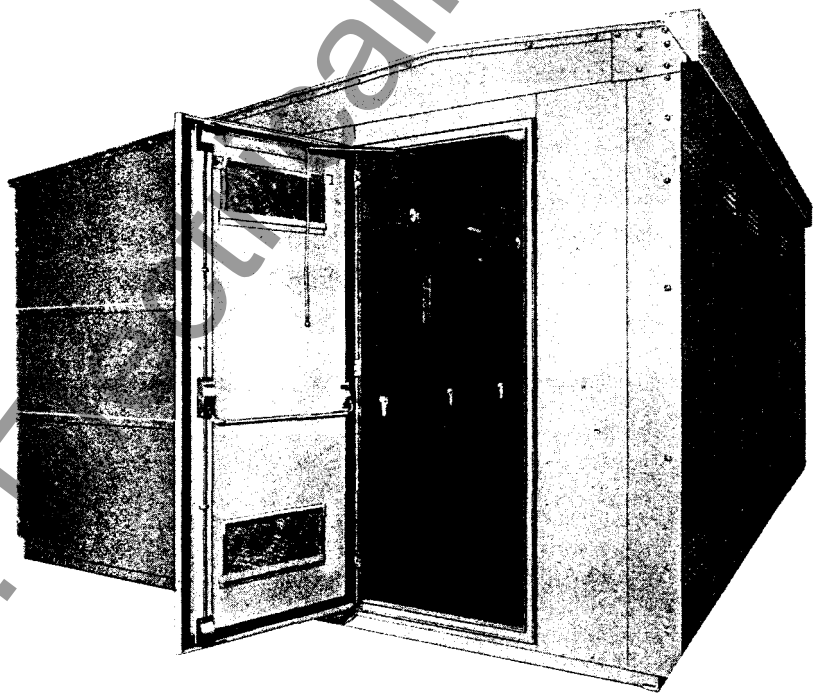
FPE

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

FEDERAL PACIFIC METAL-CLAD SWITCHGEAR

OCTOBER 1976



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List of Illustrations

METAL-CLAD SWITCHGEAR

PART I - GENERAL

CONSTRUCTION FEATURES INDOOR OR OUTDOOR:

1. Switchgear Housings and DST-2 Air Circuit Breakers are jig constructed in alignment fixtures to assure interchangeability of breakers. Compartmentalized construction segregates the circuit breaker, main bus, current transformers, potential transformers, and control power transformers.
2. Complete interlocking between the cell and circuit breaker provides safety to personnel and equipment by prevention of incorrect operating procedure.
3. Equipment is designed to reduce installation time, and to comply with ANSI Standards C37.20.

OUTDOOR:

4. Equipment is constructed so that additional sections may be readily added in the field.
5. Protected work-aisle provides ample space for a scheduled maintenance program regardless of weather. Breakers draw out into aisle with sufficient space for interchangeability. The service area is ventilated, waterproof, and adequately lighted; service receptacles are provided.
6. The undercoated structural foundation supports are designed to be self-contained making it necessary to support foundation steel only. This design permits elevating switchgear on supporting structures and thereby reduces flood hazards.
7. Outdoor finish: Three-coat system consisting of a zinc chromate primer, an intermediate coat, and a final ASA-24 dark gray exterior coat.

SHIPMENT

The switchgear is assembled, wired, adjusted and given complete tests at the factory, after which it is inspected and packed for shipment. The air circuit breakers are not shipped in the switchgear compartments, but are packed in separate crates. Each crate is identified, and a complete list of its contents is included in the shipping papers. All instruments and relays are suitably blocked as required to prevent damage to bearings and movements.

Protected work-aisle metal-clad switchgear is shipped in completely assembled sections whenever possible to provide ease of handling and installing. See job assembly drawings and floor plans for details of shipping sections.

REMOVAL FROM CARRIER AND INSPECTION FOR DAMAGE

Immediately upon receipt of the shipment, identify all component parts and check them against the shipping list. Make a thorough examination to detect any damage which may have been incurred during transit.

If any damage is discovered, file a claim immediately with the carrier, and send notice of the extent of the damage to the Federal Pacific Electric Company plant from which shipment was made, giving complete identification, carrier's name, and railroad car number if the shipment was made by rail.

The information will enable the company to supply necessary information in support of claim.

MOVING AND LIFTING SWITCHGEAR

1. It is extremely important that care be taken in handling, rigging, hoisting, rolling, or moving assembled switchgear into place. Metal-clad switchgear is designed to be handled only in an upright position and should never be handled in any other way without first consulting with the Switchgear Engineering Department.

INDOOR

2. Each shipping section of indoor switchgear is bolted to a heavy shipping skid which should remain with the gear until it is moved into it's final location.
3. When cranes are not available, the gear can be rolled into place by applying pushing or pulling forces only to the skid.
4. Remove shipping skid only when gear is at it's final location, by removing bolts inside the switchgear before lifting it from top as shown on drawing 2200C0335 (Fig. 3). If overhead lifting equipment is not available and bottom lifting provisions have been specified, proceed as follows and as shown in lifting drawing 2200C0335 (Fig. 3).
   a. Remove all bolts located inside the switchgear that hold cells and skid together.
   b. Completely remove the crating that encloses the switchgear.
   c. Break-off skid extensions to allow the switchgear to sit flush with the remaining portion of the skid.
   d. Open required front and rear doors and install the lifting channels as shown on drawings

5400D6690 and 5400D6733 (shipped with the gear) for front and rear mountings.

e. Place jacks under every lifting station and adjust each jack until its piston or platform begins to exert force on the lifting channels.

f. Begin to raise the jacks, starting at one end of the switchgear assembly (both front and rear locations) with equal increments of strokes to provide equal height displacement in relationship of front to rear.

g. When the switchgear has sufficient clearance above the skid, remove the skid.

h. With the skid removed lower the switchgear. If hydraulic jacks are used, release the pressure in the jacks that support the center span (front and rear). Allow the switchgear to compress the jacks until there is no force exerted on the jacks. Then lock these jacks in this position. Release the pressure in the end jacks in the same manner as the center span then lock in position. Continue alternating between the center span and end jacks until the switchgear rests firmly on the ground surface.

i. Remove the jacks and the lifting channels from the switchgear assembly.

OUTDOOR

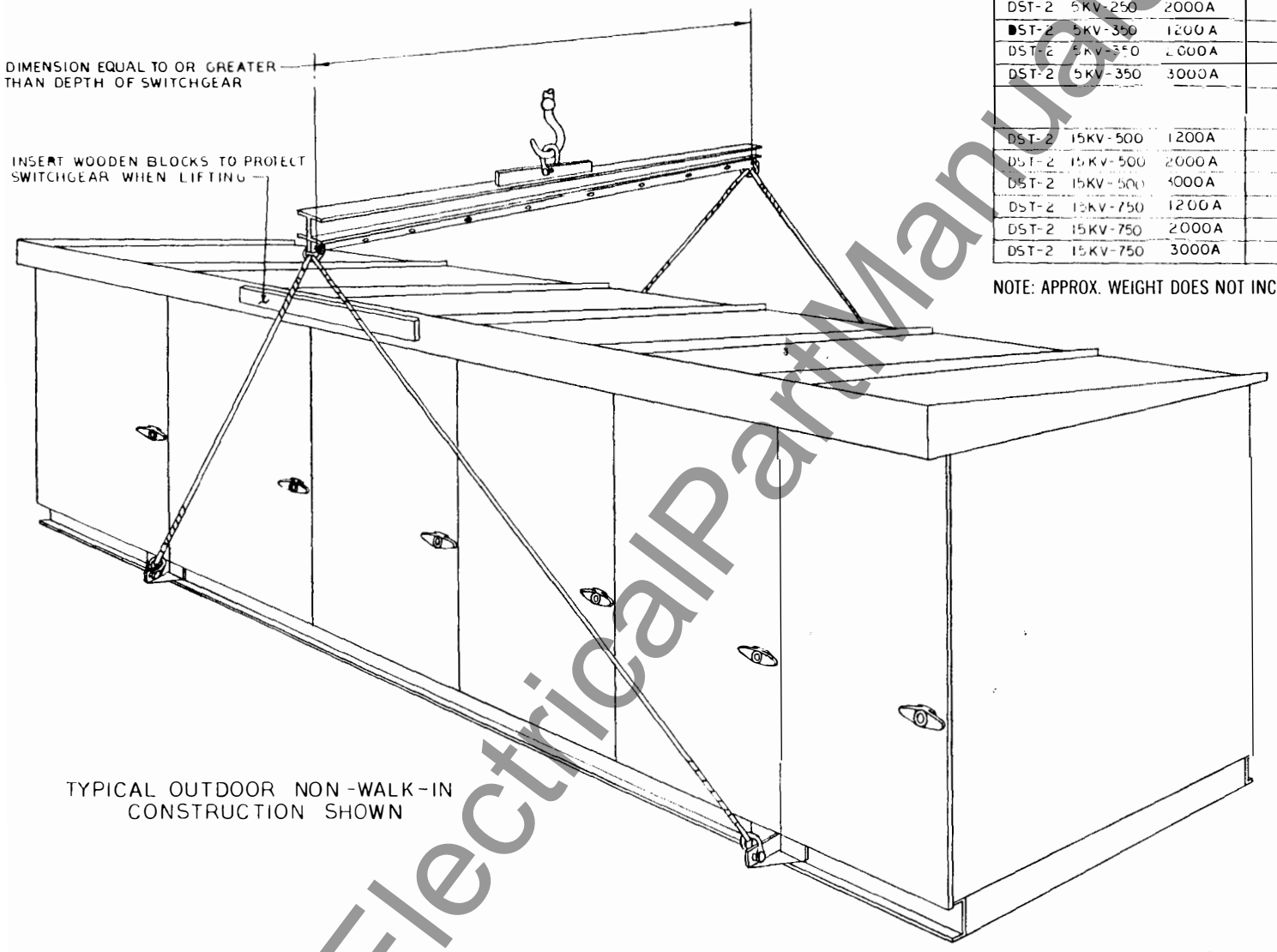
5. Each section of outdoor gear is supplied with heavy lifting lugs bolted to the switchgear base.

