 GENERAL CONTROL DEVICES

PART 1 - GENERAL

6-19.01 WORK INCLUDED

A. General control equipment.

6-19.02 RELATED WORK SPECIFIED ELSEWHERE

A. Motor Control: Section 6-20

PART 2 - PRODUCTS

6-19.03 MATERIAL AND FABRICATION

A. Control Relays:

1. General Purpose Relays

General purpose relays shall be plug-in type with contacts rated 10 amperes at 120 volts ac; quantity and type of contacts shall be as shown on the Drawings. Each relay shall be enclosed in a clear plastic heat, light indication, shock resistant dust cover and a minimum of 3 poles. Sockets for relays shall have screw type terminals. Relays shall be Square D Type K, Idec Type RR, or approved equal.

2. Time Delay Relay

Time delay relays shall be 120V AC plug-in solid state on-delay type with contacts rated 10-amperes at 120V AC. Units shall include adjustable dial with graduated scale covering the time range as indicated on drawings. Timers shall be Omron Type HC3R or approved equal.

3. Terminal Blocks

Terminal blocks shall be molded plastic with barriers and box lug terminals, and shall be rated 20 amperes at 600 volts. White marking strips, fastened securely to the molded sections, shall be provided and wire numbers or circuit identifications shall be marked thereon with permanent marking fluid. Terminal blocks shall be by Phoenix Type UK5 or approved equal.

B. Control Units, Such as Push Buttons, Pilot Lights, Selector Switches:

1. Pushbuttons

Pushbuttons shall be heavy-duty, non-illuminated oil, and dust tight

(NEMA 12/4) type with 1 normally open 10 amp 600 Volt contact, Square D 9001 Type SK series, or approved equal.

2. Selector Switches

Selector switches shall be 3 position heavy-duty, non-illuminated, oil, and dust tight (NEMA 12/4) type with 2 N.O. and 2 N.C. 10 amp 600 volt maintained contacts, Square D 9001 Type SK series, or approved equal.

3. Indicating Lights

Indicating lights shall be heavy duty NEMA 12/4 lens transformer type 120VAC. Square D 9001 Type SK series or approved equal.

6-19.04 LABELING AND IDENTIFICATION

A. Provide engraved plastic nameplates with 1/4-inch minimum height letters indicating circuit designation of panel or device controlled on controls which are individually enclosed.

B. Secure nameplates with at least two screws or rivets. Cementing and adhesive installation not acceptable.

6-20 MOTOR CONTROL

PART 1 - GENERAL

6-20.01 WORK INCLUDED

A. Motor control; including molded case circuit breakers, motor circuit protectors, or fusible disconnects, adjustable frequency AC drive units and other control devices.

6-20.02 SUBMITTALS

A. Submit in accordance with Section 6-01.

6-20.03 RELATED WORK SPECIFIED ELSEWHERE

A. SEISMIC: Section 6-01

B. OVERCURRENT PROTECTIVE DEVICES: Section 6-10

C. SOLID STATE REDUCED VOLTAGE STARTERS: Section 6-14

D. SWITCHBOARDS: Section 6-15

PART 2 - PRODUCTS

6-20.04 ACCEPTABLE MANUFACTURERS

A. MOTOR CONTROL CENTERS:

1. Square D Model 6 Industrial.

2. Allen/Bradley Centerline.

3. Cutler/Hammer Freedom Series.

4. No other manufacturers will be accepted.

B. VARIABLE FREQUENCY DRIVES (VARIABLE TORQUE):

1. Toshiba “H7” Series for 6 pulse through 350HP.

2. Toshiba “P3” Series for 18 pulse 200HP and greater.

3. Toshiba “G3 Plus Pack” Series for 200HP or greater, stand-alone outdoor applications.

4. Square D ATV58 Series for 6 pulse through 400HP.

5. No other manufacturers will be accepted.

6-20.05 MATERIAL AND FABRICATION

A. MOTOR CONTROL CENTERS:

1. Basic Construction: Motor Control Center shall consist of one or more enclosed

vertical sections joined together to form a rigid, free standing assembly with NEMA type 1B wiring. The construction of the Motor Control Center shall meet the requirements set forth by Underwriters' Laboratories publication UL 845, NEMA publication number ICS-2-322, and the National Electric Code.

