

The Medical Center Company Electrical System Installation Requirements

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Revision History

Section	Description	Date
-	Original Issue	7/15/97

Metering	Added test switches and testing requirement	9/4/97
Feeder Systems	Deleted minimum feeder size	3/23/98

1. Introduction

1. This document describes the minimum acceptable requirements of the Medical Center Company for work performed on the electrical distribution system. The work is defined as new installations, repair of existing installations and modifications of existing installations.
2. In addition to these Requirements, all work shall conform to the latest editions of national, state and local codes and ordinances, the National Electrical Code - N.F.P.A. No. 70, and the National Electrical Safety Code - A.N.S.I. C2.

2. System Description

The Medical Center Company power distribution system consists of the following:

- a. An 11,400 volt nominal three phase, three wire, grounded wye system with ground fault current limiting resistors; Substations connected to this system are connected to two feeders via primary selector switches with momentary paralleling capabilities. Correct phase sequencing is essential for the normal operation of this system. Each feeder source to a service is energized at all times. It is normal, in this system, to have the load side of switches energized. USE CAUTION AT ALL TIMES.
- b. Two 2400 volt, three phase, three wire delta systems; Some substations connected to these systems are fed with two cables in a primary selective configuration and some are connected with a simple radial feeder.

Notes on Primary Selective or Loop Type Distribution Systems:

1. Two service entrance switches will be required with these systems.
2. A common bus may be required integral to service switchgear with, in some cases, momentary paralleling capability.

1. Approvals

1. Before fabrication of any of the following equipment, detailed shop drawings, cut sheet specifications, etc. shall be submitted to Medical Center Company for approval. A review will be conducted to determine that the material and

arrangement satisfies the minimum requirements. No equipment will be connected to the Medical Center Company System until these requirements are satisfied.

1. All feeder materials (above 600 Volt).
2. Medium voltage cable splice kits
3. Medium voltage switching equipment. Include cut sheets for all switches and circuit breakers
4. Transformers with medium voltage connections
5. All protective devices such as relays and fuses

1. For all equipment where a manufacturer or a manufacturer's designation is indicated, deviations from this recommendation must be specifically approved by the Medical Center Company.

1. Scheduling of Power Shutdowns and Power Transfers

1. All power shutdowns, transfers or connections shall be coordinated with Medical Center Company.
2. All shutdowns shall be scheduled at least 7 days in advance. All load transfers shall be scheduled 48 hours in advance.
3. The operation of high voltage (above 600 volts) switchgear shall be by Medical Center Company personnel only, except as noted in Section 12 "Testing", below.

2. Service Entrance

1. A service disconnecting means shall be provided for each incoming service feeder, and shall simultaneously disconnect all ungrounded conductors. The service disconnect shall be capable of being closed on a fault equal to or greater than the maximum available short circuit current in the supply circuit.
2. The service disconnecting means shall be located at the point of service to a building.
3. Service equipment shall be installed in a vault or shall consist of metal enclosed switchgear.
4. Spare fuses or fuse refills units shall be furnished with all fusible switchgear; minimum 3 units for each set of fuses in switchgear.
5. Service entrance switches must provide a visible break of all three phases. Provide a window allowing inspection of all three phases without having to open switchgear doors, etc. Where modular draw-out circuit breakers are provided, provide provisions for locking in the withdrawn position.

3. Feeder Systems

1. A ground conductor shall be furnished in all feeder runs for fault clearing, shield grounding, etc. Ground conductor shall be insulated and shall be installed in duct or conduit with feeder.
2. All cable types, cable splices, terminations, jackets, shielding, grounding, insulation, armor, etc. shall be fully compatible with existing systems. All feeders used on the 11,400 volt system shall have 133% insulation.
3. All terminations and splicing of high voltage cable shall be completed by properly trained, experienced personnel. Personnel must have completed an approved splicing course. Provide resumes indicating relevant experience and training to Medical Center Company for the person responsible for all cable handling operations, and for all

personnel performing splicing or terminating operations.