6. When lifting shipping units with a crane, it is preferable to use two hooks simultaneously, one on each end. Each pair of lifting hooks should be equipped with a spanner bar to prevent excessive distortion. If only a single hook crane is available, arrange spanner(s) to lifting rig as shown on typical outdoor gear lifting drawings 2200C0166 and 2200C0167. (Fig. 1 and 2)

7. Equipment can be rolled into place by applying pushing or pulling forces only to the steel base.

WEIGHTS OF CELL SECTIONS			
RATING OF CELL		WIDTH OF CELL	APPROX NET WEIGHT
DST-2 5KV-250	1200A	26"	2,500 LBS
DST-2 5KV-250	2000A	26"	2,700 LBS
DST-2 5KV-350	1200A	26"	2,800 LBS
DST-2 5KV-350	2000A	26"	2,900 LBS
DST-2 5KV-350	3000A	36"	3,800 LBS
DST-2 15KV-500	1200A	36"	3,000 LBS
DST-2 15KV-500	2000A	36"	3,300 LBS
DST-2 15KV-500	3000A	36"	3,800 LBS
DST-2 15KV-750	1200A	36"	3,100 LBS
DST-2 15KV-750	2000A	36"	3,400 LBS
DST-2 15KV-750	3000A	36"	4,000 LBS

NOTE: APPROX. WEIGHT DOES NOT INCLUDE BREAKER.

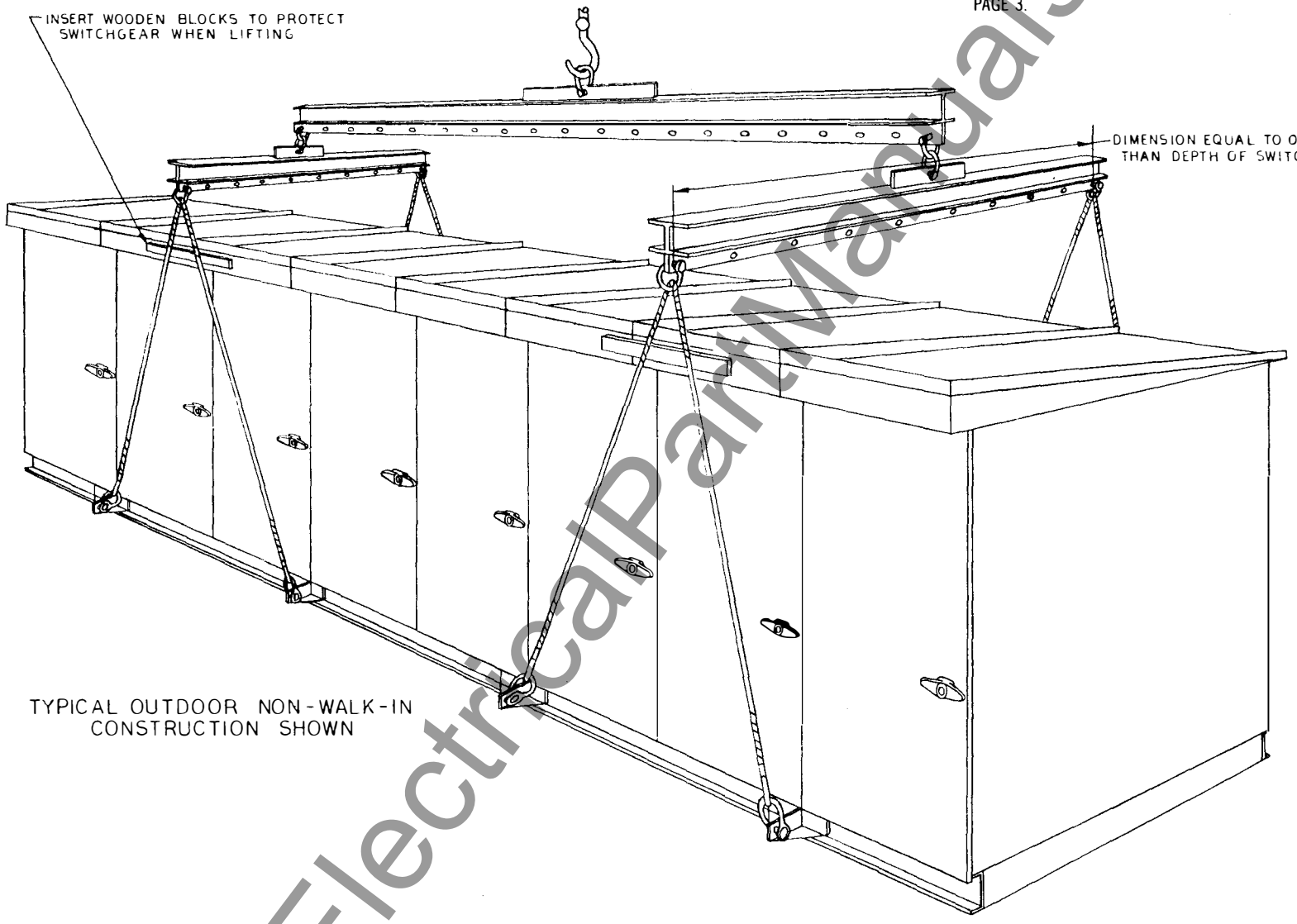


RECOMMENDED METHOD OF LIFTING CELLS (21'-0" LG. MAX) AND ALL WORK AISLE SECTIONS

FPE DWG. NO. 2200C0166

FIGURE 1

NOTE: FOR CELL WEIGHTS REFER TO DWG. 2200C0166 ON PAGE 3.



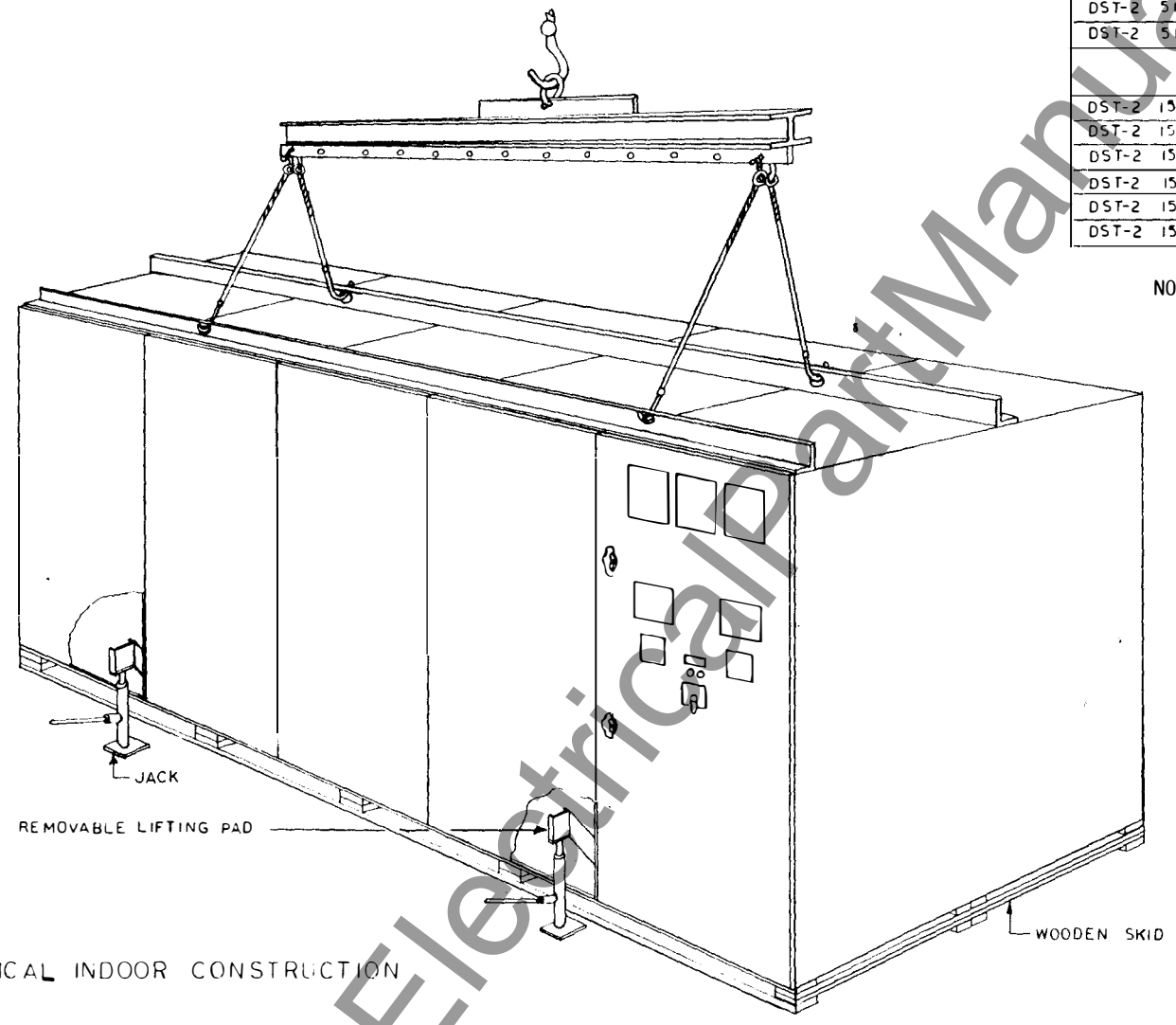
RECOMMENDED METHOD OF LIFTING
CELLS (21'-0" LG. AND OVER) AND ALL WORK AISLE SECTIONS

FPE DWG. NO
2200C0167

FIGURE 2

WEIGHTS OF CELL SECTIONS		
RATING OF CELL	WIDTH OF CELL	APPROX. NET WEIGHT
DST-2 5KV-250 1200A	26"	2,500 LBS.
DST-2 5KV-250 2000A	26"	2,700 LBS.
DST-2 5KV-350 1200A	26"	2,800 LBS.
DST-2 5KV-350 2000A	26"	2,900 LBS.
DST-2 5KV-350 3000A	36"	3,800 LBS.
DST-2 15KV-500 1200A	36"	3,000 LBS.
DST-2 15KV-500 2000A	36"	3,300 LBS.
DST-2 15KV-500 3000A	36"	3,800 LBS.
DST-2 15KV-750 1200A	36"	3,100 LBS.
DST-2 15KV-750 2000A	36"	3,400 LBS.
DST-2 15KV-750 3000A	36"	4,000 LBS.

NOTE: APPROX. WEIGHT DOES NOT INCLUDE BREAKER.



TYPICAL INDOOR CONSTRUCTION

RECOMMENDED METHOD OF LIFTING INDOOR CELLS

FPE DWG. NO. 2200C0335

FIGURE 3

STORAGE BEFORE INSTALLATION

Protection against loss of equipment is an important precaution. Trouble and delay will be avoided by having good storage facilities arranged so that the apparatus will be accessible only to authorized persons and so that it can be quickly located when required in the erection program.

