SMUD	TECHNICAL SPECIFICATION	No. SS1009 Page 1 of 21	
		REV 5	DATE: 05/09
CATEGORY WIRE/CABLE			
SUBJECT DISTRICT'S EQUIPMENT WIRING REQUIREMENTS			

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1 PURPOSE

Specifies the design, construction, testing, and documentation required for the low-voltage wiring of District electrical equipment.

2 SCOPE

Specifies the wiring requirements for all 600 volt wiring within District switchboards as defined herein. This specification is included by reference in the purchase specifications for District purchased equipment. It is also used as a standard for District designed and installed wiring.

Additional or modified wiring requirements may be defined in the District's technical specification for a specific equipment's supply. Those requirements shall take precedence over the requirements defined in this specification.

When modifications are made to existing District switchboards, drawing changes may follow the existing drawing format rather than this specification's format. The District's Project Engineer will make this decision.

3 REFERENCES

3.1 Switchboards shall be designed, manufactured, and supplied in accordance with the latest applicable standards and requirements of:

- 3.1.1 National Electric Manufacturers Association (NEMA)
- 3.1.2 American National Standards Institute (ANSI)
- 3.1.3 American Society for Testing and Materials (ASTM)
- 3.1.4 Institute of Electrical and Electronic Engineers (IEEE)
- 3.1.5 National Fire Protection Association (NFPA)
- 3.1.6 CAL/OSHA - Title 8, Chapter 4, Subchapter 5

3.2 Emphasis shall be assigned to the following standards:

- 3.2.1 ANSI/IEEE C37.1 Standard Definition, Specification and Analysis of systems used for supervisory control, data acquisition, and automatic control
- 3.2.2 IEEE C37.2 Standard Electrical Power System Device Function Numbers and Contact Designations

3.2.3 IEEE C37.21 Standard for Control Switchboards

3.2.4 ANSI/IEEE C37.90 Standard for Relays and Relay Systems Associated with Electric Power Apparatus

3.2.5 IEEE C37.100 Standard Definitions for Power Switchgear

3.2.6 NFPA 70 National Electrical Code

3.3 In case of a conflict with any of the above standards and this specification, this specification shall govern.

4 DEFINITIONS

4.1 Switchboard - As used in this document, an assembly on which low voltage electrical devices are mounted and wired. Typical examples are a Control and Relay Panel line-up, a switchgear assembly, and a power circuit breaker control cabinet. A switchboard may contain several panels, sub panels, and/or substructures.

4.2 Wiring Diagram - Wiring diagrams depict the relative physical arrangement of devices, device terminal layouts and wire connections, as viewed from the wiring side of the switchboard. These diagrams clearly show the opposite end connecting points for each wire.

4.3 Device Terminal Layout - A device's physical (relational) arrangement of terminals.

4.4 Device Location Designator - A notation which describes the location of a device on a switchboard, refer to section 5.2.

4.5 Device Function Designator - A notation which describes the function and application of a device, refer to section 5.3.

5 WIRING DIAGRAMS

5.1 POINT-TO-POINT WIRING

The District requires a point-to-point tabular form of wiring diagram. Connections are indicated by the use of Device Location Designators on

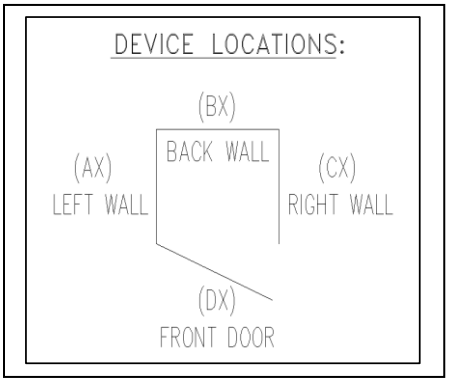
assigned devices and terminal (Stud) numbers on the devices. Connections are listed terminal by terminal in a table (Device Connection Table) next to the device depiction indicating the remote connection point of each wire. For terminal blocks a device connection table is not required; remote connection points for internal wires are listed next to the terminal depiction.

