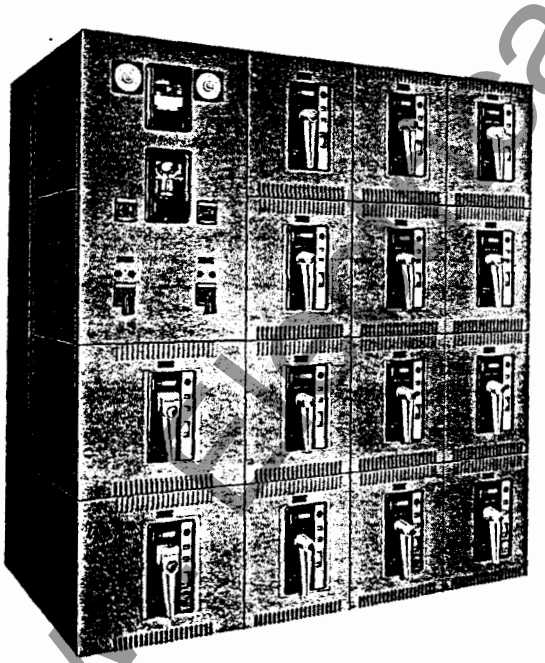
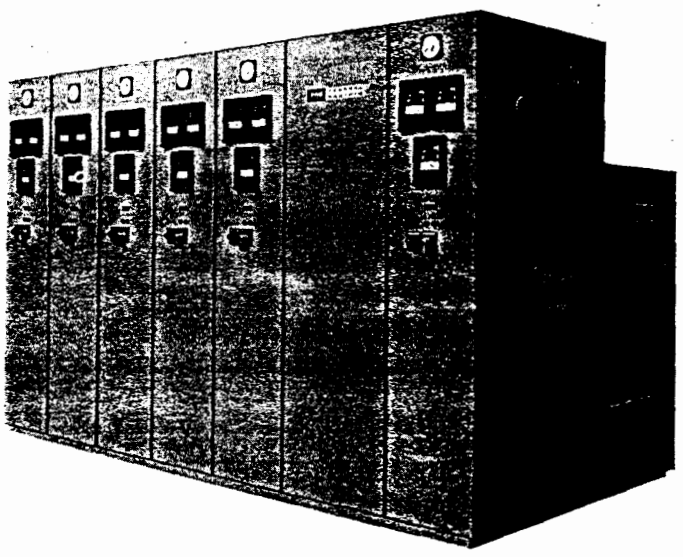
IN-820.4

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

Federal Pacific
Metal-Clad Switchgear
and
Low-Voltage Switchgear





FEDERAL PACIFIC ELECTRIC COMPANY
GENERAL OFFICES: 50 PARIS STREET, NEWARK 1, NEW JERSEY

PART I
INSTALLATION AND OPERATION

PART II
MAINTENANCE

PART I

SWITCHGEAR INSTALLATION AND OPERATION

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 to prevent damage to bearings and movements.

REMOVAL FROM CARRIER & 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. The importance cannot be overstressed regarding the care 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 switchgear headquarters design section.
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 final location. Each section of outdoor gear is supplied with heavy lifting lugs bolted to switchgear base.
3. 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 to lifting rig as shown on typical outdoor gear drawing 2200-0114. Lifting from front and rear of units permits placing shipping sections side by side for bolting without interference from lifting rig or hook.
4. When cranes are not available, equipment can be rolled into place on shipping skids provided with each shipping section. Pushing or pulling forces should be applied to the skid and not the Switchgear.
5. Shipping skids can be removed by using a foot jack in each corner of the shipping section after the switchgear has been moved to its final location.

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. It is advisable to place electric strip heaters or lamps within enclosures to raise temperature approximately 10 degrees above outside temperature at all times.

Crated apparatus which is not to be erected immediately will store much better if left crated. It should, however, be inspected to make sure that no damage has been incurred during transit.

When arrangements are made prior to shipment, electric strip heaters circuit can be taken out of crate so that heaters can be energized while switchgear equipment remains in the crates.

ALIGNMENT OF FOUNDATION

Federal Pacific metal switchgear is accurately built on true and level bedplates. This care and accuracy insures ease of operation and interchangeability. Equal care in installation should be used.

A true and level floor for this equipment is of utmost importance. A 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 member.

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.* The better this floor is finished the easier will be the rolling of the removable breaker unit.

When installing metal-clad switchgear on existing floors it will usually be desirable to pour a new finish floor 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 areas marked for main cables—when these circuits are rated at 600 amperes or above.

One of these methods or its equivalent must be used to obtain an adequate foundation. Fig. 2 and 3 tack welding equipment to floor channels is preferred since this method does not require accurate lining up of bolts.