Switchgear equipment, regardless of whether it is to be installed immediately or stored for a while before being erected, should be kept in a dry, clean place. Conditions such as dampness caused by rain or change in temperature, cement dust, etc., should be carefully guarded against. Covering the equipment with a temporary shelter or tarpaulin is frequently necessary both during storage and erection. The longer the period of storage, the greater must be the care taken for protection of the equipment. If dampness or condensation are encountered in the storage location, heaters should be placed inside the units to prevent moisture damage. Approximately 600 watts of heaters per unit will be required. Remove all cartons and other miscellaneous material packed inside the units before energizing any heaters. If the equipment has been subjected to moisture it should be tested with a 1000V or 2500V megger after heaters have been turned on for approximately one week. A reading of at least 100 megohms should be obtained.

Batteries should be uncrated and put on trickle charge immediately on receipt.

Relay covers should never be left off since the relays are delicate devices and future malfunctions because of moisture and dust could prevent proper tripping of circuit breakers.

Breakers should be prepared for storage separately. Refer to appropriate breaker instruction book.

FOUNDATION

Federal Pacific Metal-Clad Switchgear is accurately built on true and level bedplates. This care and accuracy insures ease of operation and interchangeability. Equal care during installation should be used.

True and level supports for this equipment are of utmost importance. Little more than ordinary care in laying out and preparing the foundation will be repaid in reduction of cost and labor of installation.

The steel supporting members used in the floor should be held level until the concrete is set. The surface of the floor under the housing should not project above the supporting members. For indoor switchgear only, the surface of the floor should not lie below the supporting members by more than 1/8".

**The floor in front of the housing should not vary more than 1/8" in any square yard and* must not project above *the level of the supporting members. A smooth floor will make rolling of the removable element easier.*

***When installing switchgear where floors already exist, it will usually be desirable to pour a new finished floor above with embedded channels or cut slots for embedding and leveling the supporting channels.*

Encircling loops of reinforcing or building steel around single phase conductors should be avoided in the main cable entrance area if these are rated 600 amperes or above.

FIG. 4 or an equivalent must be used to obtain an adequate foundation. Bolting the switchgear to the foundation is an acceptable method. Welding to the foundation is preferred because it does not require an accurate lining up of holes.

FIG. 5 or an equivalent must be used to obtain an adequate foundation for outdoor equipment. Welding to the foundation is the preferred method of securing.

*For indoor switchgear only.

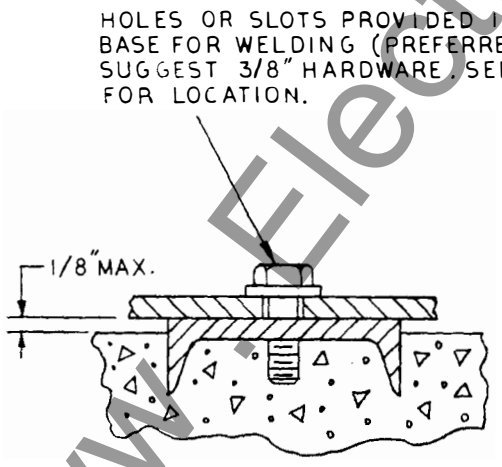


FIGURE 4

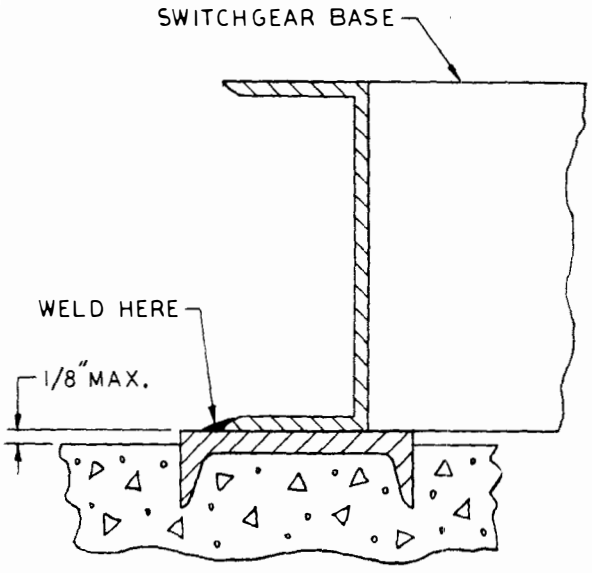


FIGURE 5

PART II - INSTALLATION

HOUSING

INSPECTION

1. Before setting equipment in place, refer to switchgear drawings and, after completely uncrating equipment, check permanent location to see that equipment will properly fit on channels and foundation location. Align and bolt all shipping sections together so that a continuous switchgear installation is obtained. (Refer to Assemblies "A", "B", and "C" below.)
2. Carefully inspect all portions of the circuit breakers for possible damage. 5kV 250 MVA circuit breakers are shipped completely assembled with arc chutes. 15kV and 5kV 350 MVA circuit breakers are shipped separate from arc chutes and may be assembled properly in the protected work aisle and center aisle outdoor houses by use of the arc chute lifting bracket attached to the aisle ceiling. After inspection, the circuit breakers should be carefully inserted and racked into the switchgear cells.
3. Remove shipping braces, inspect for damaged parts, cracked epoxy bus, primary disconnect bushings, bent secondary disconnects, cracked porcelain insulators, wiring insulation — check and report evidence of abuse to equipment.
4. Inspect cells to be certain that power contacts and secondary disconnect contacts located in rear of cell are free of dirt and dust. Cell floor must be clear of all dust and debris to facilitate easy handling of circuit breaker.
5. The breaker is provided with a maintenance closing device for manually closing the breaker. It cannot be used as a manual device to close in the breaker when in the cell. This handle should be used only when the breaker is withdrawn from the compartment.
6. Refer to the circuit breaker Instruction Manual IN-820.11 before inserting breakers into cells.
7. If porcelain entrance or load bushings are mounted in the roof, use flexible connections from incoming and outgoing lines to reduce the strain on the porcelains.
8. Inspect all instrument doors for damage to protective relays.

Control-wiring underground conduit from the control building should terminate inside the switchgear at a level above any existing high-water marks (4" maximum above floor line).

Heaters are furnished in front and rear of each outdoor unit.

The following descriptions and drawings give the general arrangement, sequence of installation, method of fastening the gear to the foundation, location of conduit areas, and other information for the proper location and assembly of the equipment:

ASSEMBLY "A": OUTDOOR PROTECTED WORK AISLE CONSTRUCTION

(See dwg. 2200D0169.)

1. Locate the cell sections accurately on the foundation. When cell equipment is in two sections, locate the sections from the center of the foundation.
2. Check the leveling of the units; use shims where foundation is uneven. Remove lifting lugs.
3. When cells are in two sections and the above are properly leveled and aligned, firmly bolt the bases, cells, and roofs together with the hardware furnished for this purpose.
4. Aisle Section:
   A. When aisle section is in one piece, remove all protective lumber and bracing except wooden horizontal and center vertical braces. Remove lifting lugs.
   B. When aisle section is in two pieces, remove all protective lumber and bracing from each section except wooden horizontal brace, wooden vertical corner and vertical center brace, and open end wooden frame bracing. Remove lifting lugs.

WARNING: UNDER NO CONDITION MAY THE WOODEN HORIZONTAL ROOF SUPPORT BE REMOVED BEFORE ITEM 5 BELOW IS COMPLETED.

5. Slide aisle section(s) into place, making sure that aisle roofs overlap cells and rest on top of cell roofs. Aisle side sheets must be on outside of cell sections.
6. When aisle section is aligned with the cell portion, apply caulk (furnished) between overlapping roof and side sheet surfaces. Firmly bolt bases, roof, and side sheets together and apply cement (furnished) to roof gasket joints.
7. Remove existing wooden braces.
8. Remove floor plates at ends and at base anchoring points.
9. Fasten aisle base to cell base. (See dwg. 2200C0171, Figure 11).
10. Tackweld or anchor the bases to the foundation as indicated on the floor plan drawing.
11. Re-install floor plates.
12. Check and adjust instrument doors for proper alignment to correct possible mishandling during shipment.
13. Assembly of main bus between shipping splits (Refer to Fig. 6)
    A. Measurements must be taken between phase to phase before installation of main bus to insure that the dimensions shown on Table "A" are kept.

    In the event the necessary dimensions are not available, loosen the riser and main bus connection in the adjacent cells and adjust until the required clearances are obtained.

B. Yellow grommets must be properly positioned in the porcelain (15KV) or glastic (5KV) bus support prior to installing the bus. The grommet position must be maintained securely in the bus support when the bus is fed through.

C. Bus Assembly
   a. Remove splice plates
   b. Install main bus through bus support
   c. Re-assemble splice plates
   d. Torque all shipping break splices per recommended torque in Table B, page 8. Assemble the PVC boots around the main bus joints and fasten together with nylon hardware furnished (see instruction Fig. 13, page 14).

14. Re-connect wiring at shipping breaks and where required per wiring diagrams furnished.

NOTE:

A. Customer control wiring connections must be terminated at terminal blocks only — no splicing is permitted.

B. All wiring in conduits must be in accordance with National Electrical Code.

ASSEMBLY "B": OUTDOOR CENTER AISLE CONSTRUCTION

1. Complete items 1, 2, 3, 10, 12, 13, and 14 per assembly "A" above.
2. Bolt aisle-end channels in place.
3. Install floor plates.
4. Assemble end panels of the aisle section.
5. Assemble aisle roofs, seam gaskets, and protective cover.
6. Apply caulk (furnished) between overlapping roof and side sheet surfaces. Firmly bolt roofs and side sheets together and apply cement to roof gasket joints.
7. Check and adjust instrument doors for proper alignment to correct possible mishandling during shipment.

ASSEMBLY "C": OUTDOOR NON-WALK-IN CONSTRUCTION

1. Complete items 1, 2, 3, 10, 12, 13 and 14 per assembly "A" above.

TIGHTENING CONNECTIONS

1. Bus splices at shipping break should be carefully inspected to be certain that good clean, uncontaminated contact is obtained before bolting up tight. A torque wrench should be used, to apply torque as recommended in Table B.
2. It is also important to be sure that all outgoing cable connections are tightened in the same manner as bus splices.