5.2 DEVICE LOCATION DESIGNATOR

Pairs or groups of letters are assigned to identify the location of each device on a switchboard. The device location designator is formed logically to represent the device location as follows:

5.2.1 In a sequential order, assign identification letter(s) to all devices on each panel or substructure. Device location sequence on each panel or substructure shall proceed from left to right and then from top to bottom, as viewed from the wiring side. Letters may be skipped if appropriate to allow for the addition of future devices.

5.2.2 If the switchboard is composed of several panels or substructures a prefix is added to identify the panel or substructure. A switchboard key layout diagram shall be shown on each wiring diagram. This key layout diagram shall show the panels or substructures, their identification characters, their relative physical positions, and the reference drawing numbers of the wiring diagrams when the switchboard wiring is shown on more than one drawing.



5.2.3 In some cases, such as transmission relay panels, each functional grouping of devices may be defined as a separate substructure with a separate left most character. See the Districts Project Engineer for approval.

5.2.4 An example of a switchboard with multiple panels is:

5.2.4.1 A distribution substation with multiple feeders where the upper and lower cells for feeder one are identified with the prefix 1A and 1B. The upper and lower cells for feeder two

are identified with the prefix 2A and 2B, etc. Terminal 3 on device AB in cell 1A would be shown as 1A-AB3.

5.2.4.2 A transmission substation switchboard with front and rear panel sections may be identified as 1F and 1R, 2F and 2R, etc. Terminal 3 on device AB in panel 2R would be shown as 2R-AB3.

5.2.4.3 When a wire starts and ends on the same panel or substructure, the panel or cell designation shall be omitted from the wire label or the diagram.

5.2.5 Terminal blocks shall be identified by the designator, "TB" for Terminal Block or "SB" for current Shorting Block followed by a pair of letters. The first letter shall identify the panel section (left, right, rear, and door) where the terminal block is located. The second letter shall be assigned from left to right or from top to bottom within each panel or substructure. Letters may be skipped if appropriate to allow for the addition of future terminal blocks.

5.2.6 Do not repeat a device location designator within the same section of a switchboard.

5.2.7 The letters I, O, & Q shall not be used.

5.3 DEVICE FUNCTION DESIGNATOR

Each device on a switchboard is identified by a device function designator. The device function designator is defined from the schematic and/or elementary. F151N, L121-2, and TBAA typify device function designators. The following two parts generally form these designations:

1) An identification of the substation line, bus, feeder, or other equipment for which the device is applied, i.e. L1, B1, F2 (This part is not required if all devices on the switchboard would use the same identifier), and
2) An ANSI standard function number designation, i.e. 51N, 21-2.

Terminal blocks are functionally identified on the schematic by their device location designator, "TB" followed by a pair of letters as described above.

5.4 DEVICE INTERNALS

Show device internal components (contacts, SCRs, and coils, etc.) between terminals in the device terminal layout depiction of the wiring diagram. These components shall be represented (open or closed) as shown on the schematic. For complex electronic or microprocessor devices on which it is not feasible to show the internal components, the terminal physical arrangement only is shown.

5.5 DEVICE JUMPER CONNECTIONS

Jumper connections between terminals of the same device or terminal block are shown by drawing line(s) connecting these terminals on the device terminal layout depiction (this is the preferred method), or in a list of jumpers adjacent to the device connection table. Point to point wire markers are not required on device jumpers.

5.6 SWITCHBOARD IDENTIFICATIONS

When more than one switchboard is shown on a drawing, each switchboard's connections must be clearly identified and separated. On the wiring drawing, outline the switchboards' connection areas and identify each area with the switchboard name. This clearly shows the area on which each switchboard's connections are shown on the drawing.

5.7 USE OF HYPHEN IN CONNECTION IDENTIFICATION

Hyphens are used only when needed for clarity, to separate two components of the connection identification that are both alphabetic or both numeric. This can occur when the device location designator is prefixed with the panel or substructure designator, per section 5.2.1. It can also occur when a terminal is identified by a letter instead of a number in the left most terminal ID position. For example:

DB3 (No hyphen)
DB-L3 (Hyphen)
TBA7 (No hyphen required for terminal block designator)

5.8 EXTERNAL CONNECTIONS

5.8.1 Field cables (multiconductor jacketed cable) routed in conduit or tray to other switchboards shall be placed on the external or field terminal side of terminal blocks and shown on the wiring diagram with hidden lines. These external connections shall also be entered in the "Interconnection Table." Connections to adjacent panels using SIS panel wiring are identified with point to point designations on the external side of the terminal blocks and are not listed in the interconnection table.