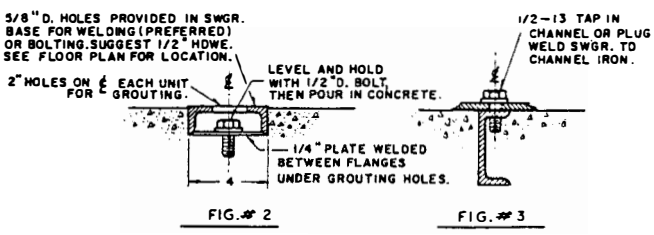
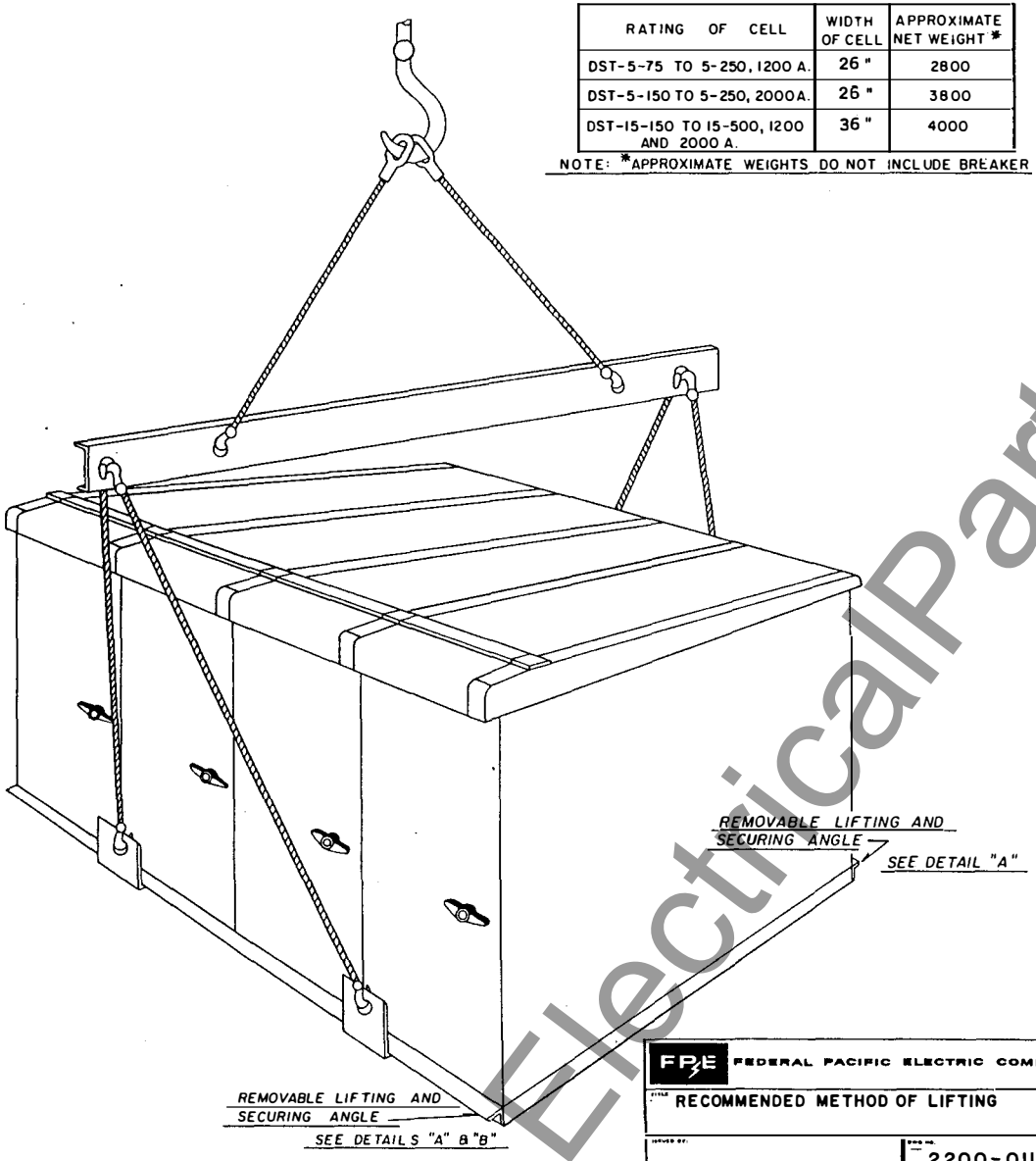
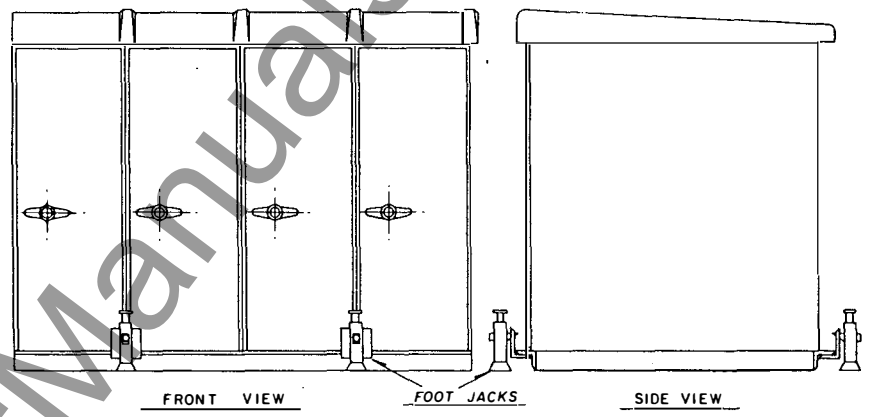


FIG. # 2 FIG. # 3

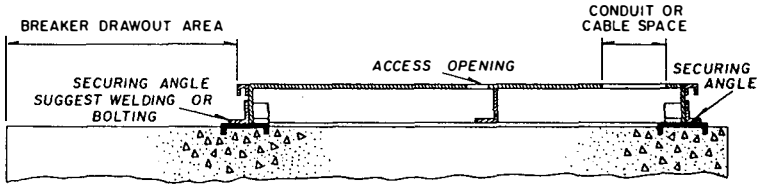
RATING OF CELL	WIDTH OF CELL	APPROXIMATE NET WEIGHT *
DST-5-75 TO 5-250, 1200 A.	26"	2800
DST-5-150 TO 5-250, 2000A.	26"	3800
DST-15-150 TO 15-500, 1200 AND 2000 A.	36"	4000

NOTE: *APPROXIMATE WEIGHTS DO NOT INCLUDE BREAKER

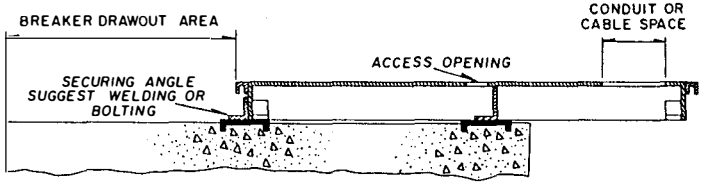




ALTERNATE METHOD OF LIFTING



DETAIL "A"



DETAIL "B"

RECOMMENDED METHODS OF ANCHORING

CONCRETE PAD AND LEVELING CHANNELS TO BE SUPPLIED BY CUSTOMER UNLESS OTHERWISE SPECIFIED.
RECOMMENDED METHODS OF ANCHORING ARE SHOWN IN DETAILS "A" & "B". THE UNITS MAY BE BOLTED, WELDED OR ANCHORED TO THE CHANNEL. SUGGEST 1/2 INCH HARDWARE FOR BOLTING. (HARDWARE SUPPLIED BY CUSTOMER.)

