WTC Primary and Emergency Electrical Power

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Pages 14-18

Primary Electrical System

Consolidated Edison provides 13.8KV electricity to all of the World Trade Center buildings except for the Vista Hotel through a ground level substation located near the Barclay Street (north) entrance/exit to the underground parking garage. Prior to the fire, the peak load provided by the substation servicing the complex was 84 megawatts for all buildings (except the Vista Hotel), the Concourse level, all basement levels and the refrigeration plant. Eight sets of service conductors carry this load from the substation to the complex. Overcurrent relays that disconnect the service conductors are provided at the substation.

Service conductors entering the complex are routed through a concrete encased duct bank which is located below an entrance/exit ramp for the B1 level. Once inside the complex, the duct bank makes a vertical transition from below the entrance/exit ramp to the B1 level ceiling. Still enclosed in concrete, the ceiling-level duct bank enters the service equipment vault, called the primary distribution center (PDC). Once inside the PDC, the service conductors drop into eight switchboards which are grouped into pairs and are separated by gypsum wallboard partitions. Electrical power from the PDC is provided to Towers 1 and 2, Buildings 4 and 5, the Customs House, the Concourse level, and to all basement levels (see Figure 5) by several electrical feeders. These feeders are protected by 1200-ampere circuit breakers with protective relays to disconnect the power when a fault occurs. The feeders for Building 7 are tapped off of the Building 4 feeders; therefore, the substation relays protecting Building 4 also protect the feeders for Building 7.

The PDC-supplied electrical systems are designed so that electrical power to each building served is provided through more than one feeder. The substations for buildings in the complex are designed such that full electrical service will not be interrupted in any building even with the loss of two 13.8-volt electrical service conductors. Though some electrical feeders are routed differently, most are routed in the ceiling/floor assembly between the B1 and B2 levels. As a result of this type of installation, the feeders are encased in concrete over the distance to their respective substations throughout the complex.

For electrical design purposes, Towers 1 and 2 have been subdivided into two vertical sections, i.e., Tower 1 — north and south sides; Tower 2 — east and west sides. Each vertical section is supplied by four electrical substations; one substation in each of the mechanical equipment rooms (MER) on the 7th, 41st, 75th, and 108th floors. Thus, Tower 1 and Tower 2 each have a total of eight electrical substations.

The arrangement of substation equipment is the same in both towers; that is, each substation has four air-cooled transformers. The transformers are rated as 1500KVA, 3 phase, 13.8KV-480/277 volt. Each is provided with a 600-ampere, 15-KV primary, no-load disconnect switch on the primary side and a 2500-ampere circuit breaker on the secondary side.

Four feeders from the PDC supply electricity to each vertical section of the tower. Each feeder supplies electricity to one transformer in each substation within a vertical section. For example, Feeder A1 supplies electricity to one transformer in each substation for the north side of Tower 1.

Similarly, Feeder A2 provides electricity to another transformer in the substations on the north side of Tower 1. According to this design scheme, each feeder will supply four transformers.

The main difference in electrical design between the towers is that Tower 2 has two additional feeders. These feeders supply a substation on the 43rd floor. The transformers in this substation are dedicated and provide power to a tenant area.

Emergency Electrical Systems

All buildings in the complex have numerous emergency systems requiring electrical power. These systems include, but are not limited to, emergency lighting in all exit stairways and corridors, public address systems, fire detection and alarm systems, fire pumps, at least one elevator in each elevator bank, fire fighter telephones in the stairways, the communications transmission equipment installed on the antenna on Tower 1, and normal telephone systems.

Many sources of electrical power have been provided for the emergency systems. The primary power supply for emergency systems in the complex is the normal electrical power provided by Consolidated Edison, and this power supply is backed up by several emergency generators located in different areas throughout the complex. Emergency generators installed in the Vista Hotel provide power to the emergency circuits in that building only. Similarly, emergency generators installed in Building 7 provide electrical power to emergency circuits in that building only. New York Telephone provides separate emergency generators dedicated to the normal telephone equipment, telecommunication circuits throughout the complex, and telephone switching equipment for the Manhattan exchange. To ensure that there is no interruption of telephone service during emergencies, New York Telephone also provides batteries to maintain electrical power in the event that the emergency generators fail.

