BASIC FUNDAMENTALS OF TESTING AND MAINTAINING BUILDING ELECTRICAL SWITCHGEAR AND ASSOCIATED EQUIPMENT

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1. GENERAL

1.01 This section covers general descriptions, terminology, and basic fundamentals of operating and maintaining building electrical switchgear equipment owned by Pacific Company (PAC) and installed on its premises.

Note: Because of the wide variety of makes, designs, and types of electrical equipment installed throughout the Company, this section is general in scope.

1.02 This section is reissued to update information relating to the switchgear coordinator.

1.03 This section covers both open and closed type main switchboards, load centers, and other means that may be used to distribute electrical energy within the PAC building. It includes switches, circuit breakers, fuses, fuse clips, lugs, bus bars, relays, automatic transfer switches, transformers, cables, incoming service cables, main power distribution cables, protective equipment associated with the emergency power plant, and other similar electrical equipment.

1.04 More detailed information on maintenance and operation of each type of electrical equipment is found in Section 171-199-901PT.

1.05 Maintenance of the telephone power distribution system is not included in this section. This will continue to be the responsibility of the central office (CO) personnel. The following (partial) list of sections refers to electrical equipment associated with telephone power distribution systems and should be used for references in connection with this section: 020-010-711, 026-305-701, 026-306-701, 026-307-701, 026-310-701, 026-315-701, 026-347-701, 030-740-701, and 030-785-701.

1.06 The Company bases its electrical preventive maintenance program and operations on the fact that sudden and accidental failures of equipment can be materially reduced in frequency and severity by giving proper recognition and attention to the following considerations:

- Ascertain that equipment is properly designed and constructed for the service in which it is being used.
- Make certain the object is properly installed in accordance with sound engineering principles and practices.
- Determine that the object is in good physical condition.
- Observe that it is being properly operated.
- Determine that it is receiving maintenance adequate to keep it in good physical condition.

1.07 Planned maintenance ensures optimum electrical equipment performance, safety to personnel, and service continuity by detecting unsatisfactory conditions which could cause extensive damage and long, costly outages, and by correcting them during scheduled periods when normal plant operation will permit.

2. SAFETY

2.01 *Working with electrical power and on the equipment used to distribute it can be dangerous.* All maintenance will be done on apparatus which has been de-energized from the commercial AC service. Where a temporary feed is required to keep vital circuits in continuous operation, provision shall be made to isolate these circuits from the equipment being routined.

2.02 It is recommended, due to the nature of this work, that PAC employees not become involved in the maintenance operations except to perform such switching operations as are necessary. However, it may not be possible to engage the services of a qualified electrical maintenance contractor (Part 4) to perform the work covered in Section 171-199-901PT, in which case it will be necessary to properly equip and train qualified PAC employees in this work operation. *All existing Bell System safety practices pertaining to working in and around electricity should be reviewed and carefully followed by all PAC employees doing this work.*

Note: The switchgear coordinator should review first aid and emergency procedures with all employees and/or contractor.

2.03 It is important that only one person (the switchgear coordinator) have the responsibility and authority to order the cutoff and restoral of electrical service. As a last check before restoring electrical power, a careful survey and inspection shall be made to ensure that no tools, equipment, loose hardware or other similar items have been left in the bus section or switchgear enclosure.

2.04 PAC employees shall never open or close any primary breakers or interrupter switches on the high voltage side of the supply transformer unless this equipment is owned by the Company. When a contractor is hired to perform the maintenance operation, it shall be his/her responsibility to coordinate this work with the local power company and the PAC representative. It shall be the responsibility of the contractor to provide adequate safety equipment and instructions to protect his employees.

3. SWITCHGEAR COORDINATOR

3.01 The building engineer electrical representative is the switchgear coordinator. He/she shall coordinate work activities of the local power company. The maintenance contractor, if used, and the various departmental representatives of PAC (including AT&T, Long Lines, and Western Electric Co. (WECo), where applicable).

3.02 The power maintenance engineer, with the assistance of representatives from the building engineering group, and the local central office (CO) supervisor/s shall determine all critical circuits such as those supplying television, radio, data, airlines, weather bureau, defense, government, CAMA C, cable pressurizing equipment and other special services. Arrangements will be made for temporary AC or DC electrical power to avoid interference with these services. The battery reserve for each CO supply will be furnished by the power maintenance engineer in order to set limits on the allowed time on battery operation when all normal AC service will be de-energized. When an inspection is to be made, it shall be coordinated well in advance with the supervisor in charge, so that special arrangements necessary to protect the various special services are provided.