CHANNELS SHOULD BE LEVEL WITH EACH OTHER AND LEVEL OVER THEIR ENTIRE LENGTH. (RECOMMENDED SIZE OF CHANNEL 4"X 5.4#/ FT.)

FINISHED FLOOR SHOULD NOT BE HIGHER THAN LEVELING CHANNELS AND SHOULD ALSO HAVE SLIGHT PITCH AWAY FROM CHANNELS.

FPE FEDERAL PACIFIC ELECTRIC COMPANY

TITLE: RECOMMENDED METHOD OF LIFTING

ISSUED BY:

DWG NO. 2200-0114

EQUIPMENT INSTALLATION

A. Before setting equipment in place, refer to switchboard drawings and, after completely uncrating equipment, check permanent location to see that equipment will properly fit on channels and foundation location. Couple and bolt all shipping sections together so that a continuous switchgear installation is obtained.

B. Carefully inspect all portions of the Air Circuit Breakers for possible damage. After inspection, the circuit breakers should be carefully inserted and racked into the switchgear cells.

C. Inspect cells to be certain that male power contacts and secondary control contacts located in rear of cell are free of dirt and dust. It is also important that cell floor be clear of all dust and debris to facilitate easy handling of circuit breaker.

D. The breaker is provided with a *maintenance* closing handle for manually closing the breaker. *It should not 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.

E. Refer to circuit breaker instruction books or leaflets before inserting breakers into cells. (See page 12 for instruction book index.)

BREAKER LIFTING DEVICES

A. For 600 volt gear it is recommended that a device for lifting and lowering DMB-15-25-50-75 breakers to and from the breaker compartments be used. For indoor switchgear it is recommended that the purchaser install a monorail crane over the front of the switchgear, or Federal Pacific can supply a hydraulically operated lift-truck as an additional item of equipment. For outdoor switchgear a special hydraulic lift-truck can be supplied (see Index for Accessories).

B. DMB-75 breakers are furnished with a lifting spreader, which provides a ready method of placing the breakers in their compartments when a crane is being used.

BATTERIES

Follow battery manufacturer's instructions carefully when installing the battery. Be sure that ventilation is provided to carry off the fumes. If steelwork 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 line drop at a minimum.

OUTDOOR SWITCHGEAR

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.

Small-wiring underground conduit from the control building should terminate inside the switchgear at a level above any existing high-water marks.

Heaters are furnished in front and rear of each unit. These heaters are enclosed type to prevent personal contact.

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 inside of the instrument door. The wiring diagram number applying to each Circuit Breaker is stamped on each breaker in a convenient location. Interconnecting wiring diagrams between the associated equipment is not normally supplied with Metal-Clad and Metal-Enclosed 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.

The ground bus should be connected to the station ground 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.

A good reliable ground connection is necessary for every switchgear installation. It should 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.

A permanent low resistance ground is essential for adequate protection. A poor ground may be worse than no ground since it gives a false feeling of safety to those working around the equipment.

GROUND DETECTION

On ungrounded low voltage systems (up to 600 volts AC) new switchgear equipment quite often does not include ground detection lamps or voltmeters. Nevertheless it is quite important to check for grounds in the system at intervals.

The simplest method for two-wire single-phase systems is to connect two clear filament lamps of the system voltage in series across the two wires with a ground connection between the two lamps. A ground on one side will short-circuit and darken the lamp on that side. The same general scheme is used for multi-phase systems.

For higher voltages, use potential transformers, or static ground detectors.

CONTROL CIRCUIT FUSES

FPE ECON CLASS 1330
DUAL ELEMENT CONTROL CIRCUIT FUSES
100,000 RMS INTERRUPTING CAPACITY

Catalog #—250 V	Ampere	Catalog #—600 V
ECN-1	1	ECS-1
ECN-3	3	ECS-3
ECN-6	6	ECS-6
ECN-10	10	ECS-10
ECN-15	15	ECS-15
ECN-20	20	ECS-20
ECN-25	25	ECS-25
ECN-30	30	ECS-30
ECN-60	60	ECS-60

These Fuses provide dual protection.

1. Time delay protection against unnecessary blowouts from high inrush currents of breaker solenoid coils and control power transformers.
2. Instantaneous protection against short circuits plus a high degree of current limiting ability within the sizes listed.

TIGHTENING CONNECTIONS

1—Bus splices at shipping break should be carefully inspected to be certain that good clean contact is obtained before bolting up tight. Torque* wrench should be used.

2—It is important also to be sure that all outgoing cable connections are tightened in the same manner as bus splices.

Recommended Torque Values

5/16" Bolt	16 Ft. Lbs.
3/8" "	24 " "
1/2" "	60 " "

* Suggested supplier for ratchet on box torque wrenches, Waldrick Engr. Co., P.O. Box 398, Huntington Station, New York. Also the P. S. Sturtevant Company, Addison, Illinois.

"POLESTIGLAS" INSULATION

It is standard manufacturing practice where practical to insulate all electrical joints except shipping breaks at the factory before shipment. Federal Pacific Electric Co.'s exclusive Polestiglas flame retardent and non-tracking molded and cast materials are used throughout. Where it is impractical to use cast on insulation such as on an outgoing cable connection, flame retardent Polyvinyl tape is supplied.

Instructions for assembling and compounding bus joints, transformer connection etc., with "Polestiglas" insulating compound are—

"Polestiglas" is a two part resin system. It is shipped in separate containers, so that the catalyst, which is about 1% by weight of the resin, when completely stirred and mixed can be poured directly from the large container into the compound box mold.

Casting compound is supplied in separate containers—each container of compound and container of catalyst, when mixed, will fill one compound box.

The identification number of the material supplied with each job is as follows:

Field joints with compound boxes,
Current Transformers, etc. 2700-5053
Patching Compound 2700-5054
Catalyst 2700-5051

Picture Number 1 . . . shows the standard assembly of a bus joint with compound box. Assemble compound box as indicated in *picture 2*, mix resin and catalyst in line with instructions furnished with material, and described above, and pour, as illustrated in *picture 3*, up to the top of the mold. This material will then set to a hard non-hydroscopic mass. The black compound box is left in position in this operation, and is not removed. The final joint looks exactly as *picture 3*, with the exception that it is filled with Polestiglas.

