GPU SERVICE CORPORATION

THREE MILE ISLAND - UNIT 2

RECOVERY FACILITIES

DESIGN CRITERIA DOCUMENTS

COVER SHEET

JOB NO: 13587 **DISCIPLINE:** ELECTRICAL

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ELECTRICAL DESIGN CRITERIA

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TITLE

1.0 SCOPE

This document delineates the electrical design criteria for general support facilities for the non-safety-related recovery activities at Three Mile Island - Unit 2. Included are general design requirements as well as codes and standards which shall be used as the basis for system design.

2.0 CODES AND STANDARDS

2.1 The codes and standards of the following organizations shall be used as guidelines in the design of electrical systems and equipment and, where required by law, such systems and equipment shall conform to applicable codes and standards.

Anti-Friction Bearing Manufacturers Association (AFBMA)

AFBMA 9	Load Ratings and Fatigue Life for Ball Bearings
AFBMA 11	Load Ratings and Fatigue Life for Roller Bearings

American National Standards Institute (ANSI)

ANSI C33	Electrical Devices and Materials
ANSI C37	Power Switchgear
ANSI C50	Rotating Machines
ANSI C57	Transformers, Regulators and Reactors
ANSI C80	Conduits
ANSI C89.2	Dry Type Transformers for General Applications
ANSI Z55.1	Gray Finishes for Industrial Apparatus and Equipment

American Society for Testing and Materials (ASTM)

ASTM A 307	Carbon Steel Externally and Internally Threaded Fasteners
ASTM A 366	Sheet Steel, Carbon, Cold-Rolled, Commercial Quality
ASTM A 386	Specifications for Zinc Coating (Hot-Dip) on Assembled Steel Products
ASTM A 525	Specification for Zinc Coated (Galvanized Iron or Steel Sheets) Coils and Cut Lengths

ASTM B 3	Standard Specification for Soft or Annealed Copper Wire
ASTM B 8	Concentric - Lay Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 33	Standard Specification for Soft or Annealed Copper Tinned Wire for Electrical Purposes
ASTM D 635	Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D 2671	Heat Shrinkable Tubing Testing

Insulated Cable Engineers Association (ICEA)

ICEA P-46-426	Power Cable Ampacities, Volume 1 - Copper conductors, and Cumulative Errata Sheets
ICEA P-54-440	Ampacities-Cables in Open-top Cable Trays
ICEA S-19-81	Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
ICEA S-61-402	Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electric Energy
Interim Standard No. 1 to ICEA S-68-516	Cables rated 0-35,000 volts and having Ozone-Resistant Ethylene-Propylene Rubber Insulation
ICEA S-66-524	Cross-Linked Thermosetting-Polyethylene-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

Institute of Electrical and Electronics Engineers (IEEE)

IEEE-112A	Test Procedure for Polyphase Induction Motors and Generators
IEEE-142	Recommended Practice for Grounding of Industrial and Commercial Power Systems
IEEE-281	Service Conditions for Power System Communications Apparatus
IEEE-288	Guide for Induction Motor Protection
IEEE-383	Guide for Type Test of Class IE Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations (flame tests only)

Illuminating Engineering Society (IES)
-Recommended Practices

National Electrical Code (NEC)

National Electrical Manufacturers Association (NEMA)

NEMA AB-1	Molded Case Circuit Breakers
NEMA ICS (Excluding Part 3)	Industrial Controls and Systems Standards for Industrial Controls
NEMA MG-1	Motors and Generators
NEMA MG-2	Safety Standard for Construction and Guide for Selection, Installation, and Use of Fractional and Integral HP Motors and Generators
NEMA PB-1	Panelboards
NEMA ST-20	Dry Type Transformers for General Applications
NEMA TR-1	Transformers, Regulators, and Reactors
NEMA TR-27	Distribution Transformers, Dry type - Commercial, Institutional and Industrial
NEMA VE-1	Cable Trays, Ventilated
NEMA WC-21	Nonreturnable Reels
NEMA WC-25	Protective Covering for Wire and Cable Reels