The backup power supply for emergency circuits in Towers 1 and 2, Buildings 4 and 5, the Customs House, the Concourse level, and all basements levels is six emergency generators located on the B6 level of the complex. The specification data for each generator are 1250KVA, 480/277 volts, 4-wire, wye connected, 1504 amperes, 1200KW continuous-duty rated. When the transfer switch senses a drop in voltage to a predetermined level, the emergency generator system will activate all six generators even though only four are necessary to carry the design load for the complex's emergency systems. The generators are automatically synchronized to operate in parallel ready to deliver 5000KVA of energy to emergency loads. The six generators have been configured so that all of the complex's emergency electrical demands can be met even if one generator is out of service for maintenance and another generator simultaneously fails to start.

The diesel engine drivers for the emergency generators are water cooled. Water tapped from the building's domestic water supply is circulated through heat exchangers which remove heat from the coolant circulating in the operating engines. Manually operated valves have been provided so that cooling water can be tapped from a system that brings Hudson River water into the complex for other purposes. After passing through the heat exchanger, the domestic water is discharged into a drain, and the Hudson River water is returned to the river.

In addition to the emergency generator backup, Towers 1 and 2 have been provided with an "alternate electrical system" which provides electrical power to some emergency systems. As indicated earlier, Tower 1 and Tower 2 are divided into two vertical electrical zones. Power is provided to areas in these zones by separate feeders. In the event that normal electrical power is interrupted to an area, switching gear will reroute normal electrical power from an unaffected vertical zone to the areas affected by the power outage. (See Figure 6.) The alternate electrical system will provide power to circuits for emergency lighting, fire detection systems, public address systems, fire alarm systems, fire suppression systems supervisory equipment, and communication systems. The alternate electrical system does not provide electrical power to elevator or fire pump motors. Electrical power for these high- load motors is provided by the normal electrical system or by the emergency generators.

Emergency Systems Power Upgrade, 1996-2001

"Towering Security" by Amy Florence Fischbach CEE News, Jan 1, 2001

..."The Trade Center was never designed for the amount of emergency power necessary for all

those trading floors they have there," Calabro said. "Tenants would come in and need emergency power, and it was not available."

To solve that problem, E-J Electric set four generators on the roof of Tower 5, which was nine stories, as opposed to the 110-story Towers 1 and 2. E-J then ran high-voltage feeder cable to Towers 1, 2, 4 and 5, installed three substations and distributed power to the tenants.

"We pulled 6,000 feet of high-voltage feeder cable from the roof of Tower 5, through the building, down through the concourse, through the parking garages and to the roof of Tower 1 and 2," Calabro said.

Calabro said E-J is fortunate to have a maintenance contract along with some other jobs for the World Trade Center.

"Security was the original contract that got us in the building and then we were fortunate enough to get these other jobs," Calabro said. "The generator job is up to about $6.5 million right now."

...Current standard tenant power capacity is 6W up to 10W per usable square foot depending on location. The World Trade Center's electricity supply is segmented for greater reliability and safety. Eight dedicated 13,800-V feeders divide into 23 building substations. [Note: this may refer to the whole complex. Above info indicates 8 substations total between the two towers.] On-floor electrical distribution is routed via at least two electrical closets per floor, each with separate high- and low-voltage bus ducts for tenant-dedicated use.

Four generators on the roof of 5 World Trade Center (8,800 kW capacity) provide standby power to tenants throughout the complex.

WTC 7

The Con Edison substation beneath WTC 7 and power to WTC 7 are discussed in depth in the NIST June, 2004 interim report. A summary of WTC 7 power distribution:

- 13,800 V from Con Edison substation below WTC 7
- Two 277/480 V stepdown transformers on each end of the building core on 3rd floor.
- Risers supplied 2 W/sq. ft for lighting and 2 W/sq. ft for floor power to each tenant
- Power to each floor provided by local 120/208 V, three-phase transformers

Source: NCSTAR 1-4B Fire Suppression Systems p. 68 & 80 (pdf p. 120 & 132)

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