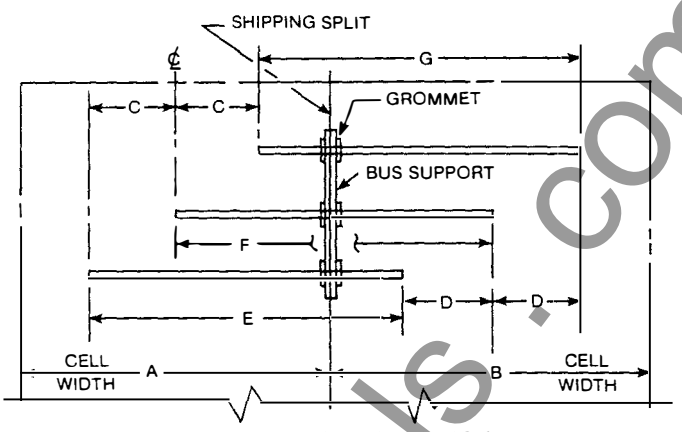


TABLE "A" (DIMENSIONS IN INCHES)

A	B	C	D	E	F	G	NOTE
36	36	10	10	36	36	36	All dimensions
26	26	7	7	24	26	26	shown from
36	26	10	7	34	31	28	℄ to ℄ of
26	36	7	10	28	31	34	bus risers

FIGURE 6 SHIPPING SPLIT

TABLE B
RECOMMENDED TORQUE (Values in Foot Pounds)

Type Bolt	Steel*	Everdur
5/16"-18	18	15
3/8"-16	31	21
1/2"-13	55	45
5/8"-11	80	65

*Steel hardware must be SAE 5 or stronger.

FIGURE 7

BUS DUCT

Bus duct connecting between groups of metal-clad switchgear or between metalclad switchgear and other apparatus, should be installed as shown on the arrangement drawings furnished with the duct. Supports should be provided as indicated on the drawings.

All joints in the bus should be assembled and insulated as previously described for main buses. Adjustable joints are provided to allow for variations in building construction, etc. These joints should be loosened before installation of the duct, then tightened after being set in the position required by the fixed points at the ends of the duct.

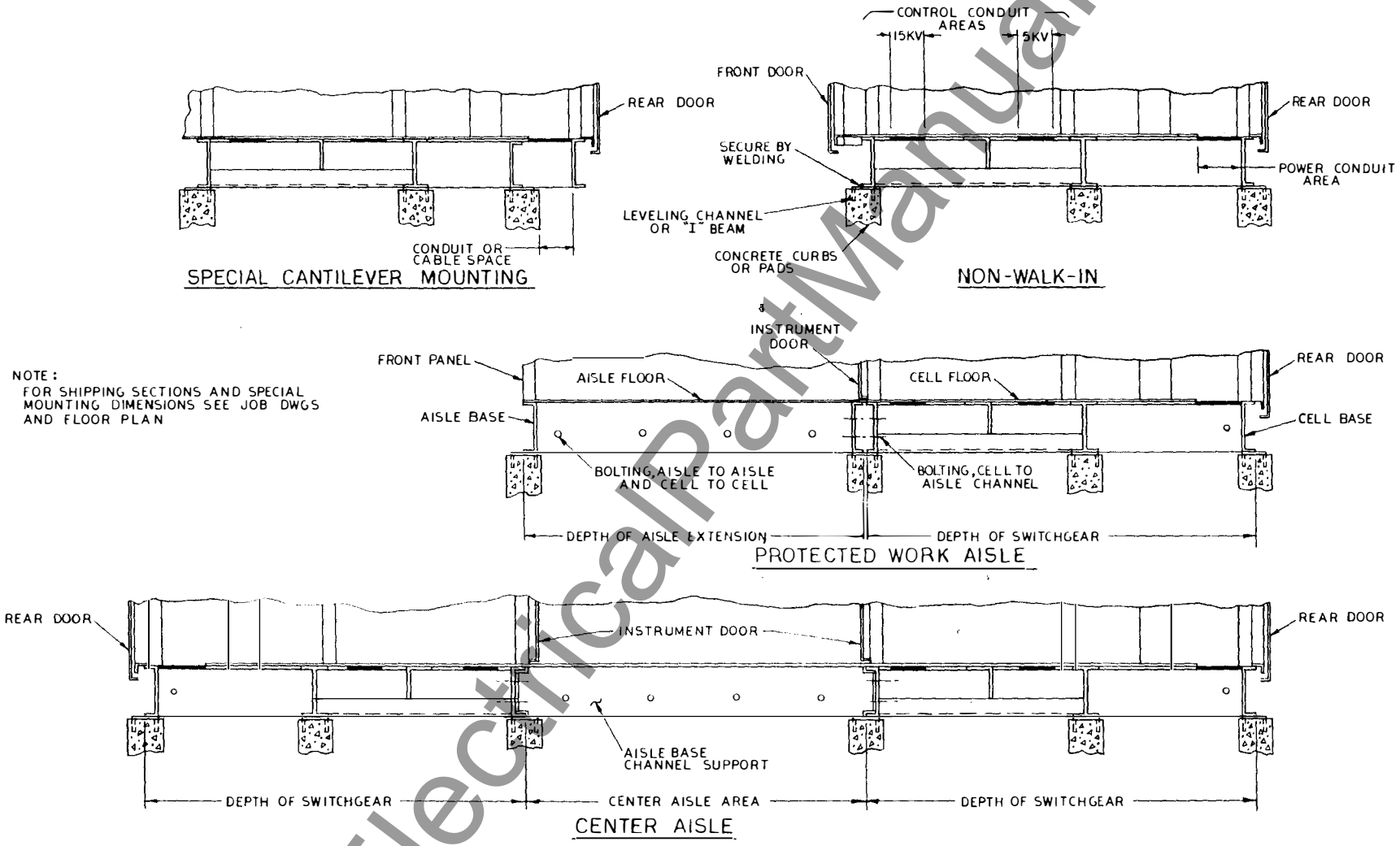
Outdoor bus duct must be gasketed at the joints between shipping sections.

All removable covers on outdoor bus duct except bottom covers must be gasketed. Do not bolt covers in place until all interior assembly work on the duct is completed and access will no longer be required.

Outdoor bus duct is provided with heaters. Connect these heaters in accordance with the wiring diagrams furnished with the equipment before energizing the bus duct.

ADDITION OF UNITS TO EXISTING EQUIPMENT

Before adding units to existing equipment, consult and study all drawings furnished with the equipment. In addition to the usual drawings furnished with new equipment, special drawings may be furnished covering complicated or special assembly work. Also, check to make sure all necessary parts are on hand.



METHOD OF MOUNTING AND INSTALLATION OF BASES FOR OUTDOOR HOUSES

FPE DWG. NO. 2200C0168

FIGURE 8

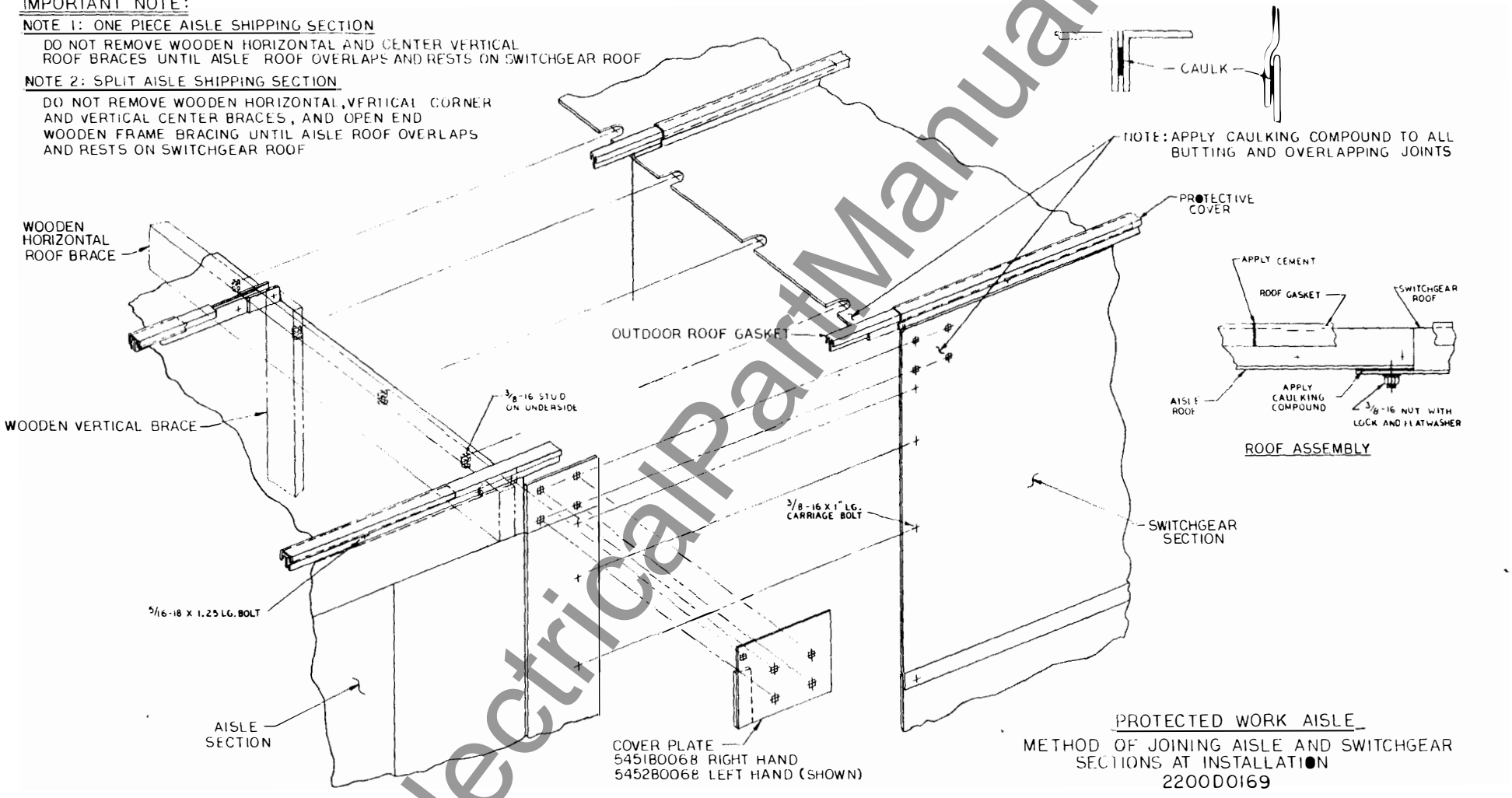
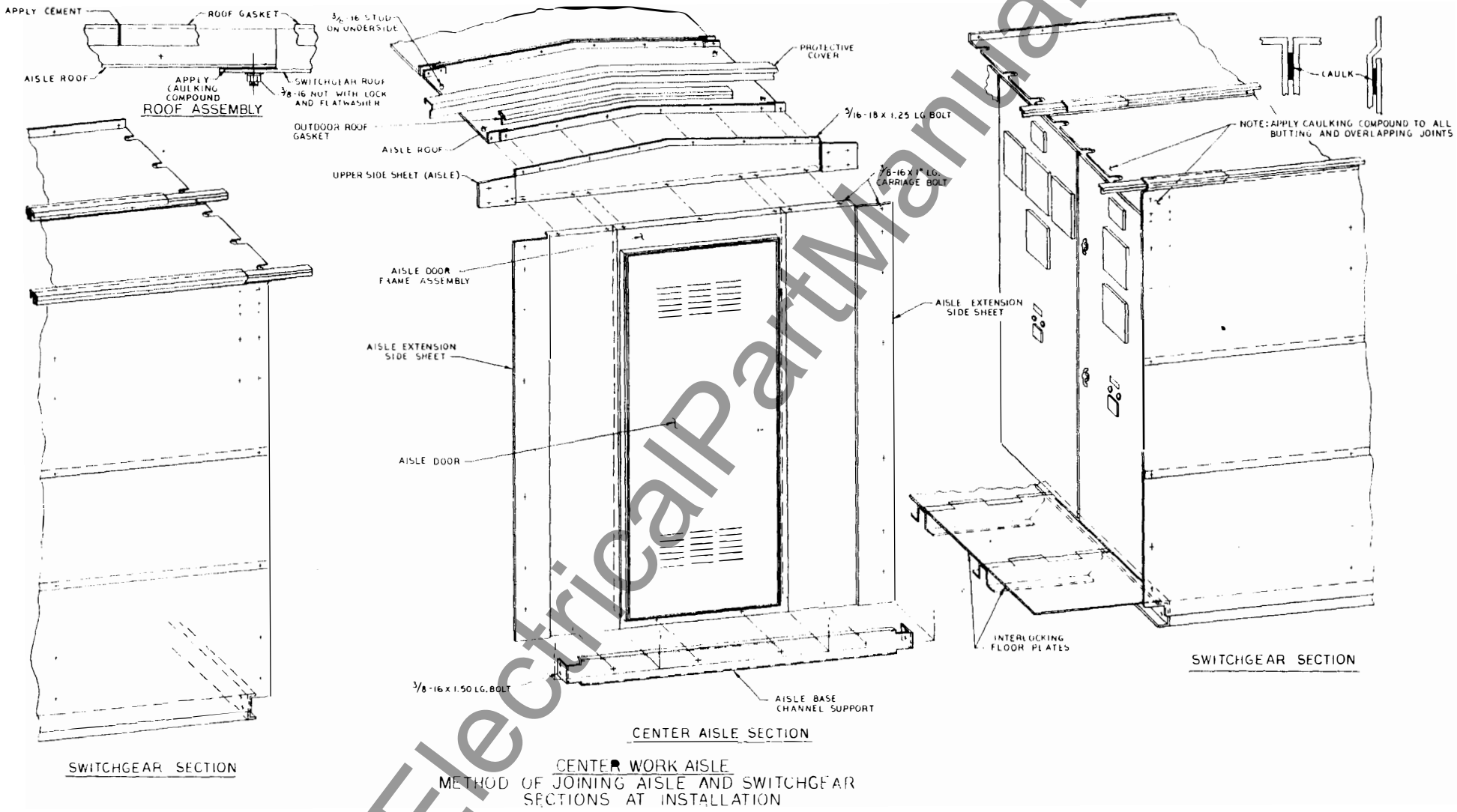