Occupational Safety and Health Administration (OSHA)

Occupational Safety and Health Standards

Underwriters' Laboratories, Inc (UL)

UL 1	Flexible Metal Electrical Conduit
UL 6	Rigid Metal Electrical Conduit
UL 44	Rubber Insulated Wire and Cables
UL 50	Electrical Cabinets and Boxes
UL 67	Electric Panelboards
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508	Industrial Control Equipment (MCCs)

UL 514	Electrical Outlet Boxes and Fittings
UL 651	Rigid Nonmetallic Electrical Conduit
UL 797	Electrical Metallic Tubing
UL 845	Motor Control Centers
UL 886	Electrical Outlet Boxes and Fittings for Use in Hazardous Locations, Class I, Groups A, B, C, and D, and Class II, Groups E, F, and G.

2.2 Existing plant documents will be used as a basis for new system designs to the greatest extent practicable.

3.0 SYSTEMS DESIGN

3.1 GENERAL

3.1.1 Each of the recovery facilities shall derive its respective power sources from existing switchgear located in the generating station or from extensions of the existing 13.2 kV overhead lines located at the northeast and southwest areas of the site. A dedicated substation may or may not be required for each facility, depending upon such factors as the electrical loads within the building, availability of suitably rated distribution switchgear present in the existing system, and physical orientations of the facilities with respect to their anticipated sources.

3.1.2 Depending upon the facility served, 480 volt, 60 Hz loads shall be supplied from unit substations, motor control centers, distribution panelboards, or all of these. The 120/208 volt, 60 Hz loads shall be supplied from distribution and lighting panelboards.

3.1.3 Motor control centers shall be energized directly from 480 volt substations. The 480/277 volt lighting panels shall be energized via 480 to 277/480 volt transformers from substations or motor control centers. The 120/208 volt lighting and distribution panels shall be fed from motor control centers or distribution panelboards via step-down transformers. Branch circuits shall be supplied through individual circuit breakers within the panelboards.

3.1.4 Voltage sensitive loads requiring a regulated and/or isolated power source shall be supplied from line voltage regulators which furnish 120 and 240 volt, 60 Hz, single phase power regulated to within 1 percent of rated voltage, with less than 5 percent total harmonic distortion.

3.1.5 A 125 volt DC service will be provided for control power for unit substations required by new facility loads. This service will be supplied by existing plant DC power panels.

3.1.6 For those locations where hazardous materials are utilized, electrical equipment installations shall conform to appropriate sections of Chapter 5 of the National Electrical Code.

3.1.7 Distribution equipment ratings shall generally be selected so that 25 percent spare capacity is available when the equipment is purchased, in order to ensure adequate margin for system growth. This margin will be reduced however, for those facilities whose permanently installed loads will be modified to operate at a lower capacity for post-recovery periods.

3.1.8 Insofar as practicable, plant loads shall be energized from diverse power sources if available in order to maximize system reliability and availability.

3.1.9 Any permanent modifications made to the existing plant in order to accommodate the additional loads necessitated by the recovery effort shall be effected so that the final design (i.e., on-line operation of TMI-2) is within acceptable limits for system loading, short circuit capacity and voltage regulation. Where any such modifications are made on a temporary basis only, that fact and any resulting precautions to be followed shall be explicitly noted in the design documentation.

3.1.10 Waterproof cabinets or drip shields shall be used to protect electrical switchgear and motor control centers in areas which will be sprinklered. | 1

3.1.11 In general, the electrical equipment and design philosophy included in the scope of this document shall be reviewed against and, wherever practicable, integrated with the existing plant design. Existing equipment specifications will be used where feasible for timely procurement of new equipment. | 1

3.2 COMMUNICATIONS

Permanently installed communications facilities shall be provided as follows:

3.2.1 For operational purposes, a public address system consisting of six separate and independent communications channels shall be provided. These channels include one page and five party lines. Communications between parties within the plant are established by using the page channel, with a party line channel being used after the page is completed. As many as five party lines may communicate simultaneously. The system is also used to broadcast multitone alarms for reactor building evacuation, site evacuation, and fire. Capability shall be provided to merge this system with the existing public address equipment of Units 1 and 2. System components include wall mount and desk-type handset stations, amplifiers, and loudspeakers.