5.8.2 Interconnection Table

For each switchboard, provide an interconnection table showing all field cable connections to other switchboards.

5.8.2.1 When the other connecting switchboards are part of the contractor's supply, place an interconnection table at the top of the drawing within 8-1/2 inches of the drawing's right margin and complete it with the cable interconnection information.

5.8.2.2 When the other connecting switchboards are <u>not</u> part of the contractors supply, provide blank space in an area 8-1/2 inches parallel to the drawing's right margin for the full height of the drawing for others to add the interconnection table.

5.8.2.3 Use the interconnection table format shown typically below.

INTERCONNECTION TABLE

FUNCTION	CODE	WIRE		FROM	TERM	TO	TERM
CAP BANK 1201A CONTROL	CN1	4/C #10	1	SWITCHGEAR CELL 1B	TBCE4	CAPACITOR BANK 1201A (E3F-M018)	TBAA1
			2		TBCE6		TBAA3
			3		TBCE10		TBAA5
			4		TBCE11		TBAA6
CAP BANK 1201A SWITCH STATUS	CN2	2/C #18	1		TBAG7		TBAA7
			2		TBAG8		TBAA10
		SH.	SHLD.		TBAG9		OPEN

FIGURE 1

5.9 OTHER DRAWING DETAILS

Show wiring construction detail in the switchboard wiring or other designated drawing(s) as follows:

5.9.1 Where hinge wire connections are required (per section 6.14), mark an asterisk (*) after the connection on the device connection table or at the terminal block. Provide a note on the drawing stating that asterisks indicate hinge wire.

5.9.2 Switchboard layout drawings (front and rear views) shall show nameplate positions and identification numbers, device bill of material numbers, and device function designations.

5.10 CABLE SHIELD CONNECTIONS

Show shielded cable shield connections as follows:

5.10.1 Mark "SHLD" at the terminal in the device connection table where the shield is connected. See figure 1.

5.10.2 Graphically show the shield connection as illustrated in figure 2.

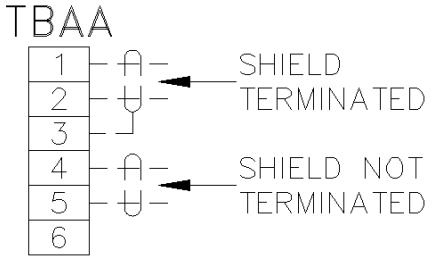


FIGURE 2
SHIELD CONNECTIONS

6 WIRING INSTALLATION & LABELING

6.1 FACTORY WIRING

All circuits internal to the switchboard shall be completely wired at the factory.

6.2 CONNECTION ON A SWITCHBOARD TO A COMMON CIRCUIT

All common connections inside a switchboard, typically an alarm positive, shall be made up internally to the switchboard. This avoids running the common connection to more than one terminal block terminal, and then connecting between those terminals in order to complete the common circuit.

6.3 SPARE AND UNUSED CONTACTS AND I/O POINTS

Wire spare and unused device contacts and input/output points with a foreseeable future use to terminal blocks in sequential order. Normally open type contacts of lockout and trip relays shall be wired to terminal blocks through test switches. The District's Project Engineer will make the final determination of which spare and unused points are wired out.

6.4 SHIELDED WIRE

Shielded power and control cable shall be grounded at both ends.

Where shielded cable is used for instrumentation, the shields shall be grounded at the signal receiver (RTU, DFR, etc.) ground bus end only. Unless otherwise specified, all instrumentation shielded cable shall be two conductor copper twisted shielded pair No. 18 AWG.

6.4.1 ANALOG CIRCUITS

For analog signal circuits the shield shall be continuous from the field device output terminals to the terminals of the signal receiver device (typically an RTU), i.e. through terminal blocks, through test switches, etc. Where a shielded cable is terminated on a terminal block, the terminal next to the paired conductors' terminals shall be used for the shield connections.

6.4.2 DIGITAL (ON/OFF) CIRCUITS

For digital signal circuits the shield shall run from the terminals of the signal receiver device (typically an RTU), to the switchboard terminal blocks. Wiring internal to the switchboard can be run with unshielded wires. Avoid physically running these switchboard wires in parallel with the wires of AC current and voltage circuits.