FIGURE 9



CENTER WORK AISLE
METHOD OF JOINING AISLE AND SWITCHGEAR SECTIONS AT INSTALLATION
2200D0170

FIGURE 10

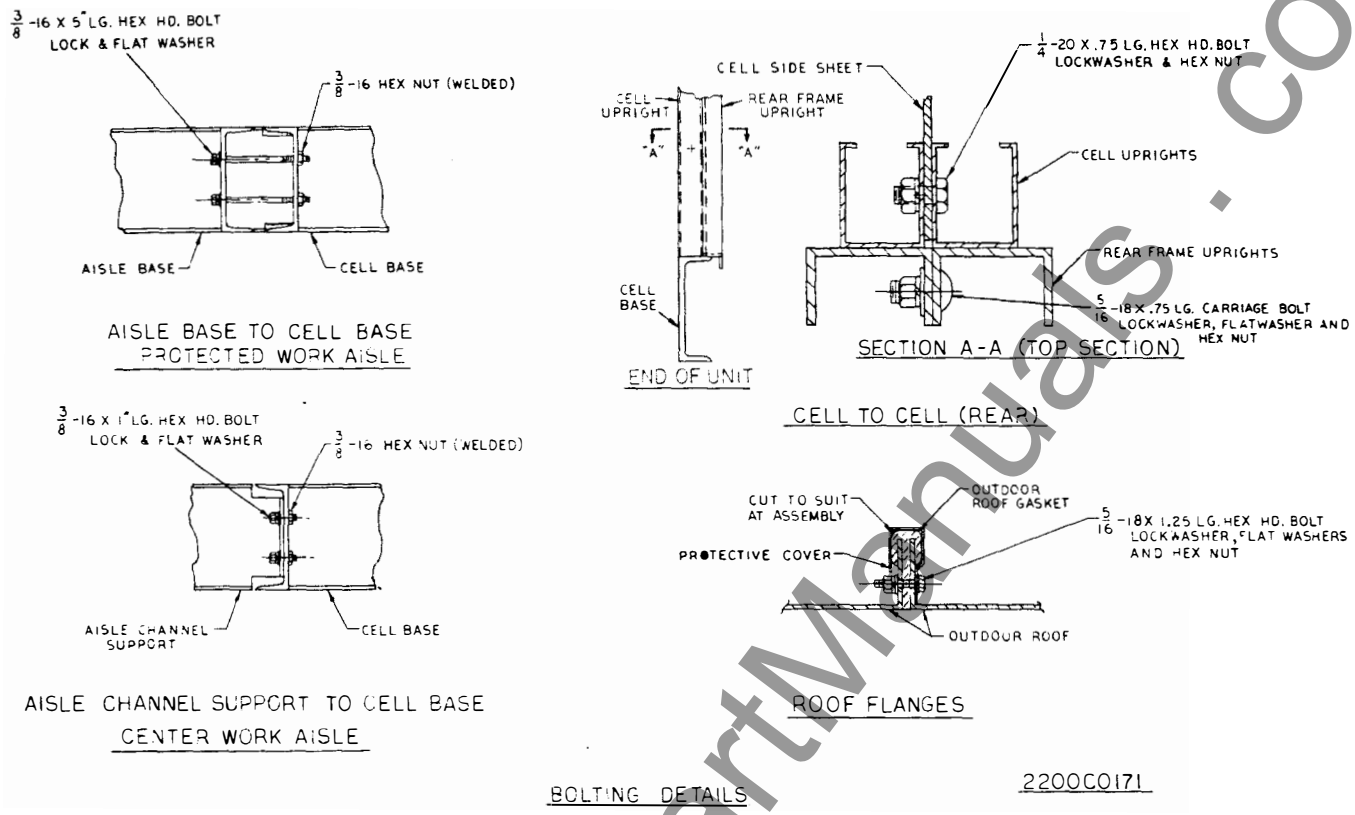


FIGURE 11

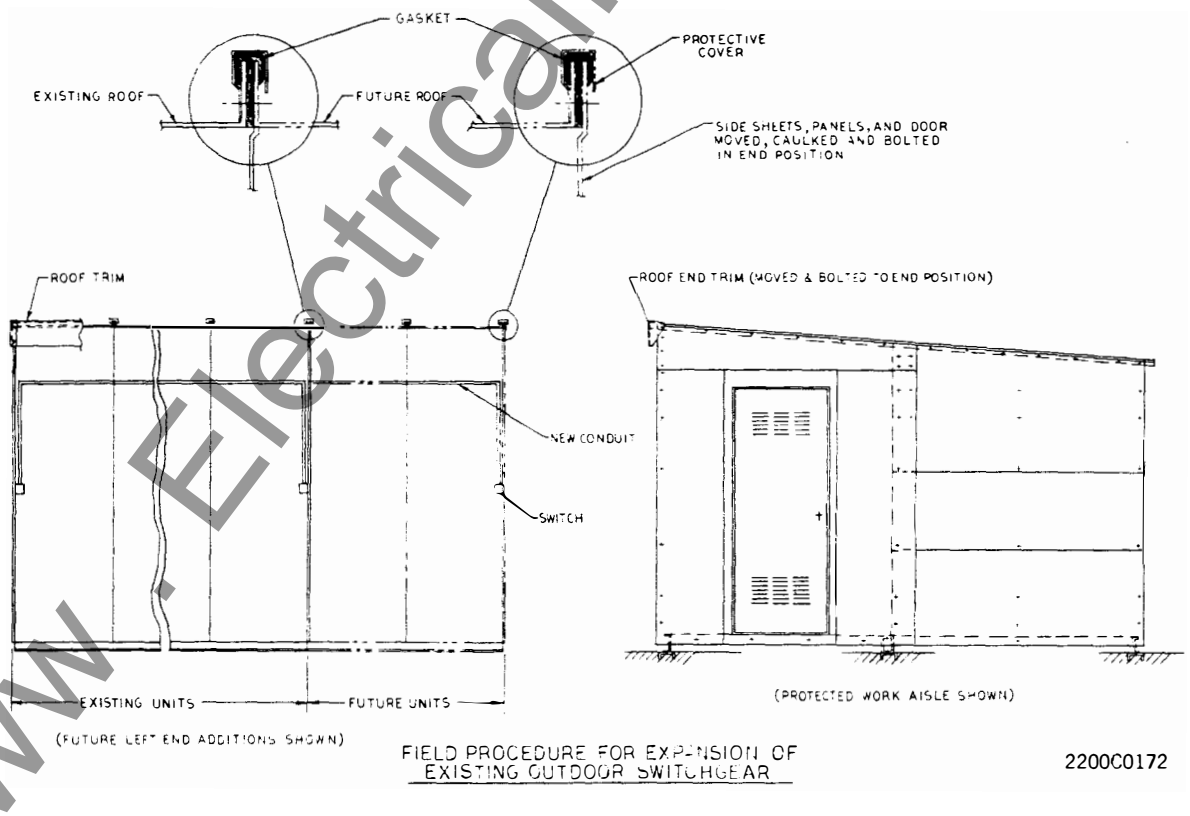


FIGURE 12

BEFORE ANY COVERS ARE REMOVED OR ANY DOORS OPENED WHICH PERMIT ACCESS TO THE PRIMARY CIRCUITS, IT IS ESSENTIAL THAT THE CIRCUIT OR CIRCUITS BE DE-ENERGIZED AND BREAKERS BE WITHDRAWN TO A DISCONNECTED POSITION AND TAGGED.