3.03 An on-site meeting and inspection will be held well in advance of starting actual maintenance work. The building engineer switchgear coordinator, CO supervisor/s (for all departments involved), as well as the contractor, shall be present. An MOP shall be prepared and reviewed at this meeting. An up-to-date set of plans and specifications for the building electrical system shall be taken on this visit. This joint visit shall be made to determine site conditions, manufacturer's data required, coordinator study, access into building for equipment and personnel, date, starting and completion time. In this survey, any spare switches or breakers will be noted. At this visit the coordinator shall record, if possible, the serial number and shop number of each circuit breaker. This needs to be done only on the initial inspection and entered in the permanent logbook for further reference. If possible, the settings of the trip devices should be recorded.

3.04 The building engineer will furnish two (2) copies of the plans, specifications, and one-line diagrams that show a riser diagram, service feeders, size of distribution feeders, switches, breakers, and fuses. One copy shall be filed at the site, along with all appropriate manufacturers' data for each piece of electrical switchgear, at the time of inspection. Should each switch, relay, or breaker not be adequately labeled to designate its function,

arrangements shall be made at the time to do so. Nameplates and numbers should be nonmetallic (lamacoretype). Size of numbers and lettering should be uniform and attached with self-tapping screws. Also all switchboards should be taped to show the busing and transfer arrangements. The following colors of Scotch tape #471 are standard:

- Blue — All lighting
- Orange — Commercial and building power
- Red — Telephone power
- Yellow — Emergency alternator power

3.05 The supervisor in charge at each location shall keep (in a log book) all records prepared by the contractor after each visit. Entries in the log book shall be made by the contractor. Each entry shall state the date, time, work performed, parts replaced, nature of trouble and any other pertinent information, and shall be signed by the contractor or his/her representative. The switchgear coordinator and engineering representatives shall prepare in advance of the maintenance work a written log indicating the sequence of operations agreed upon by all personnel. This procedure should ensure that all special telephone circuits have been provided with temporary power, and a step-by-step method of performing each operation is written in proper sequence so that wasted motion will be eliminated. Where special BSP sections have been written to cover certain installations, these sections shall be followed.

4. ELECTRICAL MAINTENANCE CONTRACTOR

4.01 Due to the nature of this work, it is recommended that all work pertaining to the actual maintenance work be done on a contract basis, employing a qualified, competent electrical maintenance contractor. *Most PAC personnel are not aware of the dangers involved nor the damage that can be done to power equipment or telephone service by inexperienced personnel.* The following criteria should be used before an electrical contractor is considered qualified to do this work. The same equipment and training will be necessary for PAC personnel that might do this work.

4.02 The contractor shall be equipped with and furnish the following test equipment, all tools, manufacturers' maintenance data, labor, solvents and lubricants:

- DC insulation test set, for nondestructive cable testing
- Megger
- Heavy-duty industrial vacuum cleaner with adequate hose length, plus insulated suction nozzle and attachment (can be furnished by PAC when available)
- Necessary small hand tools, meters, safety equipment and other material required to complete work

4.03 The contractor shall be required to carry the necessary liability insurance required by law and also liability insurance in amounts to protect PAC against any damage that may result to telephone equipment as a result of negligence on the part of the contractor's personnel. This shall be in the amount as determined by local practice or the PAC Legal Department.

4.04 The contractor shall have a service engineer capable of preparing an electrical coordinating study for each switchgear installation when required by PAC.

4.05 The success of this maintenance procedure is entirely dependent upon the advance planning of the switchgear coordinator and the quality of the electrical maintenance contractor selected to perform this work.

5. CIRCUIT BREAKERS AND SWITCHES

Circuit Breakers

5.01 To have confidence in a protective device requires familiarity, and what better way is there to gain this than by periodic maintenance to prove its condition and to understand its operation.

5.02 There are a number of factors that can render a circuit breaker unfit for dependable service. Some of the more common faults are listed here in their approximate order of importance to the safety of the equipment it protects.

- Frozen contacts and/or mechanism (will not open automatically or manually)
- Improper calibration -- trip too fast or too slow
- High contact resistance
- Low leakage resistance --- terminals to mounting parts (ground)
- Broken or cracked arc chutes
- Excessive force required to operate manually

Note: These conditions can be initiated by a variety of causes, including moisture, corrosion, abuse, wear, and vibration.