4. Cable shield shall be grounded at each splice or termination. Provide heavy-duty tinned copper braid for ground connection. Drain wire connections will not be acceptable due to the possibility of damage.
5. Phase Connecting and Paralleling - All feeders will be phase tested and parallel tested back to Medical Center Company main bus. When final test is completed, Medical Center Company main bus shall be re-insulated with bus cover, Raychem HV-BC or equivalent. The following phase sequences shall be observed when cables are connected to equipment:

1. Front view A - B - C left to right
2. Rear view A - B - C right to left
3. Top to bottom A - B - C
4. Front to rear A - B - C

1. Phase and feeder designation tags

1. Each feeder shall be marked with the MCCo feeder designation at each point where the feeder is accessible. This includes but is not limited to all manholes, pullboxes, and switchgear enclosures.
2. Each phase conductor shall be marked with its phase designation at each termination or splice.
3. At cable splices, tags will be applied on each cable that is included in the connection so that the phase and feeder designations cannot be confused while the feeder is disconnected.
4. Cable tags shall be non-metallic, with engraved block letters at least $\frac{3}{4}$ " tall. Tags shall be attached securely using non-metallic cable ties.
5. Cable tag colors shall be as follows:

1. Phase "A" - red with black letters
2. Phase "B" - white with black letters
3. Phase "C" - blue with black letters
4. Feeder designation - white with black letters

1. Feeder Splicing Procedure

The following is a typical installation procedure and is intended to indicate the steps necessary to safely commission a new feeder. These steps must be performed in coordination with Medical Center Company.

1. Disconnect all loads from cable to be modified.
2. Identify phase conductors.
3. De-energize cable and test for voltage. Medical Center Company will install safety grounds, lock out all voltage sources, and issue circuit clearance to Contractor.

4. Identify phase conductors at each point of connection using telephone equipment or other suitable means. Phase identification shall be traced back to Medical Center Company switchgear
 5. Perform cable "Pretest" if required.
 6. Cut into cable, identify phase conductors with telephone equipment from switchgear to manhole and from manhole to downstream point.
 7. Perform repair, splice, etc. Identify phase conductors at each repair, splice, etc. using telephone equipment and install cable tags.
 8. When all splices, terminations, etc. are complete, perform cable "Posttest" D.C. high potential test.
 9. If test results are acceptable, Medical Center Company will energize cable.
 10. All of the above procedures will be repeated for each feeder involved. All work will be completed on each individual feeder including acceptance tests, prior to beginning work on the next feeder.
 11. Confirm that primary selective feeders are in phase at each switch point test in conjunction with Medical Center Company personnel, using phase tester.
 12. When all of the above procedure is completed for all feeder sources connected to a common switchgear unit, a parallel feeder test shall be conducted. The contractor shall close all switches involved to verify paralleling ability. This test shall be conducted under the observation of Medical Center personnel. NOTE: This is the only instance that a switch above 600 volts may be operated by anyone other than Medical Center Company personnel.
1. All cables shall be terminated with an approved modular disconnectable splice in every manhole. Modular kits shall be compatible with Elastimold Bol-T kits used throughout the Medical Center Company system.
 2. Provide sufficient slack cable in each manhole so that splice can be remade two or more times..

1. Service Equipment Rooms

1. Rooms containing non-oil type transformers or other service equipment shall be effectively cut off from other parts of building by construction of not less than one hour fire resistance rating.
2. Rooms containing transformers or other service equipment containing oil shall be effectively cut off from other parts of building by construction of not less than three hour fire resistance rating and shall comply with all necessary construction requirements for the containment of oil, venting, etc. (refer to N.E.C. Articled 450 and 710-14).
3. All service equipment rooms shall be adequately sized to provide sufficient work space around all equipment. The plan drawings of equipment rooms shall be drawn to scale and all equipment shall be identified.
4. Piping and utilities foreign to the electrical equipment rooms shall not occupy or pass through the equipment room space. In certain cases where conditions are existing the above requirements may be waived if suitable sleeving or troughs are constructed to protect the electrical equipment from the utilities in case of pipe breakage or leaks. Piping for mechanical equipment used in the room shall be suitably protected.
5. All service equipment rooms shall be adequately ventilated to maintain a normal space temperature. Intake air to spaces containing indoor transformers and switchgear shall be filtered to promote cleanliness. Proper type of smoke and fire dampers shall be provided where required.