2. The Motor Control Centers shall be as manufactured by Square D Company type Model 6 Industrial package, or factory authorized and certified Other Equipment Manufacturers (OEM) for Square D. OEM's must be UL 508A certified, Square D service authorized, and located within 50 miles by the district office. The manufacturer of the circuit breakers and the motor starters shall be the same manufacturer. The manufacturer of the MCC enclosure shall also be the manufacturer of the magnetic starters, circuit breakers, and shall assemble and test all sections in the factory prior to shipment. The Motor Control Center enclosure type shall be in accordance with NEMA standards.

   Vertical sections shall be provided with both horizontal and vertical wireways. Sufficient clearances shall be provided in the horizontal wireway so that no restriction is encountered in running wires from the vertical to horizontal wireway. Wireways shall be in accordance with the wireway sections contained in this document.

3. Horizontal Wireways: Structures will contain a minimum 12" high horizontal wireway at the top of each section, and a minimum 6" high horizontal wireway at the bottom of each section. These wireways will run the full length of the motor control center to allow room for power and control cable between units in different sections.

4. Vertical Wireways: A vertical wire trough shall be located on the right hand side of each vertical section and shall extend from the top horizontal wireway to the bottom of the available unit mounting space. Each vertical wire trough shall have a minimum 4″ wide access door and shall be isolated from the bus bars to guard against accidental contact. A separately hinged door having captive type thumb screws shall cover the vertical wire trough to provide easy access to control wiring without disturbing control units.

5. Bus Bars: A continuous main three conductor horizontal bus shall be provided over the full length of the control center. A fully rated horizontal ground bus, 300 Ampere minimum, shall be supplied over the full length of the motor control center. When necessary, the bus shall be split to allow for ease of handling. Splice bars will be supplied for joining the bus whenever a split has been made. All splice connection shall be made with at least two bolts and shall employ the use of Belleville washers in the connection. Horizontal bus bars shall be mounted edgewise and supported by insulated bus supports.

   For distribution of power from the main horizontal bus to each unit compartment, a three-phase bus shall be provided. The vertical bus shall be firmly bolted to the horizontal bus for permanent contact.

   The main horizontal buses shall be made of copper and the entire length shall be electrolytically silver plated to provide maximum protection to the bus bars from normal or adverse atmospheric conditions. Main buss bars will be rated at 600 Ampere continuous minimum.

Bus supports shall be formed to high strength glass reinforced alkyd material. Bus supports shall have generous surface clearances in the vertical plane to shed dust and maintain dielectric integrity. Bus supports and insulators shall be red to indicate proximity of energized bus parts.

The main horizontal bus rating shall be a minimum as noted on drawings. Vertical bus rating shall be a minimum of 300 amperes for adequate current carrying capacity or as noted on drawings. Continuous current ratings shall be in accordance with temperature specifications set forth by U.L. ANSI and NEMA Standards.

A copper ground lug shall be provided in each incoming line vertical section capable of accepting #8 to 250 MCM cable. A horizontal and vertical tin plated copper ground bus shall be provided in each section of the motor control center. Horizontal ground bus shall run continuously throughout the control center except where splits are necessary for ease of shipment and handling in which case splice bars shall be provided. Ground bus shall be tin plated copper and have a cross-sectional area of equal 28 percent of the main horizontal bus cross sectional area Horizontal ground bus shall be located at the bottom of the Motor Control Center. Vertical ground bus shall run parallel to the power distribution bus in each vertical section. Design shall be such that for any plug-on unit the ground bus stall shall make contact with ground bus before the power bus contact is made.