An alternate method of making compound boxes in the field is illustrated in picture 4, where a foam mold is supplied. This foam mold is supplied as a unit, and is clamped to the joint that is to be insulated. The foam mold should be waxed inside with Johnson's paste wax before it is assembled on the joint. It is recommended that the outside surface of the compound box and adjacent bus work also be waxed to prevent spill or splashing casting compound from sticking to adjacent surfaces.

Care should be taken to be certain that no wax is used where adhesion is required. The foam mold, when removed from the joint, may be reused providing it is rewaxed. It is important that all vent holes be kept clean in the compound boxes or foam molds to prevent the entrapment of air which will result in voids in the molding. The entire process for assembling the mold and mixing the Polestiglas, takes somewhat less than 15 minutes. For the resin to become solid may take from one to four hours, depending on the ambient temperature. It is advisable, however, when using the foam removable type molds, to check with a screw driver or a pencil, the surface of the Polestiglas to see if the material has hardened, before removing the mold. The material as supplied, will have a viscosity, such that if mixed properly will complete its reaction, making a joint that is non-tracking, corona resistant, and non-hydroscopic.

In operations with other than standard compound boxes type Number 1 and Number 2, communicate with the factory for specifications. Field experience will indicate that boxes can be made in either horizontal or vertical planes. Polestiglas mix can be supplied as a patching compound or filler for small voids, etc.

TAPED CONNECTIONS

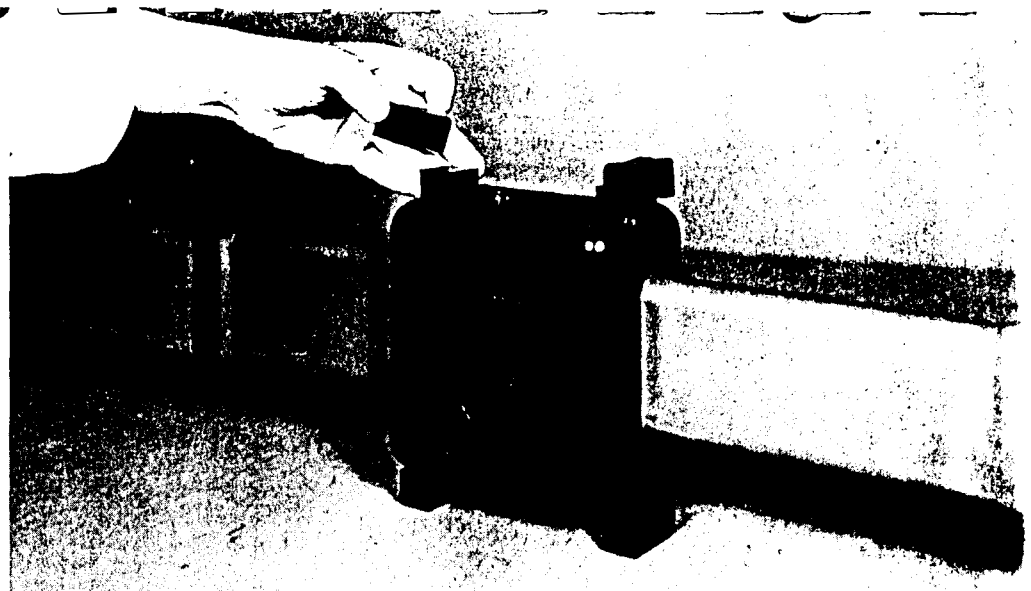
For taped connections use materials as listed on attached instruction sheet, using copper mesh and conductive tape as shown. Extreme care should be taken in taping unusual contour joints with vinyl tape.

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, film or plastic. The tape lies naturally in a spiral, and there are no problems of conformance. However, when a small degree of irregularity is present, it is helpful to use a tape with some elongation so that wrinkles are not created. This property is also useful in guiding the tape to maintain the proper overlap. Vinyl tapes possess this elongation to an exceptional degree. Combined with it is a "memory" in the tape which causes it to contract after application and pull down to a snug fit, minimizing voids or other irregularities in the insulation. This is an advantage if properly understood and used correctly, but can be harmful if the tape is stretched unnecessarily to make it "conform" to certain contours. 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.

Many surfaces requiring insulation-stress cones, for instance—are of such shape that they cannot be wrapped spirally without exessive stretching of the tape. Usually in such cases a taping method can be devised that will make use of the "memory" or "regain" characteristics of the tape to insure proper insulation.

If the surface is developable (capable of being covered by a flat sheet without stretching), it is always possible to apply the tape in such a way that there are no forces tending to make it slip sidewise. This is done by wrapping along the geodesics of the surface (lines of shortest distance between two points.) The general principle is that of letting the tape lay itself on the surface to be covered; if necessary, the tape can be cut several times for some surfaces.

