

Part 1: Electrical Requirements



180) Station Grounding

180.10) General

180.10.10) All substation grounding shall comply with the Wisconsin and Michigan State Electrical Codes and applicable local ordinances. The goal of a substation grounding system design is for the preservation of human life and the protection of equipment through the control of local potential.

180.10.20) This defines the minimum Company requirements for a grounding system; however it is not a design guide. The customer is responsible for the complete design. The following requirements are regarded by We Energies as minimum standards that must be met before We Energies personnel will enter and operate a customer substation, but do not in themselves guarantee that the design is adequate. A Company representative may add to the requirements and recommendations according to site conditions.

180.10.30) The size of the ground conductor shall be appropriate for the magnitude of the available fault current, the operating time of protective devices, and for sufficient mechanical ruggedness. The minimum conductor size for the ground grid and connections to the grid, ground rod and equipment cases shall be #1/0 copper.

180.20) Indoor Substations

180.20.10) Basement Level Substations

a) A 1/4" x 1-1/2" aluminum bar or equivalent copper bar shall be installed along all inside walls of the vault to form a closed loop. In damp areas copper bar shall be utilized.

b) Five-eighths (5/8) inch diameter copperweld ground rods shall be driven at all vault corners and approximately equally spaced along vault walls. Single 8-foot long rods at each rod location are adequate. Install as many ground rods as space permits, maintaining 6-foot typical separation between rods. Do not locate ground rods under doorways or in any other position where they will be hazardous to people walking in the vault. All ground rods are to be connected to the ground bus.

180.20.20) Above Basement Level

a) A 1/4" x 1-1/2" aluminum bar or equivalent copper bar shall be installed along all inside walls to form a closed loop. In damp areas copper bar should be utilized.

b) The ground bar referred to in 180.20.20.a) shall be bonded to building steel in at least four places. The frames of all major equipment shall be bonded to building steel.

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180.30) Outdoor Substations

180.30.10) A grid is required under the entire area substation, consisting of bare–stranded copper cable buried 18 to 24 inches below the soil rough grade . The grid conductors shall be placed 15 feet apart or less depending on soil resistivity. In areas in which We Energies suspects high–resistivity soil, such a quarry, step and touch potential calculations shall be provided with the approval drawings per IEEE 80. A 4–ft by 2 ft grounding mesh is an acceptable supplement to the grid in the absence of these calculations. When required, the supplemental mesh must be installed on top of the rough grade, just under the crushed stone layer. Within the grid, cables connecting ground rods should be laid in parallel lines and uniformly spaced. They should be located, where practical, along rows of structures or equipment to facilitate the making of ground connections. These rows are to be interconnected at various points including the peripheral cable to form a grid. Interconnecting conductor size should not be less than that of the ground bus or grid.

180.30.20) Five–eighths (5/8) inch diameter copperweld ground rods shall be driven to a depth of 8 feet or more at all ground grid corners and approximately equally spaced along the grid perimeter. All ground rods are to be connected to the grid conductors.

180.30.30) A layer of gravel or crushed stone (minimum 6 inches in depth) shall be placed over the entire grid to establish the finished grade.

180.30.40) A buried ground conductor shall encircle all switchgear and transformers within 18 inches of the edge of the equipment enclosure, at a burial depth of at least 18 inches but less than 24 inches.

180.40) Equipment and Structures – Indoor and Outdoor Stations

All noncurrent–carrying metallic parts which might accidentally become energized or statically charged (such as switchgear enclosures, metal structures, building steel, transformer tanks, metal railings, housings, and guards, oil circuit breaker tanks and circuit neutrals) shall be connected to the grid or ground bus in a minimum of two locations by conductors of adequate capacity and mechanical ruggedness. The grid or ground bus should also be connected to any metallic water pipe, metallic drain or sewer pipe located in the station area. Connection shall be made at two points on the pipe at least 20 feet apart and shall consist of a conductor not less than the size of the ground bus.

180.50) Substation Fences

The metal fence surrounding an outdoor open–type substation shall be grounded in accordance with all applicable electrical codes. Of primary concern in the design of a fence grounding system is the reduction of potentials which could prove hazardous to persons within the fence enclosure or approaching from outside.

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180.50.10) Fence Ground Interconnected With Station Ground Grid

- a) Consideration shall be given to interconnecting the station ground grid with the fence grounds at frequent intervals.
- b) The station ground grid shall be extended 2 feet beyond the substation fence. All corner and gate posts, as well as fence posts shall be connected to the grid.
- c) All metallic fence parts that might accidentally become energized or statically charged must be metallically connected together. At each entrance gate a buried ground conductor loop connected at each end to the perimeter fence ground conductor shall be placed so as to form a rectangle which encompasses an area extending at least 18 inches beyond the gate swing.

180.50.20) Fence Ground Isolated From Station Ground Grid

- a) If the Customer elects to isolate the fence ground system from the station ground grid, a potential difference may be present between the station equipment and the fence during fault conditions.
- b) Under this condition, a minimum separation of 6 feet shall be maintained between the fence and the nearest station ground conductor, grounded equipment, or structure.

180.60) Property Fence

180.60.10) These requirements are in addition to grounding requirements for substation fences (Item F above). Where a metallic property fence is attached to, or passes within 6 feet of a substation fence, it becomes an extension of the substation fence and must be treated accordingly.

180.60.20) Metal property fences installed on the Customer's property shall be grounded to ground rods installed one foot inside the fence at corner posts, gate posts, and at posts on each side of an overhead transmission or distribution line crossing. No connection with the substation ground system is necessary where a minimum separation of 6 feet is maintained between the substation fence and metallic property fence. A buried conductor connecting gateposts is recommended. Fence isolation sections may be utilized to electrically isolate extended sections of property fence from the substation.

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180.70) Outdoor Group–Operated Switches

In outdoor stations utilizing load break switches mounted on wood poles or metal structure, a three–foot by four–foot metallic grating shall be installed on the surface where a person stands when operating the switch. This section of grating shall be connected to the ground grid and the switch operating linkage as close as is practical to the handle. A minimum of #1/0 Cu conductor shall be used for this connection.