6.4.3 COMMUNICATION CIRCUITS

EIA-485 and EIA 232 cables shall be twisted shielded pair having a characteristic impedance of 120 ohms. DNP 3.0 circuits may require a 120-ohm resistor inserted at the end of line device.

6.4.4 EXCEPTIONS

Ethernet networks shall use unshielded twisted pair (UTP) cabling. The UTP cable contains eight conductors, arranged in four twisted pairs, and is terminated with an RJ45 type connector. A normal straight-through UTP Ethernet cable follows the EIA568B standard wiring.

6.5 PHASE MARKING

All phase markings shall be ∅1/C, ∅2/B, and ∅3/A; with 1, 2, 3 vectors positive sequenced when rotating counter clockwise per ANSI C37.21.

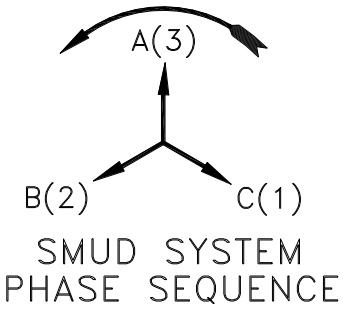


Figure 3

6.6 NAMEPLATES

All control devices and terminal blocks shall be labeled on their front sides with engraved lamacoid type identification nameplates. Front nameplates shall have minimum 1/4 inch high lettering, black on a white background. Attach them with threaded metal screws, not adhesives.

All rear-wired devices shall also be labeled with nameplates on their rear wiring side. Provide and install nameplates on the rear wiring side in exactly the same way as on the front side, except that rear side nameplates may use permanent long life flexible adhesive instead of screws for attachment. Fasteners for rear nameplates shall not be visible on front.

Identify the Device Function Designator on all nameplates. Identify the Device Location Designator on wiring-side nameplates only. A descriptive legend may also be required, as specified by the District's Project Engineer. Locate nameplates so they are clearly visible after wiring is installed, and are not obscured by wire bundles.

Each switchboard panel shall also have a large overall nameplate at the top with minimum 1/2 inch high lettering. Engraving shall be approved by the District's Project Engineer.

6.7 GROUND BUS

Each switchboard shall be supplied with a copper ground bus, ¼ inch by one-inch minimum size.

6.7.1 Provide sufficient terminals on the ground bus to directly connect each device, test switch, terminal block, cable shield, etc. requiring a ground connection.

6.7.2 Provide a minimum of 20% additional un-used spare terminals on each ground bus.

6.7.3 Wire ground connections directly to the ground bus so that the ground to any single device, test switch, terminal block, etc. can be removed without affecting the ground connection to any other device.

6.7.4 Each ground bus shall be provided with two terminals to connect NEMA 2-hole ground connectors for 4/0 copper cable.

6.7.5 Provide an integral electrical connection from the ground bus to the switchboard, having a one second current capacity of 10 kA equal to the one second current capacity of the 4/0 copper cable.

6.7.6 Switchboard enclosure metal shall not be used as part of the continuity of the grounding system.

6.8 TEST SWITCH CONNECTIONS

Install and wire test switches in accordance with SMUD Technical Design Standard, Test Switches. Provide rear connected test switches for operation from the front of the panel.

6.9 WIRING REQUIRING SPECIAL TOOLS

Switchboard wiring shall not require the use of special wiring tools (such as ABB Combiflex) unless specifically approved by the District. If approved:

6.9.1 The manufacturer shall supply one set of any special wiring tools required for each switchboard.

6.9.2 The manufacturer shall supply a stock of special connection hardware in a quantity equal to 10% of the total connection hardware used.

6.10 TERMINAL NUMBERING

All device and terminal block terminals shall be clearly numbered, and the numbers shall correspond to the numbers on the wiring diagrams. Terminal block terminals shall be numbered in numerical sequence.