①



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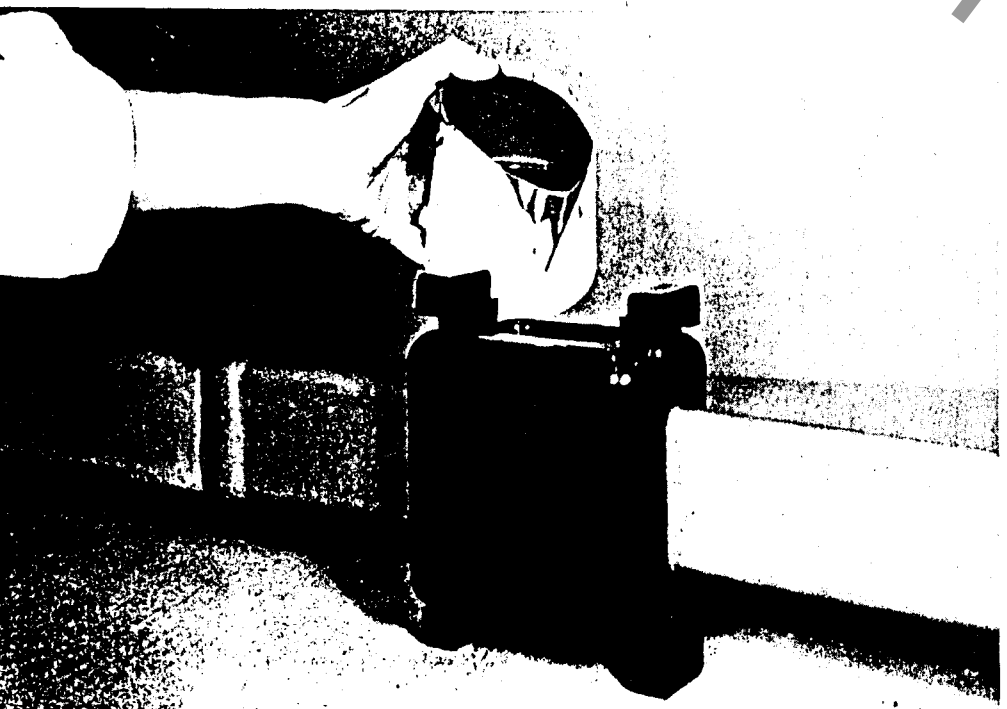

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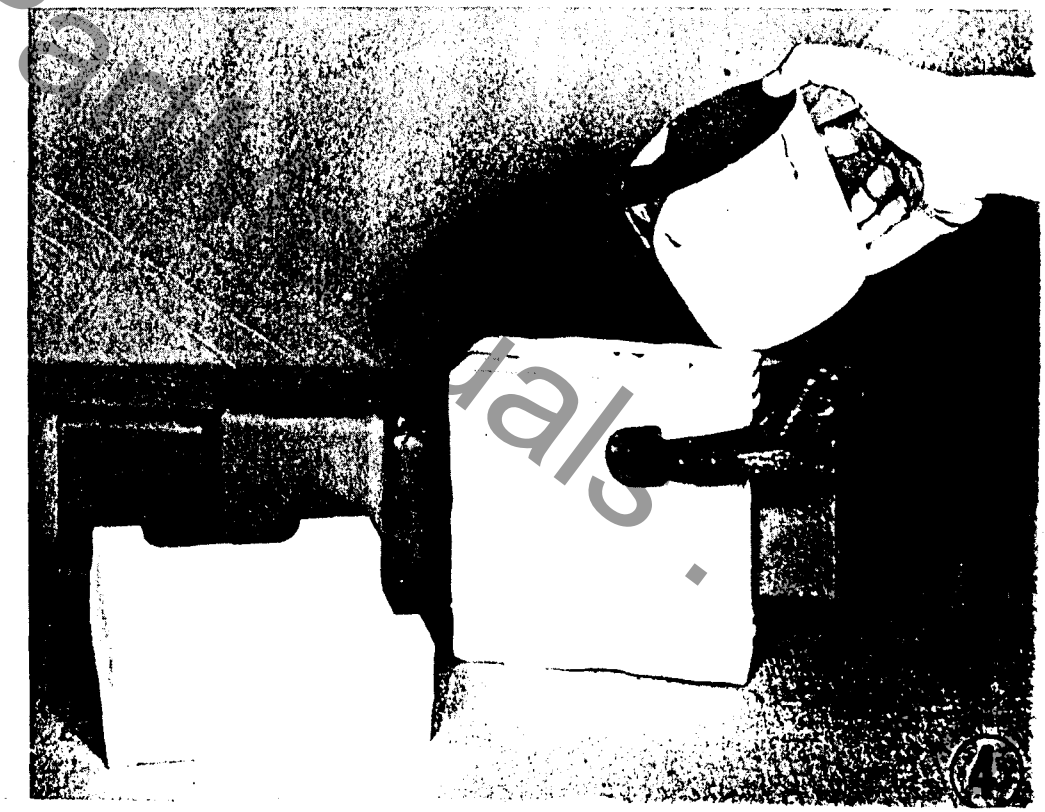


④

THE FOLLOWING INSTRUCTIONS SHOULD BE FOLLOWED IN TAPING ALL MAIN CONNECTIONS AS REQUIRED ON SWITCHGEAR.

LAYER OF HALF-LAPPED TAPE. SEE TABLE "A"

WRAP WITH HALF-LAPPED LAYERS OF .010 TAPE BEGINNING AT ONE END. REVERSE DIRECTION AND CONTINUE APPLYING HALF-LAPPED LAYERS MAKING ONE-HALF OF THE NUMBERS GIVEN IN TABLE "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.

FIG. 1

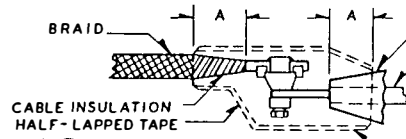


FIG. 2 CABLE CONNECTION

NOTE; FOR STRESS RELIEF CONES REFER TO THE RECOMMENDATION OF THE CABLE MANUFACTURER.

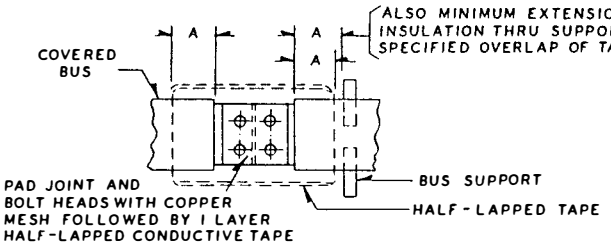
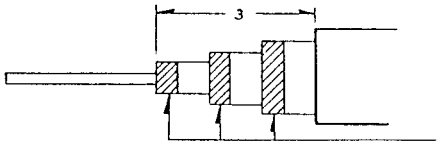


FIG. 3 BUS SPLICE



AT EACH STEP USE 3 TURNS OF TAPE. IN CASES WHERE END MUST BE BENT, SUFFICIENT AREA MUST BE TAPED TO PREVENT VARNISH CAMBRIC FROM COMING LOOSE.