3.2.2 For communications between control consoles and equipment being maintained, calibrated, or tested, a multi-channel maintenance jack system consisting of a permanently interconnected series of jack stations shall be provided. The system provides two-way communication between multiple stations on a preselected channel by means of plug-in headsets.

3.2.3 A raceway system only for a leased, automatic dial-type commercial telephone system with extensions for intra- and inter-plant use interconnecting all buildings shall be provided.

3.3 FREEZE PROTECTION

3.3.1 Freeze protection shall be provided for outdoor water lines and instrumentation taps as required. This may consist of heater tape or electrically heated enclosures which are energized/deenergized by a locally mounted ambient air thermostat. Temperature monitors shall be provided in order to alarm a low temperature condition on the piping or enclosure served.

3.3.2 Outdoor water storage tanks shall be provided with either thermostatically controlled strap-on type heaters or immersion-type heaters. Temperature monitors shall also be provided.

3.3.3 All alarms shall be annunciated in the command center.

3.4 LIGHTING

3.4.1 Normal Lighting System

3.4.1.1 This system shall provide adequate illumination levels and convenience power for operating and service conditions. In addition, it serves as a distribution system of 120/208 VAC power to serve miscellaneous small load requirements. This system consists of a complete distribution network of cables, raceways, transformers, lighting panels, lighting fixtures, receptacles, and switches.

3.4.1.2 Lighting shall be served from diverse sources to preclude complete loss of illumination in an area in the event of equipment malfunction.

3.4.1.3 Lighting levels shall be as recommended by the Illuminating Engineering Society.

3.4.1.4 The raceway system shall be steel conduit, rigid, IMC or EMT. No EMT shall be used within the existing plant buildings. Where EMT is used, its application shall be restricted to preclude personnel walking and/or climbing on it.

3.4.1.5 The receptacles shall be 20 ampere or larger, 120 volt, NEMA configured, 3-wire grounding, duplex type. GFI circuit breakers shall be used for receptacle circuits in laboratories and shops. Switches shall be 20 ampere 120 or 277 volt bakelite base, single-pole, double-pole, three-way and four-way, as required. Where building construction permits, receptacles and switches shall be flush mounted; otherwise they shall be surface mounted. In outdoor areas, switches and receptacles shall be in weatherproof enclosures with raintight covers. Lighting fixtures may be fluorescent, incandescent, or high intensity discharge depending on environment and application. No mercury-bearing fixtures or switches shall be used in the containment or fuel storage areas. 1

3.4.2 Emergency Lighting System

3.4.2.1 This system shall provide emergency lighting for egress routes in all areas.

3.4.2.2 This system shall consist of individual, self-contained, 8-hour rated, sealed-beam battery units connected to the normal lighting AC source to maintain battery charge and which automatically transfer to their internal batteries upon loss of AC.

3.4.2.3 Illumination levels shall match existing plant design or where required shall be in accordance with the Pennsylvania Department of Labor and Industry Fire and Panic Regulations.

3.4.3 Exterior Lighting System

3.4.3.1 Exterior lighting shall be limited to fixtures mounted on perimeter building structures for entrance areas and where required for security illumination of areas adjacent to structures.

3.4.3.2 Exterior lighting levels shall be in accordance with existing site surveillance requirements.

3.5 RACEWAY

3.5.1 A complete system of raceways shall be provided to furnish protection and support for all wire and cable systems.

3.5.2 These raceway systems shall include separation of voltage classes such as 5 kV power cables, large 600 volt power cables requiring maintained spacing, 600 volt power, control and digital signal cables and analog instrumentation cables.

3.5.3 The systems shall be installed according to the applicable portions of the NEC and applicable NEMA standards except as noted in paragraph 3.5.5.