6. Equipment rooms shall be provided with emergency lighting to provide approximately 10 foot candles of lighting. Emergency generator power source is preferred.
7. Each equipment room shall be provided with a minimum of one (1) 120 volt 20 amp duplex receptacle connected to the emergency generating system. This receptacle shall be red in color.
8. Each equipment room shall be provided with a minimum of one (1) ionization type area smoke detector, and one (1) flame detector. Spacing shall be as recommended by the manufacturer. The detectors shall be connected to the building alarm systems and shall be supervised. A remote alarm lamp shall be located outside of the equipment room at the door or doors to indicate when a detector is in alarm.
9. High voltage signs shall be posted on all Service Equipment Rooms and rooms containing equipment operating at a voltage level above 600 volts.
10. All wiring below 600 volts shall be run with a green grounding conductor.

2. Switchgear and Transformers

1. All switchgear, etc. shall be installed on 4" concrete pads.
2. Switches, fuses, switchgear, etc. will be located with the proper electrical clearances for maintenance and egress. Equipment will not be located in positions that require personnel to reach over exposed live terminals to open a switch, replace a fuse, etc.
3. All mounting hardware for outdoor installations shall be type 316 stainless steel and shall be fastened with stainless steel bolts, nuts, washers, etc., type 316. Non-metallic materials may be used with prior approval.
4. Phase sequencing and paralleling check shall be conducted prior to performing replacement work.
5. The following basic requirements shall be observed for all transformer installations:
 1. Oil filled transformers shall be installed in a vault constructed per N.E.C. Article 450.
 2. Dry type, less-flammable liquid type, non-flammable fluid type, etc. transformers shall be installed in a (1) one hour minimum fire resistant room or greater when indicated in codes or standards.
 3. Individual primary overcurrent protection shall be provided for each transformer installed. The primary overcurrent protection shall be sized to conform with the latest "ANSI point" criteria for through fault protection.
 4. Individual primary disconnect switch shall be provided for each transformer.
 5. All transformers shall be installed properly on 4" concrete pads, shimmed, leveled, anchored and properly grounded. Grounding of case enclosure, grounded conductor, etc. all in accordance with codes, ordinances and manufacturer's instructions. Oil drain shall be unobstructed and readily available.
 6. Foreign piping and utilities SHALL NOT enter or pass through transformer rooms or vaults.
1. All test results shall be included in a written report on the condition of the equipment. The report shall utilize Medical Center Company printed forms.
2. Phase sequencing and paralleling check shall be conducted prior to performing replacement work.
3. Air break isolating switches shall be provided on the supply side of any of the following.

1. Oil switches.
2. Air or oil circuit breakers.
3. Exceptions - as listed in N.E.C. 230-204.

1. Oil-filled switching equipment, capacitors, etc. shall be installed in a vault constructed per N.E.C. Article 450.
2. Distribution cutouts and fuse links of the expulsion type SHALL NOT BE USED INDOORS, Per N.E.C. Articles 710-21c.