FIG. 4

POTENTIAL TRANSFORMER ETC. CABLE TERMINATION

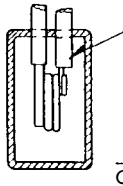


FIG. 5

POTENTIAL TRANSFORMER CONNECTION IN BUS JOINT COMPOUND BOX

		51	PART NO.	DESCRIPTION	ITEM
		8 ROLLS	150-100	VINYL PLASTIC ELECTRICAL TAPE 1 INCH WIDE X 36 YARDS LG. FLAME RETARDENT	1
		15 FEET	082-009	4 INCH WIDE KNITTED COPPER MESH.	2
		1/2 ROLL	082-012	CARBON BLACK BIAS SEMI-CONDUCTIVE TAPE 1 INCH WIDE X 72 YARDS LONG	3

ORDERING INSTRUCTIONS

SERVICE VOLTAGE	LAYERS OF TAPE	"A" CREEPAGE MIN.
750	2	1
5,000	6	1 1/2
15,000	13	2

TABLE "A"

MAT. SPECIFIED IN GRP. 51 WILL MAKE THE FOLLOWING AMOUNT OF CONNS.	KV.	AMPERAGE
12	5	600
6	5	1200
3	5	2000
3	15	1200
1 1/2	15	2000
1 1/2	5	3000

PART	5000 V. LIGHT AND HEAVY DUTY			
	600 AMP.		1200 AMP.	
	QTY.	UNITS	QTY.	UNITS
1	12 ROLLS	1	4 ROLLS	1
2	8 FEET	1	8 FEET	1
3	1/2 ROLL	1	1/2 ROLL	1

1 UNIT CONSISTS OF MATERIAL FOR 3 CONNECTIONS

PART	15000V. HEAVY DUTY			
	600 AMP.		1200 AMP.	
	QTY.	UNITS	QTY.	UNITS
1	4 ROLLS	1	8 ROLLS	1
2	8 FEET	1	15 FEET	1
3	1/2 ROLL	1	1/2 ROLL	1

1 UNIT CONSISTS OF MATERIAL FOR 3 CONNECTIONS

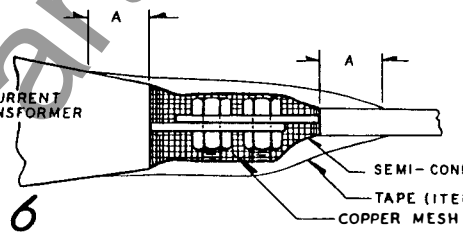


FIG. 6

TRANSFORMER CONNECTION

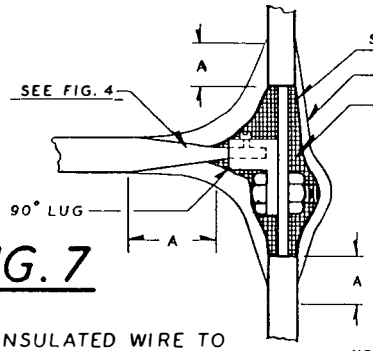


FIG. 7

INSULATED WIRE TO BUS CONNECTION

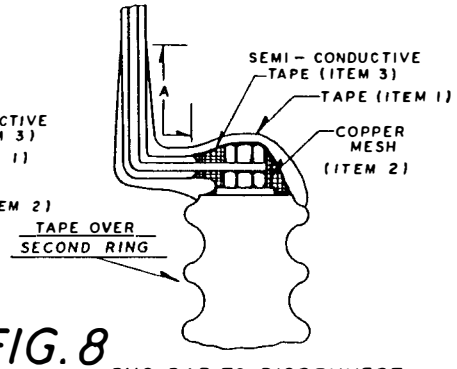


FIG. 8

BUS BAR TO DISCONNECT SWITCH STUD CONNECTION

NOTE: THIS DRAWING TAKEN FROM 2751-0442.

FPE FEDERAL PACIFIC ELECTRIC COMPANY

TITLE

TAPING INSTRUCTIONS

GETTING READY FOR SERVICE

Careful reference should be made to each component instruction leaflet before attempting to place the switchgear in service. If dry-type or oil or 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.

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 degrees centigrade 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, allowing approximately 10 days drying time. The value of test voltage should correspond to the voltages listed below.

DIELECTRIC TESTS

The following dielectric tests shall be made to determine the adequacy of insulation. Devices used as part of switchgear assemblies shall be capable of meeting the following dielectric tests.

Exception—There is certain apparatus such as potential transformers, auto transformers, motor starting reactors, and motor-operated devices the standards for which call for lower test voltage than those given below. When such devices are used, they may 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.

A. Equipment Rated 60 Volts and Below

That part of assembled equipment rated 60 volts or less shall withstand an alternating-current voltage test of 500 volts.

B. Equipment Rated 61 to 600 Volts

Alternating-current assembled equipment and alternating-current circuits of equipment of higher rated voltage rated 61 to 600 volts shall withstand an alternating-current voltage test of 1000 volts plus twice rated voltage, with a minimum of 1500 volts. Factory Test. When assembled in field and connected, test voltages should be 75% of factory test value.

C. Equipment Rated 601 to 2399 Volts— Alternating Current

Alternating-current assembled equipment rated 601 to 2399 volts shall withstand an alternating current voltage test of 2000 volts plus 2¼ times rated voltage. When assembled in field and connected, test voltages should be 75% of factory value.

D. Equipment Rated 2400 Volts Alternating-Current and Above

Rated Voltage KV	60 Cycle KV Field Conn.	60 Cycle KV Factory	Standard Full-Wave Impulse (Withstand) Tests KV
2.4	11.25	15	45
4.16	14.25	19	60
7.2	27.0	36	95
13.8	27.0	36	95
14.4	37.50	50	110
23	45.0	60	150
34.5	60.0	80	200

The equipment should be checked to be certain no tools on 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.

OPERATIONAL TESTING

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.

If it is a Power Center with Power Transformer and high-voltage disconnect or interrupter switch ahead of the switchgear, lock the switch in the open position in order to protect the test operator.

Similarly if it is a generating station, the generator breaker should be locked open.

If there are low voltage manual breakers, they may be checked in "test" and "operate" positions. Extreme care should be taken that all contacts and housing switches (if any) align properly.