3.5.4 Materials shall be UL approved unless specifically approved otherwise on the drawings or specifications.

3.5.5 Where raceways are to be routed through existing plant areas, these raceways shall comply with the existing Unit 2 Burns & Roe Specification 2555-70 Section 16 Z, paragraphs 6.1.2.4 and 6.1.2.5 regarding separation and seismic II over I criteria which deal with seismic-generated collapse of non-seismic II equipment located above seismic I equipment.

3.5.6 Exposed raceways may consist of steel ladder-type cable tray, rigid steel, IMC or EMT conduit up to 4-inch sizes and rigid steel above 4 inch. For new conduit within the existing plant, EMT shall not be used for any applications. Flexible steel conduit shall be used at the connection to all equipment and devices subject to removal or vibration. Liquid-tight, flexible, metal conduit shall be used for these applications outdoors and in wet areas indoors. No setscrew conduit fittings shall be used. Threaded fittings shall be used for rigid steel conduit, clamp or compression type for EMT and flexible conduit. Where EMT is used its application shall be restricted to preclude personnel walking and/or climbing on it.

3.5.7 Underground or embedded raceways shall be rigid steel conduit, heavy wall PVC conduit, or steel floor raceways. PVC shall be used primarily in outdoor or underground locations and for specific nonmagnetic applications. Where standard 90-degree bends are to be used at the end of an underground duct run, the 90-degree bends shall be rigid steel conduit.

3.5.8 Where raceways are brought to an interface point, provisions shall be made for extension of connections.

3.5.9 Penetrations for electrical cable trays or multiple conduits penetrating a fire-rated wall or ceiling shall be sealed with fire stop materials to an extent commensurate with the wall or ceiling rating. Individual conduits or raceways embedded or concealed in walls or ceilings for direct feeds to lighting fixtures or receptacles will not be sealed. In addition, openings for electrical raceways passing through partition walls or drop ceilings which are not fire rated shall not be sealed.

3.6 GROUNDING SYSTEM

3.6.1 All new structures, electrical equipment, and metal components shall be grounded by direct or indirect connection to the existing site grounding system.

3.6.2 Buildings shall have a 4/0 AWG bare copper or larger ground cable run beneath or embedded in grade-level floor slabs at the building perimeter and connected to the site ground grid at a minimum of two places with the same size conductor. Steel building structures shall be connected to these perimeter cables by riser cables at a minimum of two locations on small structures and every other column on large structures.

3.6.3 Large electrical equipment, i.e., switchgear, unit substations, motor control centers, and large transformers, shall have direct connections to the grounding system in at least two places.

3.6.4 All electrical equipment mounted on concrete shall be connected to the nearest point of the grounding system.

3.6.5 All concrete buildings which may house electrical equipment shall have a minimum 4/0 AWG copper cable embedded in walls and/or floors and be connected to a minimum of two surface-embedded ground pads per room.

3.6.6 In addition to equipment grounds, all electrical apparatus operating above 240 volts shall be provided with a ground fault return conductor which is to be run as close as practicable to the power conductors. Metallic conduit and/or cable tray (if NEC approved) may serve as the ground fault return conductor if the conduit and/or tray (if NEC approved) is electrically continuous and has the required conductivity to pass sufficient current to ensure the operation of the overcurrent device.

3.6.7 At least one end of all steel conduit extensions to nonmetallic conduit shall be connected to the grounding system.

3.6.8 Cable tray installations, unless specifically certified to National Electrical Code requirements as a ground fault conductor, shall have a bare 4/0 AWG copper conductor installed and attached to each section of all trays carrying power cables. This cable shall be connected to the ground bus of the power source. Where conduits are used as the ground fault conductor, the conduits shall be connected to this ground cable on or in the cable tray and the conductor for this connection shall be sized in accordance with Table 250-95 of the National Electrical Code. Where flexible conduit is attached to rigid steel conduit that is being used as a ground fault conductor, the flexible conduit shall be jumpered with a bare copper cable.