6.11 WIRE LABELS

At all wire terminations a machine-printed plastic shrink wrap sleeve label, or District approved equal, shall identify the wire's remote termination (other end). Identification shall correspond to the switchboard panel designator (if required), device location designator, and terminal number, as used in the device connection tables of the wiring diagrams. The switchboard panel designator shall be omitted if both ends of the wire terminate on the same panel (Do not identify wires by any other notation on either the wiring diagram or wire labels). Wire labels shall be installed so they are clearly visible without moving wires, and shall read top to bottom and left to right. Short jumpers shall be labeled if they enter a wireway or bundle.

6.12 WIREWAY FILL

The total cross sectional area of cables and wires in wire channels, conduits, or tray shall comply with the NEC, but shall not exceed 40% of that wireway's cross sectional area. The Contractor shall analyze conductor loading, field installed cables, possible future expansion, and other design features to determine if further restrictions are required on the wireway fill.

6.13 WIRE BUNDLING

When feasible, route all switchboard internal wiring in readily accessible

wiring channels with snap-on covers. Wire bundles external to the channels shall be secured with nonmetallic wire wraps at intervals not exceeding eight inches apart. All wire wraps shall tie together all wires of the bundle. Wire wraps shall be secured to the switchboard structure using mechanical, non-adhesive fasteners. Wire bundles shall be installed clear of any device that racks in or out. No wire bundle shall be tied directly to any metal or structural device without sufficiently protecting it from abrasion. All wire runs shall be vertical or horizontal, never diagonal.

6.14 HINGE WIRING

Wiring across hinges and wiring that will be subjected to movement during maintenance or other operations shall be arranged to twist around its longitudinal axis in order to avoid bending the wire. This hinge wiring shall be made of wire strand no larger than No. 32 AWG. This wiring shall be protected from rubbing on or touching exposed metal edges. The Contractor shall minimize the amount of wiring across door hinges by connecting the common circuit points together on a moveable panel (refer to above section 6.2). Hinge wiring shall not obstruct door movement.

6.15 TERMINATION OF WIRES

All wires shall be terminated on device terminals or on terminal blocks. Do not splice or tap-connect any wire. Insulated compression ring tongue type lugs shall be used, one lug per wire. Wires shall be stripped and installed in the lug so that no bare wire is visible at the barrel end of the lug yet the bare wire is visible at the ring tongue end of the lug. No wire strands shall be cut or removed prior to lug insertion. Current circuit terminal lugs shall not be insulated. A maximum of two wires in ring tongue lugs per termination point shall be installed. All lug crimps shall be completely visible and not covered with labels.

6.15.1 Insulated terminal lugs shall be self-insulated with high dielectric-strength nylon sleeves, rated for temperatures up to 105^0C. The nylon jacket shall be color coded to identify the appropriate wire size:

Red	22-16 AWG
Blue	18-14 AWG
Yellow	12-10 AWG

6.15.2 Insulated terminal lugs shall be crimped with ratchet-type crimping tool having a color-coded crimping nest matching the terminal lug color. The ratcheting mechanism must be fully closed before tool is allowed to open, ensuring a proper crimp.

6.15.3 Non-insulated terminal lugs shall be crimped with ratchet-type crimping tool having a crimping nest matching the size of the terminal lug. The ratcheting mechanism must be fully closed before tool is allowed to open, ensuring a proper crimp.

6.15.4 Ring tongue lugs shall be used wherever possible. Where ring tongue lugs cannot be used Molex wire pin terminal lugs, or District approved equal, may be used. A maximum of one pin terminal lug per termination point shall be installed, unless otherwise approved by the District.

6.15.5 Wires brought out of a device without terminals (pigtails) shall be terminated on terminal blocks, and not spliced.

6.16 TERMINAL BLOCKS

Terminal blocks shall be provided in all circuits leaving a switchboard to connect to a device(s) on another switchboard. Exception: some current circuits (refer to section 6.19).

6.16.1 Terminal block terminals shall have slotted head screws.

6.16.2 Control (600V, 30A) terminal blocks shall be single-piece, phenolic assembly G.E. No. EB25B12, Buchanan No. B112, or District approved equal. Each terminal shall be permanently identified with a sequential number.

6.16.3 CT shorting terminal blocks shall be single-piece, phenolic assembly G.E. No. EB27B06S, Buchanan No. 4B106P, or District approved equal.

6.16.4 Heavy duty (600V, 75A) terminal blocks shall be single-piece, phenolic assembly and be suitable for use with crimp type ring tongue lugs.