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 and stationary secondary contacts in both 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 relay contacts during the shipment. Preliminary settings for test purposes should be applied to relays. The various operational functions are indicated on the schematic and wiring diagrams of the switchgear equipment.

After completion of all operational tests, all relays should be set. All trip indicators on the relays should be checked to see that they function properly.

Upon completion of device settings and tests, 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.

The entire switchgear structure shoud 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 merger. Megger readings of one megohm per thousand volts is 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
Insulation Resistance Megohm at 25°	12	25	50	150	300

PART II

GUIDE TO SWITCHGEAR MAINTENANCE

A preventive maintenance program is outlined for medium-voltage, metal-clad type switchgear, low voltage metal-enclosed switchgear, and air-magnetic power circuit breakers. The outline lists benefits to be derived, records, tests and facilities required, and inspection and servicing steps.

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.
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 circumstances, 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.
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 nine-foot test-jumper drawing #3351-0017 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 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 INSPECTION

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 operation 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, and 7. history on preceding inspections.

SAFETY PRACTICES

Maintenance employees must follow all recognized safety practices, such as those contained in the National Electrical Safety Code and in company or other local safety regulations during maintenance. All of the units of switchgear to be maintained must be de-energized, tested for potential, grounded and tagged out before removing covers and barriers for access to primary circuits. As is well known, the solid insulation surrounding an energized conductor in power apparatus should not be relied upon to provide protection to personnel. Another example is the maintenance closing device, which is exactly what the name implies and should never be used to close manually a circuit breaker that is connected to an energized circuit. All removable devices, such as the circuit breakers and rollout potential transformers, should be removed from the metal-clad switchgear housing.

MAINTENANCE PROGRAM FOR SWITCHGEAR

The maintenance program should include the thorough inspection, servicing and adjustment of the following components for 2.4-13.8 KV operating service.

A. *METAL-CLAD STATIONARY UNITS*

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 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 Federal Pacific drawing page 6.
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 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.

B. *MEDIUM VOLTAGE POWER CIRCUIT BREAKERS (AIR MAGNETIC TYPE) 2.4 TO 13.8 KV*

Air magnetic type circuit breakers should be maintained on the same schedule as the metal-clad units, or every 2500 non-fault operations, or at least every six months, whichever comes first. 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 and the inside of box barriers, clean of smoke and dust. Repair moderate damage to bushing insulation by sanding smooth and refinishing with a clear insulating varnish.
2. Inspect alignment 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 slow aging, heat resistant petrolatum.
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. Clean and relubricate operating mechanism. Use a non-hardening grease to lubricate cams, rollers, latches and props, and pins and bearings. We recommend LUBRIPLATE, "AERO" grade, manufactured by Fiske Bros. Refining Company, Newark, N. J.
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. Check control device for freedom of operation. Replace contacts when badly worn or burned.
9. Inspect breaker control wiring for tightness of connections.
10. 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.

C. *LOW VOLTAGE POWER CIRCUIT BREAKERS 600 VOLT AC*

The preceding information applies in nearly all details to Low Voltage Metal Enclosed (600 Volt AC) switchgear, both indoor and outdoor, the differences are only minor, and are due to physical differences in the switchgear.

METAL-ENCLOSED SWITCHGEAR 600 VOLT MAXIMUM SWITCHGEAR ACCESSORIES

Description	Part No.
*Breaker Racking-in Handle	
DMB-15-25-50T	1151-0001
FP-400/800, FP-2000	1101-9251
*Breaker Maintenance Closing Handle	
DMB-75-100	M-6414677, Group #1
Breaker Hydraulic Lifting Truck	
DMB-15-25-50T	2651-0200
Breaker Inspection Rack for DMB-50T	2751-0241
Breaker Inspection Rack for DMB-25-15T	2751-0242
Breaker Monorail Hoisting Device, Track, Clamps, etc.	
DMB-50-25-15T	2751-0227
*Breaker Maintenance Handle	
FP-400/800, FP-2000	1151-9252
*Hand Closing Lever (Gang Operated Disconnect Switch)	2751-0145

METAL-CLAD SWITCHGEAR 2.4 TO 13.8 KV SWITCHGEAR ACCESSORIES

Description	Part No.
Breaker Racking-In Cranks	
DST-5KV-15KV, 20", 30" & 34" Wide Breakers	2251-0222
DST-5KV-17" Wide Breaker Indoor & Non Walk-in	2252-0222
DST-5KV-17" Wide Breaker Outdoor Walk-in (And right end cell is 17" Breaker otherwise use 2252-0222)	2253-0222
*Breaker Maintenance Closing Lever DST-5-250, 5-350, 15-500 & 15-1000	2251-0215
*Breaker Spring Charging (Stored Energy) Lever	1551-2454
Breaker Test Jumper Cable—9 Ft. (18 Points) (Not required when test cabinet is specified)	3355 B 0017
*Breaker Test Jumper Cable—9 Ft. (30 Points) (Required only if test of brkr. out of cell must include circuit function of the auxiliary contacts)	3354 B 0017
*Breaker Outdoor Transfer Truck	
DST-5KV-20" Wide Breakers	3351-1458
DST-5KV-30" Wide Breakers (except 5-350)	3352-1458
DST-15KV-30" Wide Breakers	3353-1458
Steel & Aluminum Bolted Cell Non-Walkin	
DST-17"-21" Alum. House	2251 D 2851
DST 30" Alum. House	2252 D 2851
DST-17"-21" Steel House	2253 D 2851
DST 30" Steel House	2254 D 2851
DST 30" Steel House 5350 & 15-1000	LATER
DST 30" Steel House 5350 & 15-1000	LATER
*Breaker Handling Dolly—Indoor	
DST-5-75	1551-2825
DST-5-250, 5-350, 15-500, 15-1000	2251-0333
Breaker Test Cabinet—Indoor (Except 15-1000)	
125V DC Close & Trip (4101 D 0116)	3354 D 0070
230V AC Close Cap. Trip (4101 D 0117)	3355 D 0070
230V AC Close Battery Trip (4101 D 0115)	3356 D 0070
250V DC Close & Trip (4101 D 3987)	3357 D 0070
230V AC Close Cap. Trip (4101 D 0117)	3359 D 0070
230V AC Close DC Trip (4101 D 0115)	3360 D 0070
48V DC Close, Trip & Motor (4101 D 5114)	3366 D 0070
125V DC Close, Trip & Motor (4102 D 5114)	3367 D 0070
48V DC Close, Trip & 125V AC Motor (4103 D 5114)	3368 D 0070
125V DC Close, Trip & 125V AC Motor (4104 D 5114)	3369 D 0070
115V AC Close, Motor & DC Trip	3370 D 0070
230V AC Close, Motor & DC Trip	3371 D 0070
230V AC Close, Motor & Cap. Trip	3372 D 0070
Breaker Test Cabinet—Outdoor Specify circuit requirements	3351-0660
Cell Main Contact Wrench—15KV	
DST-15-500	2251-0277
DST-15-1000-3000A	3351-1807
*Hand Closing Lever (Gang Operated Disconnect Switch) 5 and 15KV	2751-0145
*Arc Chute Lifting Yoke	
DST-5-75	1551-2826
DST-15-500, 5-250	1551-0429
DST-5-350	1551-1693
DST-15-1000	1552-1693
*Arc Chute Maintenance Prop	
DST-5-350	1551-2124