IF WORK IS TO BE DONE ON REMOTE EQUIPMENT CONNECTED TO A UNIT THE BREAKER FOR THAT UNIT SHOULD BE PLACED IN THE DISCONNECTED POSITION AND TAGGED. ALSO THE REMOTE EQUIPMENT SHOULD BE ISOLATED FROM ANY OTHER POWER SOURCES CONNECTED TO IT.

Dwg. No. 2200C0172 (Figure 12) indicates the special procedures required to add new metal-clad units to outdoor equipment with protected aisle. For indoor equipment it is usually necessary only to remove the end cover sheets and to re-assemble them on the new units after these are located and bolted to the existing units. Otherwise, the installation procedure is the same as described in Part II.

When the units are in place and mechanical assembly is completed, assemble the main bus and other primary connections. Secondary wiring and control bus connections should be made in accordance with the wiring diagrams furnished with the equipment.

EQUIPMENT

BATTERIES

Follow battery manufacturer's instructions carefully when installing the battery. Be sure that ventilation is provided to carry off the fumes. If steel work seems to be affected by the fumes, apply black asphaltum paint.

Make sure that the battery charger is functioning, and that the charging rate is not excessive. Test for specific gravity regularly.

If battery is installed remote from the switchgear, have cables of sufficient size to keep the voltage drop at a minimum.

Be sure battery is charged and no abnormal loads are evident before putting switchgear in service.

WIRING

All incoming and outgoing control connections should be made in accordance with the switchgear schematic and wiring diagrams. After wiring is completed, all connections should be carefully checked against the diagrams to insure that all connections are correct and proper.

The wiring diagram number of each switchgear unit is stamped on the nameplate of the control panel. The wiring diagram number applying to each circuit breaker is stamped on each breaker on the nameplate.

Interconnecting wiring diagrams between the associated equipment are not normally supplied with metal-clad switchgear.

GROUNDING

Each switchgear assembly is provided with a ground bus extending the full length of the complete assembly. Sections of ground bus previously disconnected at shipping breaks must be reconnected when the units are installed. For recommended bolt torque see Table B.

The ground bus should be connected to the station ground at both ends with as direct a connection as possible and should not be run in metal conduit. The grounding conductor should be capable of carrying the maximum line-to-ground current for the duration of the fault.

When switchgear has center aisle construction, insure that the connecting ground bus is connected between opposite aisle sections.

A reliable permanent and low resistance ground connection is necessary for every switchgear installation. A poor ground may be worse than no ground since it gives a false feeling of safety to those working around the equipment. It should also be of sufficient capacity to handle any abnormal condition that might occur on the system and should be independent of the grounds used for any other apparatus.

CONTROL CIRCUIT FUSES

FPE ECON® CLASS 1330
DUAL ELEMENT CONTROL CIRCUIT FUSES
100,000 AMP RMS A.C.
INTERRUPTING CAPACITY

Catalog # - 250V	Ampere
ECN-1	1
ECN-3.2	3.2
ECN-6.25	6.25
ECN-10	10
ECN-15	15
ECN-20	20
ECN-25	25
ECN-30	30
ECN-35	35
ECN-60	60

These fuses provide instantaneous protection against short circuits plus a high degree of current limiting ability within the sizes listed.

DUMMY BREAKER

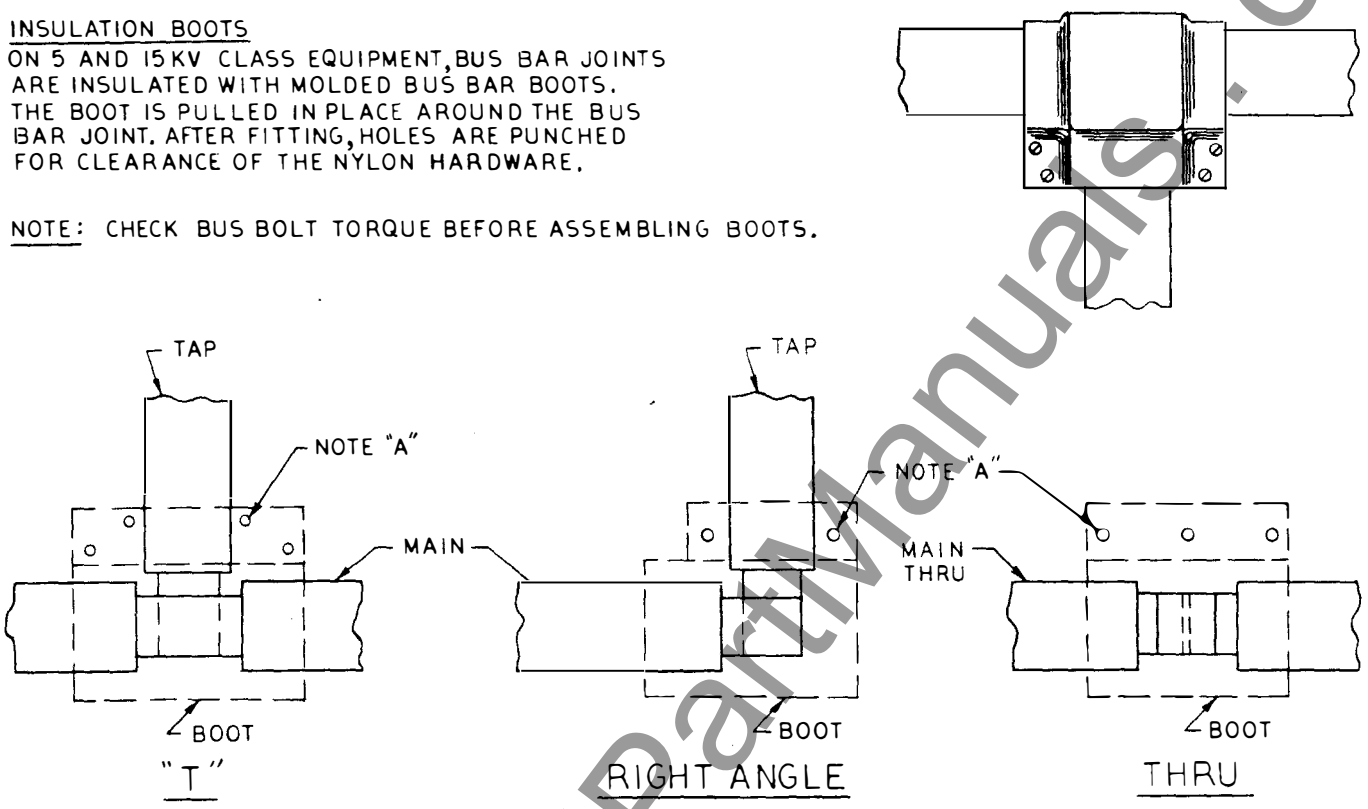
Dummy removable elements are used as a means of isolating circuits or bus sections where operation is infrequent and a circuit breaker cannot be economically justified for an interim of time. The device consists of a framework to simulate the circuit breaker removable element with a set of six studs similar to those on the breakers. The studs are connected by shorting bars which are fully insulated and metal-enclosed. The stationary structure is the same as for a circuit breaker. When the device is racked into position, it connects the line and load side of bus.

Under no conditions must the dummy element be racked into or out of the cell when the bus or the unit is energized. Key interlocks are applied to insure that all sources of power are disconnected before the dummy element can be operated. Floor interlocks are provided to prevent insertion into specific cells.

INSULATION BOOTS

ON 5 AND 15 KV CLASS EQUIPMENT, BUS BAR JOINTS ARE INSULATED WITH MOLDED BUS BAR BOOTS. THE BOOT IS PULLED IN PLACE AROUND THE BUS BAR JOINT. AFTER FITTING, HOLES ARE PUNCHED FOR CLEARANCE OF THE NYLON HARDWARE.

NOTE: CHECK BUS BOLT TORQUE BEFORE ASSEMBLING BOOTS.



NOTE "A": PUNCH 9/32 DIA. HOLES AND ATTACH WITH NYLON HARDWARE.

FIGURE 13

TAPED CONNECTIONS

For taped connections use materials as listed in taping instructions, Fig. 14. Extreme care should be taken in taping unusual contour joints with vinyl tape.

Taping a flat or a cylindrical surface such as a bus bar or cable is a relatively simple process in which much the same technique is used whether the tape is paper, cloth, or plastic. Vinyl tape may be stretched *slightly* to help it conform to irregular contours. This is an advantage if properly understood and used correctly, but can be harmful if the tape is stretched unnecessarily to make it "conform." The pressure sensitive adhesive is not designed to withstand large sidewise (shear) forces for a long time; and if the contour is such that the tape tension can be relaxed by a side slippage, some slippage will take place.

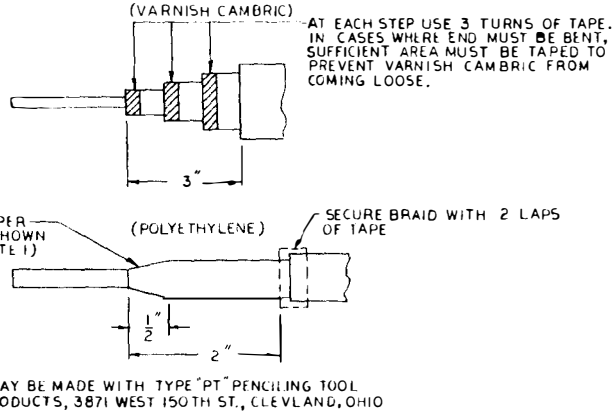
GROUND FAULT CURRENT TRANSFORMERS (THROUGH-TYPE)

Through-type current transformers are furnished where specified for sensitive protection against ground faults. These transformers are normally installed in a horizontal position directly above or below the primary cable terminals, so that the primary cable or cables can pass through them. One transformer is required for each three-phase circuit.

Where armored cable is used, the armor must be terminated and grounded before the cable passes through the transformer. Armor clamps are furnished for this purpose when specified.

When lead or other conducting sheath cable, or cable with shielding tape or braid is used, it is recommended that the sheath or shield be grounded solidly to the switchgear ground bus. The ground lead should be bonded to the sheath or shield on the side of the current transformer away from the primary terminals. In cases where the ground cannot be applied before the cable passes through the transformer, bond the lead to the sheath or shield between the transformer and the primary terminals. The ground conductor must then be passed back along the side path through the current transformer before being connected to the ground bus.

Where potheads are used in units provided with ground fault current transformers, the pothead mountings must be insulated from ground.