3.7 CABLE DERATING AND CABLE SIZE SELECTION

3.7.1 Ampacity rating and group derating factors of cables shall be in accordance with ICEA P-46-426 for cables in conduit, ducts, and trays with maintained spacing. ICEA P-54-440 shall be used for cables in random filled tray.

3.7.2 In determining cable sizes for various services, the following load factors shall be used:

a. Transformer feeders	-	125 percent of transformer full load current
b. Motors feeders	-	125 percent of motor full load current
c. MCC feeders	-	100 percent of the bus rating plus 25 percent of the full load current rating of the largest motor which can be connected to the bus or where the actual loads are a small percentage of the main bus rating the cables shall be sized for the actual load plus 25 percent of the full load rating of the largest motor plus 25 percent for load growth.
d. Distribution panel branch circuits	-	100 percent of the maximum load to be served and/or 100% of the protective device setting. Where the ampacity of the conductor does not correspond with the standard fuse or breaker size, the next higher device rating may be used.

3.7.3 For those facilities to which the NEC applies, cable sizing will be in accordance with NEC recommendations in lieu of the above. (Applicability is defined in specific facility criteria.)

3.8 TEMPORARY LIGHTING AND POWER SYSTEM FOR CONTAINMENT RECOVERY

3.8.1 This system shall provide adequate lighting and power for the entry and decontamination phases of the recovery effort.

3.8.2 This system shall be served from the existing electrical system in Unit 2 via the containment recovery service building electrical system. Services at 480 volt, 3-phase and 120/208 volt, 3-phase, four wire will be sufficient for all temporary electrical requirements.

3.8.3 Temporary power outlets shall be provided for lighting, CCTV, heaters, steam jennies, power tools, radiation monitors, and welding machines.

3.8.4 Lighting levels shall be consistent with specific work tasks and with the requirements of the CCTV system.

3.8.5 Emergency lighting shall be provided to ensure egress lighting throughout the containment upon loss of normal power.

3.8.6 To ensure personnel safety, all electrical equipment shall be effectively grounded. In addition, ground fault circuit protection will be provided.

3.8.7 Existing electrical systems within containment, where operable, shall supplement the systems described in 3.8.1 through 3.8.6.

4.0 MAJOR EQUIPMENT DESIGN

4.1 SWITCHGEAR

In the event that the recovery facilities' loads necessitate the addition of 4160-volt switchgear, the additional equipment shall, insofar as possible, duplicate the existing switchgear in order to maintain standardization of large electrical apparatus within the general plant areas. All such switchgear shall be controlled from the main control room.

4.2 LIGHTING AND DISTRIBUTION PANELBOARDS

4.2.1 Lighting panelboards for 277/480 volt, 3 phase 4 wire service shall be equipped with molded case single pole circuit breakers. Interrupting ratings at 277 volts shall be a minimum of 10,000 amperes symmetrical. Power distribution panelboards for 480-volt, 3-phase, 3-wire service shall be equipped with 3-pole molded case circuit breakers rated 22,000 amperes symmetrical.

4.2.2 Panelboards for 120/208 volt, 3 phase service shall be equipped with molded case circuit breakers having 1 or 2 poles, as required. Interrupting ratings at 120 and 208 volts shall be a minimum of 10,000 amperes asymmetrical.

4.2.3 Circuit breakers for all panelboards shall be the indicating type. Multipole breakers shall have common trips. Circuit breakers

shall be of the bolt on, quick make, quick break type, having thermal-magnetic overcurrent and short circuit trip elements, and shall be trip-free on overload and short circuits.

4.2.4 Panelboards shall have NEMA 12 enclosures, be surface mounted in general plant areas, and flush mounted in office areas.

4.3 MOTOR CONTROL CENTERS

4.3.1 Motor control centers shall consist of vertical sections joined together to form a rigid, free-standing enclosure. Each section shall be compartmentalized into combination starters and feeder tap breakers. MCC units shall be removable and interchangeable.