* Standard Accessories normally supplied with switchgear. All other items included only where specified.

MISC. SWITCHGEAR ACCESSORIES

Closing Rectifiers — 240 V 60 cycle AC (264V Max) 125 volt DC intermittent duty. AC not to be applied longer than one (1) second nor more than ten (10) times in any one minute period.

	Part No.
100 Amp 4-8-1 Stock, 240V AC. 125 Volt DC	2701-0244
60 Amp 4-8-1 Stock, 240V AC. 125 Volt DC	2702-0244

Arc Suppression Rectifier (DST Breaker only)

125 volt DC—Service 1-Stack	087-004

Hook Stick For Disconnecting Switches

8-foot Stick	3751-0540
10-foot Stick	3752-0540
12-foot Stick	3753-0540
14-foot Stick	3754-0540

Cable Lugs, Cast Eyebolt — Dwg. 2701-0010

Cable Range	
#10W to #2W	2701-0010
2C to 4/oC	2702-0010
250MCM to 500MCM	2703-0010
600MCM to 1000MCM	2704-0010
1250MCM to 1500MCM	2705-0010
1500MCM to 2000MCM	2706-0010

Touch Up Paint

Exterior outdoor dark gray ASA-24	Finish S-18
Interior indoor light gray ASA-61	Finish S-20

Joint Compound Box Ordering Information ½ X 3, ¼ X 3 Conductors Kit

Box & Compound (1 Connection)	2751-0470

Joint Compound Box Ordering Information ½ X 6, ¼ X 6 Conductors Kit

Box & Compound (1 Connection)	2752-0470

Unit Heaters

Description	Part No.
120 Volts, Complete Assembly, 250 Watts	2751-0187
230 Volts, Complete Assembly, 250 Watts	2752-0187
230 Volts, Complete Assembly, 160 Watts	2753-0187

Switchgear Indicating Lamps

Catalog No.	Description		Catalog No.	Description	
Indicating Lamps—not including color caps.			**Resistors**		
	Voltage AC or DC	Series Resistor OHMS		OHMS	SERVICE VOLTAGE
2751-0135	50	800	2708-0116	110	24
2752-0135	70	1400	2701-0116	800	50
2753-0135	115	2900	2702-0116	1400	70
2754-0135	125	3200	2703-0116	2900	115
2755-0135	208	5800	2704-0116	3200	125
2756-0135	230	6500	2705-0116	5800	208
2757-0135	250	7100	2706-0116	6500	230
2758-0135	24	110	2707-0116	7100	250

Color Caps		Indicating Lamp Parts	
2701-0117	red	064-007	24-E Lamp 24 V. .032-.038 amps.
2702-0117	green		
2703-0117	amber	2701-0124	Spacer 1/32"
2704-0117	blue	2751-0119	Receptacle assembly, less Resistor, Bezel and Color Cap.
2705-0117	white		
		2701-0118	Spring Retainer Washer

Instruction Books

600 V Air Circuit Breaker

DMB-15T	IN-810.1
DMB-25IT	IN-810.2
DMB-50T	IN-810.3

2.4 to 13.8 KV Air Circuit Breaker

DST-150, 250	IN-DST (IN-820.2)
DST-15-150, 250, 500	IN-DST (IN-820.2)
DST-5-75, 150, 250X	IN-DST (IN-820.2)
DST-5-75	IN-820.5

Transformer

Dry type Class B Insulation	#32956
Oil Immersed Transformers	IN-T-103
Oil & Askarel Transformers	INT-100
Filtering & Testing Oil	IN-266
Instruction and Maintenance of 4.16 and 13.8 Metal-clad and 600 volt Metal-Enclosed Switchgear	IN-820.4
Instruction for Installation of Outdoor Switchgear	IN-820.3
Ground and Test Device	IN-822.0

600 V Air Circuit Breaker

FP-50-800/2000	IN-810.4
FP-25-600	IN-810.5
FP-100-3000	IN-810.6

MISC. SWITCHGEAR ACCESSORIES

RELAYS

Inverse Time Overcurrent	CDG	IB 5-050
Voltage Controlled Overcurrent	CDGV	IB 5-051
Directional Overcurrent	CDD	IB 6260
Overvoltage and Undervoltage	VDG	IB 6300
Power Directional	WDG	IB 6320
Generator Differential	DDG	IB 6350
Transformer Differential	DDT	IB 6360
DC Timing	VAT	IB 6400
Immediate, Single Shot Reclosing	VAR 11	IB 6420
Multi-Shot Reclosing	VAR 42	IB 6425
Instantaneous Overcurrent	CAG	IB 6450
Instantaneous Voltage and Current Auxiliary	CAA VAA	IB 6460

INSTRUMENTS

Type JA and JD Long Scale SWBD Instruments	IN-350.1

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