NOTE 1
TAPER MAY BE MADE WITH TYPE "PT" PENCILING TOOL
PLM PRODUCTS, 3871 WEST 150TH ST., CLEVELAND, OHIO

METHOD 1
NON-SHIELDED CABLE TERMINATION

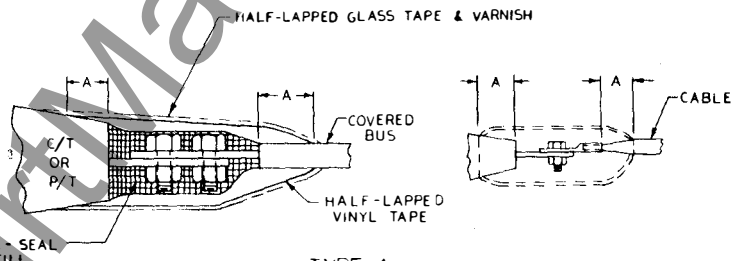
DESCRIPTION	ITEM
VINYL PLASTIC RED ELECTRICAL TAPE	1
DUX-SEAL	2
ELECTRICAL GLASS TAPE—MEDIUM WEAVE 1-1/2" WIDE X .004 THK. 36 YDS. LG. BURLINGTON "HESGON A" OR EQUAL	3
U 310 QT. CAN VARNISH STERLING VARNISH SEWICKLEY, PA.	4

WRAP WITH HALF-LAPPED LAYERS OF TAPE BEGINNING AT ONE END. REVERSE DIRECTION AND CONTINUE APPLYING HALF-LAPPED LAYERS MAKING ONE-HALF OF THE NUMBERS GIVEN IN CHART "A". THESE LAYERS ARE APPLIED WITH JUST SUFFICIENT STRETCH TO INSURE GOOD CONFORMANCE WITH NO AIR VOIDS OR WRINKLES. AFTER THESE LAYERS ARE APPLIED, REVERSE DIRECTION AND APPLY BALANCE OF LAYERS WITH NO STRETCH.

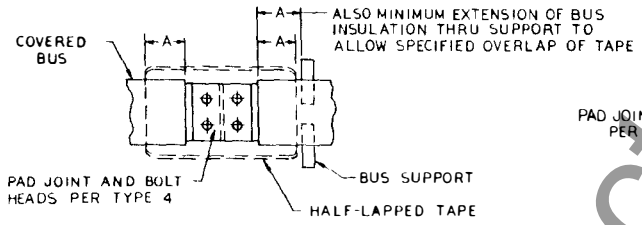
CHART "A"

MAX. VOLTAGE	LAYERS OF TAPE	"A" INSULATION OVERLAP MIN.
600	2	1
5000	6	1½
15000	13	2
23 & 38000	18	4

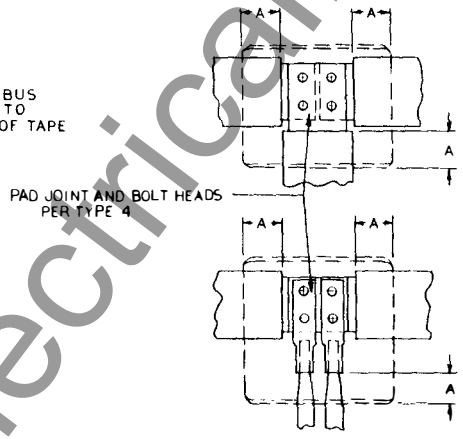
METHOD 2
LAYER OF HALF-LAPPED TAPE
SEE CHART "A"



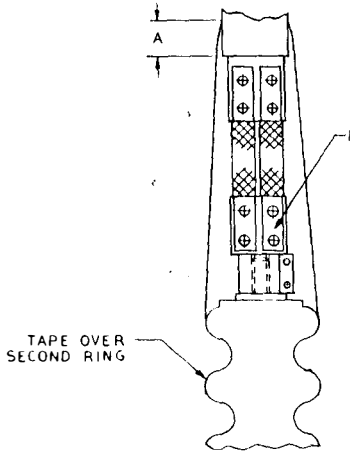
TYPE 4
SPLICE (BUS OR CABLE) TO C/T OR P/T



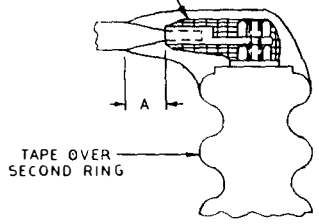
TYPE 3
BUS SPLICE



TYPE 5
"T" BUS & CABLE TO BUS



TYPE 6
BUS-FLEXIBLE CONNECTOR-PORCELAIN TERMINAL



TYPE 7
CABLE TO PORCELAIN TERMINAL

TAPING INSTRUCTIONS

FIGURE 14

PART III - PRE-ENERGIZATION TESTS

PREPARATION

BEFORE STARTING ANY INSPECTION OR TESTING BE SURE PRIMARY CIRCUITS ARE DE-ENERGIZED.

Careful reference should be made to each component instruction leaflet before attempting to place the switchgear in service. If dry-type or oil askarel-filled power transformers are furnished as part of the switchgear equipment, consult their instruction books or leaflets, particularly regarding absorption of moisture, and effects of dust and sand, etc.

The equipment should be checked to be certain no tools or any other equipment have been left in the switchgear. When connections are to be made to or from an electric utility, public or privately-owned, consult their representatives very early in the construction period, as many of them have very strict requirements which must be met before service connections will be made.

Any indication of moisture will require that equipment be dried out before placing in service. Care should be exercised in drying-out operations to be certain that the maximum temperature during the drying period does not exceed 70 to 75° C. on switchgear. In the event it is desired to give the equipment a high potential test before placing in service, this test should only be made after the equipment is thoroughly dry. The value of test voltage should correspond to the voltages listed in Table C. Note that field tests are 75% of the factory test values.

DIELECTRIC TESTS

Dielectric tests are made at the factory to determine the adequacy of insulation. Devices used as part of switchgear assemblies shall be capable of meeting these tests.

Exception—There are certain apparatus such as potential transformers, auto transformers, motor starting reactors, and motor-operated devices whose standards call for a lower test voltage than those given in Table C. When such devices are used, they must be disconnected during these tests.

Alternating-current test voltage shall have a crest value equal to 1.41 times the values specified. A sine wave shape is recommended. The frequency shall not be less than the rated frequency of the apparatus tested. The test voltage shall be applied for one minute.

Direct-current test voltage, if used in lieu of alternating-current test voltage, shall be 1.41 times the specified alternating-current voltage.

OPERATIONAL TESTS

Upon completion of installation, and inspection of the circuit breakers and other components, together with installation of any incoming and outgoing control connections, it is time to start operational testing. Outgoing feeder cables should not be connected at start of test.

TABLE C
DIELECTRIC TEST VALUES

Rated Voltage	60 Cycle KV Field Test	60 Cycle KV Factory Test	Standard Full-Wave Impulse (Withstand) Tests KV
600 V	1.6	2.2	NA
4.16 kV	14.25	19	60
7.2 kV	27.0	36	95
13.8 kV	27.0	36	95
23 kV	45.0	60	150
34.5 kV	60.0	80	150

FIGURE 15

When the switchgear has electrically operated circuit breakers, they are operated in some installations from local battery or auxiliary control supply, and in other installations are operated from the switchgear bus, or a connection ahead of the incoming master circuit breaker. In the event the primary source of power is locked open, it will be necessary to use an auxiliary source of power to operate the circuit breakers, lamps, bell-alarm switch, undervoltage devices, rectifiers, capacitor shunt trips, etc. Check circuit breakers in "test" and "operate" positions, paying particular attention to good contact between movable stationary secondary contacts in both positions. Check puffer by placing hand over arc chute and feeling puff of air during opening operation. Check that primary disconnect penetration is *at least* ⅛" on cell stabs. Check that breaker mechanism closing springs discharge between "test" and "removed" positions.

Key interlocks should be operated manually to make sure that protection is complete. Remove spare keys to supervisory office.

Each relay and trip device or other component should be operated manually to be certain its contacts perform their required function. Remove any material that was installed at the factory to block parts or devices during shipment. Preliminary settings for test purposes should be applied to relays. The various operational functions are indicated on the schematics and wiring diagrams of the switchgear equipment.

After completion of all operation tests, all relays should be set according to specified requirements. If a coordination study has been made this study should be referred to for the settings. Check that the primary device settings are accepted by the Power Company if required. All trip indicators on the relays should be checked to see that they function properly.

Upon completion of device settings and test, the main incoming and feeder cables should be properly phased out and connected to the switchgear. Incoming and outgoing cables should be braced so as to take mechanical strain off studs of circuit breakers and porcelain supports of various types. Clean out construction materials, dirt, nests, etc.

Inspect for damaged parts, cracked epoxy bus, primary disconnect bushings, bent secondary disconnects, cracked porcelain insulators, wiring insulation — check and report evidence of abuse to equipment.

The entire switchgear structure and all bus duct should be carefully vacuum cleaned (preferred) or blown out, and all rear and side plates that have been removed should be rebolted in place. All secondary and power connections should be tested for grounds with high potential tester or megger. Megger readings of one megohm per thousand volts are acceptable. If readings are lower, equipment should be dried out until insulation resistance values improve to one megohm per thousand volts.

Preferable readings are:

Operating voltage KV	1.2	2.5	5.0	8.66	15	23	38
Insulation Resistance	12	25	50	100	150	250	400

Megohm at 25°C.

PART IV - MAINTENANCE

The following preventive maintenance program is outlined for medium and high voltage metal-clad switchgear with air-magnetic or low oil content type power circuit breakers.

Should the need occur, the Field Service Department of the Power Equipment Systems Division of Federal Pacific Electric Company is equipped to assist you with any maintenance or repair which may be required throughout the anticipated long life of this equipment.

FPE "On-Site Test Facilities" are available to you. This service includes engineering inspection and testing of electrical equipment planned to supplement your regular maintenance program, to improve equipment reliability and to protect your investment.

MAINTENANCE BENEFITS AND FACILITIES

Basic elements are outlined for a maintenance program of switchgear installations.

A. MAINTENANCE PROGRAM

A well executed program has these benefits:

1. Longer life of switchgear and fewer replacements.
2. Reduced time on repairs and overhauls, and the option of scheduling them at an opportune time.
3. Fewer failures with unexpected outages.
4. Timely detection of any undesirable operating conditions which require correction.
5. Improved plant performance and increased operating economies.

B. MAINTENANCE RECORDS

A file should be established and include:

1. A record of all installed switchgear and its maintenance schedule.

Check proper operation of doors, transfer trucks, latches, filter units, lighting, hinges, key interlocks (keys and function), gaskets and seals.

On protected work aisle and center aisle O.D. house check that contractor properly assembled and caulked the shipping breaks, and aisle split. Check undercoating, foundation, and for rodent holes.