6. Bus Barriers: Insulated horizontal and vertical bus barriers shall be furnished to reduce the hazard of accidental contact with the bus. Barriers shall have a red color to indicate proximity of energized buses. Vertical bus barriers shall have

interlocking front and back pieces to give added protection on all side and shall segregate the phases to reduce the possibility of accidental "flash over". Small separate openings in the vertical bus barriers shall permit unit plug-on contacts to pass through and engage the vertical bus bars.

Bottom bus covers shall be provided below the vertical bus to protect the ends of the bus from accidental contact with fish tapes or other items entering from the bottom of the enclosure. Unused plug-on openings in the bus shall have plastic snap-in closing plates for added safety.

7. Main Incoming Lug Compartments: A front floor standing, accessible lug compartment shall be provided with suitable lugs to accommodate the incoming cables as shown on the Drawings. The main incoming lug compartment shall be covered by a hinged door for maintenance access. This door shall be held closed with captive type screws to discourage unauthorized access. A unit door padlock attachment shall also be provided to lock the door in the closed position with one 5/16 inch diameter shackle padlock. This attachment shall also accept a meter type seal. All lug connections, bus work bolts, etc. shall be torque tightened to manufacturer's specifications.

8. Units: Combination starter units shall consist of full voltage magnetic starters, motor circuit protectors, auxiliary control devices, such as reset buttons, meters, contactors, phase voltage relays, switches, transformers, control circuit breakers or fuses, control stations, timers, pilot lights, ground fault protection equipment, automatic transfer switches, wiring, plug-in block terminal, and nameplates as specified and/or shown

on the user's one-line and elementary diagrams. All auxiliary equipment, except that which is specified for mounting on the door, shall be mounted within the compartment: All units shall be provided with unit doors, unit support pans, unit saddles, and unit disconnect operators as outlined in this specification. Each unit compartment shall be enclosed and isolated from adjacent units, buses, and wireways except for openings for conductor entrance into units. Units shall be designed and constructed so that any fault will be localized within the compartment. All units shall be UL listed for a minimum of 42,000 amperes RMS symmetrical fault withstandability.

Plug-on combination starter units of the same NEMA size and branch feeder units of the same trip size shall be readily interchangeable with each other. It shall be possible to withdraw each plug-on unit to a de-energized position with the unit still being supported by the structure. It shall be possible to lock the unit in the off position with one padlock.

Full voltage non-reversing combination starter units shall have the following minimum space factor requirements (X = 1 space factor = 6 inches), shall be provided with plug-on connections and shall be provided with ample space for customer wiring room:

Starter with Circuit Breaker-Space Factor

Size 1	1X
Size 2	2X
Size 3	2X
Size 4	3X
Size 5	4X

9. Unit Plug-On: For convenient unit connection to bus bars, unit plug-on contacts shall be provided on the following units:

   For Circuit Breaker Type Units: Full voltage starters, Size 4 and smaller; branch circuit units, 225 ampere, and smaller.

   The plug-on connection for each phase shall be of a high quality two point connection and shall be designed to tighten around the vertical bus bar during a heavy current surge. For trouble free connections, the plug-on fingers shall be silver plated and coated with a compound to assure a low resistance connection. Contact fingers shall be of a floating and self-aligning design to allow solid seating onto the vertical bus bars.

   Latching pull-apart terminal blocks shall be provided for solid electrical control connection to ensure permanent circuit continuity. The terminal blocks shall be rated for continuous operation at 600-volts AC, 20-amperes, and shall accept two-#12-AWG (2-#12AWG) stripped conductors. Terminal marking strips shall be affixed to both pull apart terminal blocks and shall be marked with the same control point numbering as indicated on the control wiring diagram. Provide a minimum of 20 percent (20%) spare terminals.