4.3.2 Generally, the motor control centers will supply motors rated 460V and 200 HP or less.

4.3.3 The MCC bus system shall be braced to withstand a short circuit current of 42,000 amps symmetrical (50,000 amps asymmetrical) amperes. The main bus shall be rated 600 amperes continuous. The vertical and ground busses shall be rated 300 amperes continuous.

4.3.4 Short circuit protection of combination motor starters shall be provided by circuit breakers equipped with adjustable instantaneous magnetic trip elements. Running protection of the motors shall be provided by ambient compensated overload elements in each phase of the motor starters. The overload elements shall have long-time-trip characteristics which approximate the heating curves of the motors. Protection of feeder tap units shall be provided by circuit breakers equipped with inverse time thermal overload protection and instantaneous magnetic short circuit protection on each phase. Breaker rated symmetrical interrupting capacity shall be greater than or equal to the total available symmetrical current at the point of application, as determined by the procedures of NEMA AB-1.

4.3.5 Ground fault protection shall be provided on an individual basis to ensure coordination with the incoming MCC feeder breakers. In general, this is provided for combination starters feeding loads exceeding 25 HP, and for feeder tap breakers with ratings exceeding 15A.

4.4 DRY TYPE TRANSFORMERS

4.4.1 Transformers shall be dry type, having a 480 volt, 3 phase delta primary and 120/208 volt, 3 phase, 4 wire wye secondary (or a 277/480 volt, 3 phase, 4 wire wye secondary for one-to-one transformers used as discussed in paragraph 3.1.3), or 480 volt, one phase primary and 120/240 volt, one phase, three wire secondary.

4.4.2 Transformer insulation shall be Class F or Class H. When fully loaded at rated voltage, the transformers shall have a maximum allowable temperature rise, as measured by resistance, of 115 degrees centigrade over an ambient of 40 degrees centigrade for Class F, or 150 degrees centigrade over 40 degrees centigrade for Class H insulations.

4.4.3 Transformers shall be furnished with four 2-1/2 percent full capacity taps, two above and two below nominal primary voltage.

4.4.4 Transformers shall have maximum noise levels of 45 decibels above a standard 24-decibel noise level of an anechoic test chamber as determined by NEMA standards.

4.5 MEDIUM VOLTAGE TRANSFORMERS

4.5.1 Transformers shall be provided for the facilities served by the 13.2 kV overhead lines to step down distribution voltage to a utilization voltage suitable for the building electrical loads.

4.5.2 The transformers shall be suitably rated 13.2 kV - 480 volt, 60 Hz, 95 kV BIL.

4.5.3 The primary winding configuration shall be delta capable of accepting a 3-wire, 13.2 kV feed from an overhead distribution line fused disconnect. The secondary winding configuration shall be a wye, with solidly grounded neutral for 480 volt feeds to the facilities.

4.5.4 The transformer shall be equipped with four 2½-percent taps, two above and two below nominal primary voltage.

4.5.5 The transformer shall be liquid immersed, padmount type suitable for outdoor application. Polychlorinated biphenals (PCBs) shall not be used in insulating fluids.

4.5.6 The transformer shall be provided with lightning protection.

4.6 UNIT SUBSTATIONS

4.6.1 Unit substations shall be provided to distribute power to large electrical loads as required for the various permanent facilities which must be served from the existing 4160 volt distribution system. These substations shall consist of a primary incoming cubicle, a power transformer, and 480 volt switchgear section, complete with all necessary accessory equipment. The substations shall be rated for operation from a 4,150 volt, 3 phase, 60 Hz primary system with a resistance grounded neutral.

4.6.2 The primary equipment shall have copper bus work insulated for 5 kV and be suitably braced to withstand a momentary short circuit current of 80,000 amperes.

4.6.3 A disconnect switch, rated 5 kV, shall be provided with an external operating handle and an external position indicator which shall positively indicate whether the switch is in the open or closed position. The disconnect switch shall be kirk-key interlocked with the 480 volt secondary main circuit breaker.