Check phasing connections of buses (especially at transition points) and connections to transformers and bus ducts. Capacitor trip device — check operation and check that it will hold charge at least 5 minutes by de-energizing primary power as checking operation 5 minutes later. Spot check secondary voltages to make sure proper connections and proper transformer ratios have been selected. Overvoltage can cause premature burnouts of indicating lights. Check lamp burnouts.

Check that C. T. secondaries are not open circuits, especially if going off the board to a remote location. Check that zero seq. C. T.'s have been properly connected and that cable has been properly grounded.

2. Nameplate data of the equipment and its major components, instruction books, renewal parts bulletins and drawings.
3. A list of all items which have to be inspected and what adjustments are to be checked.
4. A record of past inspections and test results.

C. MAINTENANCE TESTS

Maintenance tests are applicable as indicated:

1. Insulation resistance tests of the breakers and of the switchgear bus can be useful in determining the condition of the insulation if they are made regularly. Since definite limits cannot be given for satisfactory insulation resistance, a record must be kept of the readings and comparisons made. Deterioration of insulation and the need for corrective action can be recognized if the instrument readings are progressively lower after each test.
2. High potential tests are not required and are not recommended except in special circumtances, such as after repairs or modifications to the equipment that included the primary circuit. When such tests are necessary, they may be made using 75% of the standard 60-cycle insulation test voltage for new equipment at the factory. See table C, page 16.
3. After the switchgear has been serviced and adjusted, its operation should be checked before it is returned to service. This can be best done by putting the breaker in the test position and operating it with its associated control and protective devices. If it is desired to test the breaker outside its compartment, use the test-jumper supplied with the switchgear.

D. MAINTENANCE EQUIPMENT

Adequate maintenance equipment should include:

1. Spare parts for at least those parts of the switchgear that are vital to continued operation. Manufacturer's recommended list of spare parts can be used as a guide in combination with operating experience to determine variety and quantity of parts to be stocked.
2. A well-lighted shop equipped with the following:

   a. A test cabinet for air magnetic breakers or an inspection rack.

   b. Maintenance closing device for power breakers.

   c. Test jumper for connecting breaker to control circuit when it is outside its compartment.

   d. Relay test plugs for making tripping, timing and calibration tests of relays.

   e. A selection of ammeters, voltmeters and instrument transformers.

   f. An insulation resistance tester.

   g. An overhead crane or hydraulic lifting device.

FREQUENCY OF INSPECTIONS

It is generally good practice to inspect equipment three to six months after it is first put in service and then inspect and maintain it every one to three years depending on its service and operations conditions. This suggested schedule is only a guide. Conditions that can make more frequent maintenance necessary are:

1. High humidity and ambient temperature.
2. Corrosive atmosphere.
3. Excessive dust and dirt.
4. High repetitive duty.
5. Frequent interruption of faults.
6. Older equipment.
7. History on preceding inspections.

MAINTENANCE PROGRAM FOR SWITCHGEAR

The maintenance program should include the thorough inspection, servicing and adjustment of the following components.

A. METAL-CLAD STATIONARY UNITS AND BUS DUCT

1. Remove accumulated dust and dirt. Vacuum cleaning is recommended.
2. Wipe insulated buses and bus supports with a clean cloth moistened (when necessary) with a petroleum solvent (such as trichlorethylene) or similar cleaner. Wipe insulation dry after cleaning.
3. Inspect buses and connection bars for physical damage, evidence of corona cutting or other conditions that can indicate deterioration of the insulation.
4. If taping has been damaged or needs replacing follow instructions on pages 14 and 15.
5. Inspect alignment and contacting of primary disconnecting devices, checking for signs of abnormal wear or other damage. Note: Discoloration of the silvered surface is not usually harmful unless caused by sulphide deposits which can be removed by a solvent, such as alcohol, or by silver polish.
6. Check adjustments and operation of safety shutters, interlocks, auxiliary and limit switches.
7. Inspect all relays, contactors, switches, fuses and other devices for correct operation.
8. Check tightness of main bus bolts, anchor bolts, and structure bolts, also control connections and continuity of wiring.
9. Check strip heaters and clean air filters at ventilation openings when these are present.
10. Repair damaged paint finishes.
11. Check seals, gaskets, watertightness, etc., of outdoor equipment.

B. POWER BREAKERS

Air magnetic type and low oil content breakers should be maintained on the same schedule as the metal-clad units, or at least every year, or per the following schedule, whichever comes first:

— Air magnetic type — every 2000 non-fault operations, refer to instruction manual IN-820.11.

— Low oil content — every 100 non-fault operations, refer to instruction manual IN-825.0.

It is also recommended that when the normal operating duty is a combination of fault interruptions and repetitive operations, the breaker should be inspected and serviced after a fault operation at or near its interrupting rating. Remove the breaker from its housing for inspection.

1. Wipe insulating parts, including bushings, clean.
2. Inspect alignment, penetration, and condition of movable and stationary contacts. Check their adjustment as described in the instruction book.
3. Check arc chutes for evidence of damage, and replace damaged parts. When arc chutes are removed, blow out dust and loose particles.
4. Clean silver-plated breaker primary disconnecting devices. Whether cleaned or not, lubricate devices by applying a thin film of contact grease.
5. Inspect breaker operating mechanism for loose hardware and missing or broken cotter pins, retaining rings, etc. Examine cam, latch and roller surfaces for damage or excessive wear.
6. Check puffer operation (air magnetic only).
7. Check breaker operating mechanism adjustments and readjust as described in the instruction book. If these adjustments cannot be made within specified tolerances, it will usually indicate excessive wear and need for a complete overhaul.
8. Inspect breaker control wiring for tightness of connections.
9. After the breaker has been serviced, operate it slowly

with closing device to check freedom from binding or friction and check that contacts move to the fully opened and fully closed positions. Check electrical operation either in test position or removed from compartment.

10. Check oil level and dielectric condition (Low oil content only).
11. Check for leaks (Low oil content only).

PART V - SAFETY REQUIREMENTS FOR POWER SWITCHGEAR ASSEMBLIES

Power switchgear assemblies covered by this instruction are characterized by not only high-voltage, but also by high continuous currents and high interrupting requirements. Conformance to the requirements of this publication are deemed adequate to assure normal safety to operating, maintenance, and inspection personnel on the basis that such personnel are Qualified.

1. UNQUALIFIED PERSON — GENERAL PUBLIC
General public is all persons, without exception, who are not qualified in accordance with Section 2.

General public includes unqualified persons who might be authorized by reason of employment or conditions to have access to the area of power switchgear. Examples are plumbers, janitors, owners, etc.

2. QUALIFIED PERSON
For the purpose of this instruction, a qualified person is one who is thoroughly trained, and understands the hazards involved in any area which may be within his responsibility, such as construction, installation, operation, and maintenance of switchgear apparatus. In addition, he has the following qualifications:

(1) Is able to de-energize, clear and tag circuits and equipment in accordance with established safety practices.

(2) Wears protective equipment such as rubber gloves, hard hat, dark glasses, flash-clothes, etc., in accordance with established safety practices, and is trained in their proper care.

(3) Is certified in rendering first aid, especially in the technique of removing a person in contact with a live circuit, and in applying artificial respiration.

3. GENERAL INSTRUCTIONS TO QUALIFIED PERSONS
Qualified persons shall work only on equipment that is completely de-energized from all sources of electric power, including control power.

A. Understand the Equipment — Qualified persons shall learn and understand instruction information furnished.

B. Clearing Equipment for Work — Qualified persons shall consider all circuits and equipment as live at all times until completely de-energized, tested, grounded, tagged or properly identified, and released for work in an authorized manner.

C. Cleaning of Equipment — No cleaning or similar work shall be done by qualified personnel within the reach of parts or equipment unless they have been de-energized and prepared for work in accordance with (B) above.

D. Working Alone — Where Permitted — When alone, a qualified person shall do no cleaning or other work inside compartments or compartment doors and covers unless the equipment to be worked on has been de-energized and prepared for work in accordance with (B) above.

E. Carrying Equipment and Tools — Qualified personnel shall at all times be aware of the hazards associated with carrying and placing equipment and tools such as ladders, brooms, mops, lamp holders, tool belts, tool boxes, keys, etc., in places where circuits may become energized.

F. Removing Tools — Qualified personnel shall exercise care in not leaving tools or keys on buses, doors, panels, equipment cases or tanks, rotating machines and in or on compartments.

PART VI - SWITCHGEAR ACCESSORIES

FOR DST-2 5KV AND 15KV
(Unless otherwise specified items listed below are for both 5KV and 15KV).

DESCRIPTION	PART NO.
Breaker Racking-In Handle	
5KV-250MVA & 15KV-500 & 750MVA-1200A & 2000AMP	2251C5412
5KV-350MVA-1200 & 2000AMPS	2252C5412
Breaker Maintenance Closing Lever All 5KV-250MVA & 350MVA, 350MVA-1200A & 2000A	1551B5628
Breaker Maintenance Closing Device All 15KV & 5KV-350-3000A	1551C5820
Breaker Mechanism Charging Handle	1551A5539
Breaker Test Jumper Cable 10 Ft. 24 Points (Not required when test cabinet is specified)	2252C4509
Breaker Test Jumper Cable 10 Ft. 40 Point	2251C4509
Breaker Outdoor Transfer Truck (6″ High) 5KV	2251D4689
Breaker Outdoor Transfer Truck (6″ High) 15KV	2251D4690
Breaker Handling Dolly (Indoor)	2251C4842
Breaker Test Cabinet—Indoor:	
1. AC or DC control voltage— "close" and "motor", DC voltage "trip"	2251D4340
2. AC or DC control voltage— "close" and "motor", AC voltage "capacitor trip"	2252D4340

MISCELLANEOUS SWITCHGEAR ACCESSORIES

CELL HEATERS—Complete Assembly

With terminal block	
120V-125 watts & 208V-175 watts	2751C0706
208V-220 watts, 240V-300 watts, and 277V-375 watts	2752C0706
Without terminal block	
120V-125 watts	2751C0704
220-300-375 watts, 208V-220 watts, 240V-300 watts, and 277V-375 watts	2752C0704

THERMOSTAT

120-240 Volt Thermostat (Type 11T11) (Close 100°F., Open 110°F.)	237-001

SWITCHGEAR INDICATING LAMPS

Catalog No.	Description	
Indicating Lamps—not including color caps.		
	Voltages	**Series Resistor OHMS**
234-001	48	200
234-002	115AC/125DC	2000
234-003	230AC/250DC	5100
Colored Caps		
234-004	white	
234-005	blue	
234-006	amber	
234-007	green	
234-008	red	
234-009	clear	
Indicating Lamp Parts		
064-007	Lamp .040 amps	