6.16.5 Power (600V, 230A) stud terminal blocks shall be single-piece, phenolic assembly Marathon No. 14xx series, or District approved equal.

6.16.6 The terminal block terminals shall be grouped such that terminals for connections going to a common external switchboard are adjacent. Adjacent common external switchboard terminals shall be further

grouped by function, such as potential transformer circuits, current transformer circuits, AC power circuits, and DC control circuits.

6.16.7 Group and locate terminal blocks for easy accessibility and easy connection to external circuits. The arrangement of circuits on terminal blocks shall be subject to District approval.

6.17 TERMINAL BLOCK MOUNTING SPACE AND USAGE

Provide sufficient space and support for all District-installed cables and wires to be routed and connected on terminal blocks. Internal wires shall be installed on one side of terminal blocks, with the other side left open for District-installed cables. The Contractor shall not terminate wires from devices inside the switchboard on the side provided for external cable and wire interconnections. Provide sufficient space on each side of each terminal block to allow an orderly arrangement of all wires terminated. The space between parallel terminal blocks shall be four inches minimum.

6.18 TERMINAL BLOCK SPARE TERMINALS

Provide a minimum of twenty percent (20%) spare terminal block points. Evenly distribute ten percent (10%) of the spare terminal points among the terminal blocks. Provide the other ten percent (10%) spare terminal points on entirely unused terminal blocks. Terminals used for shields, grounding or connecting unused contacts and devices are not considered spare.

6.19 CURRENT CIRCUITS

6.19.1 Current circuit wiring shall not be spliced.

6.19.2 Current circuits shall not terminate on standard terminal blocks.

6.19.3 Current secondary circuits shall be grounded at one point only.

6.19.4 CT leads shall terminate directly on CT shorting blocks unless the CT leads first pass through a pressure penetration.

6.19.4.1 Current circuit pressure penetrations shall not be spliced.

6.19.4.2 Current circuit pressure penetrations shall have stud or bolted terminals suitable for termination of #10 AWG ring

tongue lugs.

6.19.5 Current circuits shall enter and leave a switchboard as follows:

6.19.5.1 Field cables entering a switchboard from a remotely located CT shall terminate directly on a CT test switch.

6.19.5.2 When equipment is split for shipping the CT shorting block shall be installed and wired in the same section where the CT is installed.

6.19.5.3 When wiring between panels the #10 AWG SIS panel wire shall be connected from CT test switch to CT test switch or from the CT test switch directly to the device.

6.20 WIRE SIZING

Current transformer secondary circuit leads shall be #10 American Wire Gauge (AWG) wire or larger. Potential transformer secondary circuit leads shall be #12 AWG or larger. Power and control wiring shall be #14 AWG or larger. Use the wire sizes indicated above except when the Contractor identifies technical reasons for a larger wire size. Wire size shall be indicated on Wiring Diagram when not #14 AWG.

6.21 SWITCHBOARD WIRE & INSULATION

Use stranded copper conductor wire, insulated with SIS cross-linked polyethylene insulation rated 90 degrees C. The insulation class of all wiring shall be coordinated with the voltage conditions it may be expected to encounter, but shall in no case be less than 600 volts.

6.22 TERMINAL BLOCK AND CURRENT TEST SWITCH TERMINAL SIZE

All terminals of terminal blocks and current test switches shall accept a minimum of two compression ring-tongue type lugs for #10 AWG wire.

6.23 CABLE SPARE CONDUCTORS

Spare conductors of a multiconductor cable shall be recorded in the interconnection table. These spare cable conductors shall have sufficient length to terminate on any terminal block located on the side of the switchboard where the cable is located. The spare conductors shall be

labeled spare and neatly tied down.

6.24 INTERCONNECTIONS BETWEEN SHIPPING SPLITS

It is desirable that structures containing several sub panels (i.e. a control panel line-up, metal-clad switchgear, a unit substation, a prefabricated control building, etc.) be shipped as a single shipping unit. In the case that the structure must be split for shipping, wires on both sides of the split shall terminate on terminal blocks. Interconnection wires crossing the shipping split shall be disconnected at one end and marked with the switchboard identification, terminal block and terminal from which they are disconnected. For shipping, neatly coil, secure, and store all these wires at the shipping split for installation in the completed structure.