1. Metering

1. Watt-hour meters shall be installed on each transformer with a primary voltage above 600 volts.
2. Watt-hour meters shall be installed on each service (regardless of voltage) which is used to transmit power from one corporate member to another corporate member of the MCCO system.
3. Watt-hour meters shall be installed on each separate feeder within a corporate member's system that requires a separate billing
4. Watt-hour meters shall be installed in other special cases as determined by the MCCO during a review of the proposed electrical system.
5. Where one transformer feeds more than one corporate member there shall be one watt-hour meter for the transformer plus one meter for each corporate member fed by the transformer, for a minimum of three meters.
6. Each watt-hour meter shall be a Westinghouse IQ DATA PLUS II, or equivalent and shall include a PONI card, or equivalent. If an alternate meter is used, it must be completely compatible with MCC's SCADA system and must be approved by The Medical Center Company. The Engineer shall specify all metering related equipment including the type of meter power modules, CTs and PTs, and CT and PT ratios. The programming of the meter and related equipment shall be specified by Medical Center Company.
7. Watt-hour meters will be required for any new installation, renovation to an existing service, repairs or replacement of an existing service.
8. Watt-hour meters shall be mounted a minimum of 4'-0" to a maximum of 5'-6" from the finished floor to the centerline of the meter face.
9. Meters shall be connected to allow on-line testing of connections. Meter potential connections shall be made using individual knife switches and shall be fused. Current transformer connections shall be made using individual shorting switches and test jacks to allow current measurements to be made with the meter in or out of the circuit. Turn over appropriate test tool to the Medical Center Company. Meter Devices or equivalent.
10. Meter connections shall be verified prior to acceptance by the Medical Center Company to confirm that each current and voltage input has been made properly.

2. Manhole Construction

1. All manholes shall be constructed of steel reinforced concrete, designed to support loads greater than or equal to ODOT H-20 wheel loading. Excavation and backfill shall be controlled to prevent settlement after installation.
2. The entrance to the manhole shall be covered with a suitable frame and solid cover certified to support loads

greater than or equal to ODOT H-20 wheel loading. The cover shall have a roughened surface suitable for vehicle and pedestrian traffic, and the lettering "MCCo" cast into the top. The minimum entrance size shall be 25" X 29" clear. The frame shall be frost proof and furnished with grounding provisions. Where due to its shape or weight the outer cover may fall into the manhole, an inner cover shall be provided. The top cover shall be self sealing with flush stainless steel handles. The inner lid shall be constructed of linear low density polyethylene or approved equivalent and be capable of supporting the top cover. All covers shall be installed flush with surrounding area and shall not be covered by pavement or landscaping.

3. The interior of the manhole shall be sized a minimum of 8' -0" from the floor to ceiling and shall be a minimum of 8' - 0" in length or width, or minimum of 8' - 0" from any opposite face when octagon or other geometric configurations are used. Each installation shall be capable of accommodating the bending radius of a 3/c - 500 Kcmil, 15KV shielded cable (approximately 42" inside radius).
4. Each manhole interior will be equipped with a dry sump located at the lowest point of the manhole (nominal 18 inches deep, 12 inches in diameter), with a non-metallic sump cover. The following cable accessories shall be provided:
 1. Non-metallic cable supports.
 2. Copper ground bus or busses, sized to accommodate one ground (minimum) per duct entering manhole, plus whatever grounds are needed in manhole. Ground bar shall be mounted to wall with two (2) stand off supports. Locate ground bus at 6'-0" above floor. All cable ground conductors, metal cable supports, ladders, shields, cover frame, etc. shall be grounded to ground bus. All ground connections to fixed equipment shall be made using an exothermic welding process.
 3. 3/4" x 10' copper clad driven ground rod located below the manhole connected to ground bus using a No. 4/0 copper ground cable.
 4. Pulling irons located in each side wall and the floor of manhole.
 5. All manhole steel accessories shall be type 316 stainless steel and shall be fastened with stainless steel bolts, nuts, washers, etc., type 316.

1. Duct Bank Systems

1. Ducts shall be PVC, 5" trade size minimum, with cemented joints.
2. Ducts shall be spaced a minimum of 3" apart and shall be covered with a minimum of 3" of concrete on the outside. Provide fiberglass spacers to maintain duct separation.
3. Concrete shall be compatible with duct material.
4. Concrete shall be red in color. Red dye shall be thoroughly mixed throughout the concrete. Dye placed on top of or raked or troweled into top of concrete will not be acceptable.
5. Provide end bells at end of duct bank (that is, at connection to building or manhole).
6. Concrete shall be vibrated during installation to prevent voids.
7. All trenching and backfill shall be specified to prevent settling after installation.