5.03 Causes of malfunction of the circuit breaker are dependent upon time and severity of duty. Common causes of malfunction of circuit breakers generally fall into three (3) categories:

- Loss of oil or air seal due to physical damage to dashpot; aging of seals or physical wear, causing incorrect operation
- Clogging of parts (orifices) with foreign matter or oil sludge that forms due to atmospheric and environmental conditions and aging of oil
- Freezing of components in plunger assembly due to corrosive atmospheres and extensive periods of inoperation

Switches

5.04 Switches generally found in AC power switchgear systems are:

- Disconnecting switches for circuit isolation
- Transfer switches for changing power sources (automatic-manual)

Note: All switches are rated for current capacity and voltage

6. TRANSFORMERS, BUSWAYS, AND CABLES

6.01 Depending upon local conditions, the ownership of transformers and service entrance busways and cables will vary. Also, the degree and extent to which the local power company will perform preventative maintenance on this equipment will vary. At the outset of this maintenance program of our building electrical switchgear, it is advisable to contact the local power company and discuss the PAC practices covering the subject. Many local power companies will perform tests and routines on transformers, service entrance cables and other similar devices.

Note: Do not enter the vault until the atmosphere has been tested in accordance with Section 620-140-501.

6.02 Where the power company performs regular inspections and maintenance on the portion of the equipment owned by them, it is suggested that the power company's portion and the telephone equipment be tested and routined at the same time.

6.03 Where part of the equipment is owned by the power company and part is owned by PAC, and arrangements are made with the power company to inspect all of the equipment, the power company will bill PAC for the inspection and maintenance work on the part of the equipment owned by PAC.

6.04 **Transformers:** Transformer vaults should be maintained in a clean, dry, and well-ventilated condition at all times. Conduit runs entering or leaving equipment vaults should be sealed, using an approved duct seal or putty.

6.05 **Busways and Cables:** Dust is probably the greatest enemy of all electrical equipment, because the accumulation of dirt and dust affects the equipment's internal and external ventilation. This results in greater heating of parts with the resulting lowered efficiency and, therefore, progressively increased heating. At the same time, this shortens the life of the insulation because most insulating materials have a life expectancy which decreases rapidly when the temperature rises. Equipment insulation usually depreciates with age. Careful checks on the decrease of insulation resistance prevents many failures. A sudden drop in insulation resistance of any unit is indicative of developing trouble; this can frequently be forestalled by immediate corrective measures.

Note: Tests and routines for this equipment are covered in Section 171-199-901PT.

7. FUSES AND MOTOR PROTECTIVE DEVICES

Fuses

7.01 A fuse is defined by NEMA as "*an overcurrent protective device with a circuit opening fusible member directly heated and destroyed by the current passing through it.*" From this definition, it can be seen that a fuse is primarily responsive to current and does not selectively respond to any other system occurrence.

7.02 In the application of a fuse, it must be selected for voltage, current-carrying capacity, and interrupting capacity. Ambient temperatures and types of enclosures affect fuse performance and should not be overlooked. Fuses are available in a wide range of voltage, current and interrupting ratings, current-limiting, and noncurrent-limiting types, and for indoor/outdoor applications.

7.03 Current-limiting fuses are extremely fast in operation and blow in one-quarter cycle or less before the available short-circuit current reaches peak value. Non-current-limiting fuses may operate in one to two cycles. Caution should be taken in all cases when fuses have been blown and replacement is necessary. An improperly sized fuse is dangerous and could adversely affect service (see Section 026-3 layer for maintenance of this equipment).

Motor Protective Devices

7.04 For switching motors and other similar devices remotely or automatically controlled, the magnetic switch or contactor is used. Contactors for alternating current are usually three-pole.

7.05 Contactors are intended for repetitive operation and, therefore, need some maintenance to ensure continuous, uninterrupted service. The interrupting capacity of a contactor is of the order of 10 times its continuous current rating. No other means (such as fuses or breakers) are used for the short-circuit protection.

7.06 In alternating-current motor starters, contactors are generally used for controlling the circuits to the motor. The simplest starter is the across-the-line or full-voltage type, wherein a contactor is the main switching means. When the contactor closes, the motor starts with full voltage applied at once. Other forms of starters may involve more elaborate schemes.

7.07 Motor starters are equipped with overload relays. These relays may be magnetic or thermal type:

(a) If magnetic type:

- A dashpot allows the necessary time for the proper flow of starting current.
- A particular coil is required to adapt the relay for a given size motor.

(b) If thermal type:

- The time delay is inherent.
- Adaptation is accomplished by a heater of a particular size, corresponding to the motor.

Note: In many of our installations, single-phasing protection is provided by two (2) overload elements when used in conjunction with a three-pole circuit breaker.

7.08 A safety switch for motors is rated in horsepower and voltage. This switch is capable of interrupting the maximum operating overload current of a motor. The motor starter is available in standard sizes, rated in horsepower. A starter is adapted to a particular motor by proper choice of over-current relay. In order that circuit and motor may both have protection, the starter — with its overcurrent relays — is mounted in an enclosure which also contains a fused switch or a circuit breaker. In application of combination starters, it is essential that interrupting capacity of the circuit protective part of the combination be adequate.