6.25 EXTERIOR WIRE WAYS

Interconnections between switchboards supplied on a common structure and run on the exterior of that structure shall be installed in rigid steel or flexible metallic liquid-tight conduit.

6.26 INTERIOR WIRE WAYS

Interconnections between switchboards supplied on a common structure and run on the interior of that structure shall be by wires leaving terminal blocks and run in wireways that neatly train the interconnecting wires.

7 TEST REQUIREMENTS

Factory tests described here are for acceptance of the switchboard wiring supplied. These tests are to be conducted after construction of the switchboards and in the order listed. The initiation of these tests is a "Hold Point", per the General Conditions of this Bid Request. Other tests not described here are required for structure, system and component acceptance. The Contractor shall record all errors or failures found during the tests as well as the required corrective action with acknowledgement that the corrective action has been completed. The Contractor shall furnish a copy of these records to the District at the conclusion of the factory tests.

7.1 CONTINUITY TESTS & WIRE LABEL VERIFICATION

7.1.1 Visually verify terminal-by-terminal that all wire labels show the remote connection point described in the latest approved wiring

diagram.

7.1.2 Wire by wire, verify the electrical continuity from end to end. Temporarily lift wires from terminals as required for positive verification.

7.2 DIELECTRIC TESTS

7.2.1 The Contractor shall conduct the following tests to verify that switchboard wiring has an adequate insulation level to ground.

7.2.1.1 Disconnect ground connections and device terminals subject to damage at test voltage. Contacts shall be blocked closed as required to connect portions of the wiring otherwise not connected to the applied voltage. The test records shall record all disconnected terminals and contacts blocked closed.

7.2.1.2 When the circuits being tested involve expensive or long lead time equipment apply this less destructive Megger dielectric test before applying the hi-pot dielectric test described in the following section.
Measure dc insulation resistance while applying 2200 volts dc. One mega ohm resistance or greater is acceptable.

7.2.1.3 Using the same test procedure and setup described above for measuring the dc insulation resistance, apply 1500 volts rms 60 Hz for one minute to all terminals entering the switchboard.

7.2.1.4 At the conclusion of the tests the Contractor shall restore all connections and contacts and furnish Dielectric test records to the District.

7.2.2 Test District field modified AC current circuits as described in section 7.2.1.2, except that the applied voltage shall be 500 v dc instead of 2200 v dc.

7.3 FUNCTIONAL TESTS

7.3.1 Within three weeks following schematic/elementary approval, the Contractor shall submit for approval a detailed function test proposal. This proposal shall detail a test plan specifically, by individual

components, and organized as a checklist, so that it can be used to record each component's acceptance tests function by function.

7.3.2 Functional tests shall verify all functions including phase sequence, directionality/polarity, disable functions, trip functions, and close functions.

7.3.3 Power circuit breaker operating sequence shall be included in all functional tests of switchboards that control power circuit breakers. When the power circuit breaker is not part of the scope of equipment supply, a circuit breaker simulator shall be used to perform these tests. The District may supply the Contractor with a circuit breaker simulator for use in these tests or require the Contractor to supply power circuit breaker simulator(s) of an approved District design. The equipment's technical specification will indicate when the Contractor is required to supply power circuit breaker simulator(s).

7.4 DISTRICT WITNESSED & CONDUCTED TESTS AT FACTORY

7.4.1 The Contractor shall notify the District four weeks before the above tests are to be conducted, so that the District may arrange to have a representative present to witness these tests.

7.4.2 District personnel may conduct total or partial label verification, continuity tests, and function tests in the Contractor's factory. These tests will be in addition to those required by the Contractor. The Contractor will facilitate these in-factory tests and correct any errors encountered.

7.5 TEST WIRING

All temporary wiring installed in the factory for testing shall be removed prior to shipping the equipment.

8 QUALITY ASSURANCE

8.1 All requirement(s) of this Engineering Specification with which the Contractor cannot or will not comply shall be identified in the Bidding Schedule's Exception Section as an exception.

8.2 The Contractor's quality control procedures shall include methods to verify and document compliance with all requirements of this Engineering Specification.

8.3 The QA documents shall be readily available to the District's representatives for review during an audit or inspection of the Contractor's facility.