8. All duct banks shall be designed with 100% spare capacity as a minimum. (Special conditions may require that this requirement be increased due to known future plans.) All spare ducts shall be capped with standard plugs.
9. All ducts shall be sealed upon entering any building, vault, etc.
10. Provide a minimum of 24 inches of clearance between roof of the manhole and the centerline of the highest duct. Provide a minimum of 30 inches clearance between the floor of the manhole and the centerline of the lowest duct. A pulling iron shall be located in the wall opposite duct bank entry wall.
11. All duct banks shall be installed a minimum of 30 inches below final finished grade to top of concrete envelope.
12. Provide a mylar warning tape above the duct bank within twelve inches of grade. The plastic tape shall be bright yellow or red in color and imprinted with the words "Caution, High Voltage Electric Line Below." Three tapes shall be placed above the duct bank, one on each side and one in the middle.
13. Provide sufficient manhole cable rack inserts for present and future needs as required by duct bank configurations.
14. Where new duct banks enter existing manholes, buildings, etc., all points of penetration shall be through a window large enough to encompass all ducts entering. Entering ducts shall be finished flush with the interior wall of the installation and duct bank shall be pinned to the existing structure using minimum of (4) No. 6 rebar dowels.

2. Testing

1. All test results shall be included in a written report on the condition of the equipment. The report shall utilize Medical Center Company printed forms.
2. All testing shall be performed by a third party testing organization approved by Medical Center Company before acceptance.
3. These test procedures shall not be conducted until a witness of the Medical Center Company is present.
4. Testing shall be performed on site. Manufacturer's tests will not be accepted.
5. Switchgear Tests
 1. Acceptance tests for switchgear shall include but not be limited to the following:
 1. Visual inspection
 2. Mechanical inspection
 3. Insulation resistance
 4. Contact resistance
 5. D.C. hi-potential test
 6. Ground system resistance
1. Transformer tests
 1. Acceptance test shall include but not necessarily be limited to the following.
 1. Visual inspection
 2. Power factor
 3. Turns ratio and polarity test

4. Insulation resistance
5. Insulating fluid analysis
6. D.C. hi-pot test
7. Accessory equipment tests

1. Cable Testing

1. If existing feeder systems are permanently modified, a cable "Pretest" and a cable "Posttest" shall be conducted on each feeder system.
2. If the source of power is an existing substation or switchgear, and the entire cable run is new, a cable acceptance test shall be conducted on the new cable after it is installed. The contractor may elect to test all new cable prior to installation as a precaution to insure that the cable will meet specifications.
3. Cable Testing (New Cable)
 1. All wire and cable for circuits in excess of 600 volts consisting of new cable only, shall be D.C. hi-potential tested after stress cones have been installed but before connection to line or load devices. The test will consist of raising the applied D.C. voltage in equal steps and shall reach the final test voltage in not less than eight (8) steps.
 2. Each step voltage level shall be maintained until the leakage current has stabilized, or a minimum of one (1) minute. Voltage and current readings shall be recorded and plotted on graph paper after the current has stabilized. Tests shall be performed on each phase separately.
 3. After the final test voltage has been reached, a dielectric absorption test will be performed at the final test voltage level by maintaining voltage for ten (10) minutes and recording the diminishing leakage current after each minute.
 4. At the completion of the test, gradually decrease the voltage to zero. When the test set voltmeter indicates zero volts, place a ground wire on the cable. This ground shall be left in place for 30 minutes or the test duration, whichever is longer.
 5. The final test voltage shall meet, but not exceed, the IPCEA specifications applicable to type, size and voltage rating of the cable, or 80 percent of factory test, whichever is less.

1. Cables shall be phase tested for parallel operation.

1. Parallel feeder test as defined previously shall be performed by the Contractor and witnessed by the Medical Center Company staff prior to acceptance or use.

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