10. Unit Doors: Each unit shall have a door securely mounted with rugged concealed-type hinges which allow the door to swing open a minimum of 112 degrees for ease of unit maintenance and withdrawal. Doors shall be fastened to the structure so that they remain in place when a unit is withdrawn and may be closed to cover the unit space when the unit has been temporarily removed. Doors shall be held

closed with captive type screws which engage self aligning cage nuts. These screws shall provide at least two threads of engagement to hold doors closed under fault conditions. Each unit door shall be interlocked with its disconnect mechanism to prevent the door from opening when the unit is energized. A defeater mechanism shall be provided for defeating this interlock by authorized personnel. Removable door panels held with captive type thumb screws shall be provided in starter unit doors for mounting push buttons, selector switches or pilot lights. Blank door panels capable of accepting future pilot devices shall be furnished when pilot devices are not originally specified for starter units. Each starter unit door shall house an external low-profile overload reset button for resetting the overload relay in the event of tripping.

Control conductors connecting components mounted on the panel enclosure door shall be bundled with nylon spiral wrap and wire ties in accordance with good commercial practice. Bundles shall be made flexible at the hinged side of the enclosure. Adequate length and flex shall be allowed so that the door can swing to its full open position without undue mechanical stress or abrasion on the conductor insulation.

Each unit door shall have the following:

a. HAND-OFF-AUTO three-position selector switch (Allen/Bradley 800T-J44A keyed switch only).

b. Mushroom type “E-Stop” maintained push button.

c. Green indicating light labeled "PUMP RUN".

d. White indicating light labeled “PUMP TIMING”.

e. Red indicating light labeled “PUMP OFF”.

c. Non-resetting run time hour meter (elapsed time meter) with a tenths of and hour wheel.

11. Unit Support Plan: Each plug-on unit shall be supported and guided by a tilt and lift-out removable pan, so that the unit rearrangement can be easily accomplished. For easy unit installation and rearrangement, transfer of this unit support pan from one location to another shall be accomplished with ease after the control unit and door have been removed.

12. Unit Saddles: Each plug-on unit shall have a saddle of 14 gauge hot rolled steel designed and constructed to physically isolate the unit from the bus compartment and adjacent units. Saddles shall be equipped with captive, self-aligning mounting screws which shall hold the unit securely in place during shipment. Flanged edges shall be provided on each saddle to facilitate unit removal.

13. Disconnect Operators: An external operator handle shall be supplied for each switch or breaker. This mechanism shall be engaged with the switch or breaker at all times regardless of unit door position to prevent false circuit indication. The operator handle shall be color coded to display red in the ON position and black in the OFF position. The operator handle shall have a conventional up-down motion and shall be designed so that the down position will indicate the unit is OFF. Circuit breaker operator handle shall not exceed 78-inches above the floor with the MCC installed on a concrete curb of three-inches above finish floor. For added

safety it shall be possible to lock this handle in the OFF position with up to three padlocks. The operator handle shall be interlocked, with the unit door to prevent switching the unit to ON while the unit door is open. A defeater mechanism shall be provided for the purpose of defeating this interlock by a deliberate act of an electrician, should he desire to observe the operation of the operator handle assembly or the unit components. In the tripped position, the external mechanism will assume a neutral or horizontal position with at lease 40 degrees of movement from the "ON" position.

14. Circuit Breakers: Circuit breakers shall be molded case 480-volt, three-pole, or two-pole, and shall have the ampere tripping as shown on the Drawings.

PART 3 - EXECUTION

6-20.06 INSTALLATION

A. Bolt all sections of the control centers together tightly and secure to concrete pad with anchor bolts after setting assembly plumb and level.

B. Secure units to structures to withstand wire pulling strains.

6-20.07 LABELING AND IDENTIFICATION

A. Provide engraved plastic nameplates on all electrical equipment shown on the single line diagram.

B. Provide engraved plastic nameplates with 1/4-inch minimum height letters at branch overcurrent devices and control equipment.

C. Secure nameplates with at least two screws or rivets. Cementing and adhesive installation not acceptable.