4.6.4 Power transformers shall be of the open, dry, ventilated type, with 4160 volt primaries and 480 volt, 3-wire solidly grounded secondaries. The transformers shall be provided with four 2½-percent full capacity, no-load rated taps in the primary winding, none above and four below rated primary voltage. The transformers shall have Class H insulation, with a basic insulation level of 25 kV.

4.6.5 Circuit breakers shall be equipped with solid state, direct acting series overcurrent devices providing adjustable long- and short-time overcurrent and short circuit protection and shall have trip-free operating mechanisms.

4.6.6 Ground fault protection relays shall be furnished for each substation.

4.7 MOTORS

4.7.1 In general, motors shall be energy efficient, squirrel cage induction type suitable for operation in a 40-degree centrigrade environment. All motors shall be capable of full voltage starting, and shall be able to accelerate their loads to rated speed with only 80 percent of rated nameplate voltage applied to their terminals. Motors shall be capable of delivering their rated output in continuous operation within the range of plus or minus ten percent of their rated voltage.

4.7.2 In sizing motors, no portion of a motor's service factor above 1.0 shall be used in continuous operation throughout the operating range of the load. Motors shall have a service factor of 1.15.

4.7.3 Unless specified otherwise, motors shall be of the self-ventilated type, with open drip-proof enclosures with screened openings.

4.7.4 Motors shall have windings with Class B insulation.

4.7.5 Motors sized smaller than 1/2 horsepower shall be rated 115 volt, 60 Hz, single phase and shall be used on a 120 volt, 60 Hz solidly grounded system.

4.7.6 Motors sized from 1/2 to 200 horsepower shall be rated 460 volt, 60 Hz, three phase and shall be used on a 480 volt, 60 Hz solidly grounded system.

4.7.7 All motors larger than 5 horsepower which are located in a high humidity environment shall be provided with space heaters suitable for operation on a 120 volt single phase supply. Space heaters shall be rated at twice the operating voltage to prolong heater life.

4.7.8 All motors shall be provided with terminal boxes one size larger than specified in NEMA MG-1. Separate boxes shall be provided for power terminals and space heaters.

4.7.9 All valve electric motor operators shall be suitable for use on a 480 volt, three phase supply. Motor insulation shall be Class B. Each motor operator shall be furnished with self-locking gears and two-train geared limit switches and torque switches which operate in the closing and opening mode. All operators anticipated for use in a high humidity environment shall be provided with a 120 volt space heater. All components shall be housed in a NEMA IV enclosure.

4.8 WIRE AND CABLE

4.8.1 The following voltage classes of cables will be used:

a) 5 kV and 15 kV power cable

b) 600 V power cable

c) 600 V control cable

d) instrument and special cables

4.8.2 Power cables supplying facilities from 13.2 kV overhead lines shall be 15 kV, shielded and suitable for grounded service. Power cables for the 4.16 kV feeders supplying the unit substations shall be unshielded and rated 5 kV ungrounded. The 600-volt power and control cable shall be single conductor or multiple conductor, as required. Power and control cables shall have Class B stranded copper conductors with 90 C insulation, which meets IEEE 383 flame resistance tests.

4.8.3 Instrument cables for low level signals shall be shielded and twisted to reduce noise pickup. Conductors shall be copper with insulation rated 90 C and which meets IEEE 383 flame resistance tests.

4.8.4 Single phase branch circuit wiring for receptacle and lighting runs shall be copper with insulation rated for 90 C, 12 AWG minimum gauge. Insulation shall be 600 volt, type THW moisture and heat resistant thermoplastic. Lighting fixture wire shall be Class B stranded, tinned copper with insulation rated for 200 C, 14 AWG minimum gauge. Insulation shall be 600 volt, type SF-2 silicone rubber, or other suitable code approved type.

4.8.5 Polyvinylchloride (PVC) insulation shall not be used in any cable construction with the exception of lighting, receptacle and communications wiring which will be totally enclosed in conduit. For new installations within the existing plant, PVC shall be totally precluded. All lighting and receptacle wiring shall carry Underwriters' Laboratories approval.