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Design Requirements Manual
The formulae for building state of the art biomedical research facilities.
'Design Requirements Manual (DRM) News to Use' is a monthly ORF publication featuring salient technical information that should be applied to the design of NIH biomedical research laboratories and animal facilities. NIH Project Officers, A/E's and other consultants to the NIH, who develop intramural, extramural and American Recovery and Reinvestment Act (ARRA) projects will benefit from 'News to Use'. **Please address questions or comments to:** shawm@mail.nih.gov

Spot Network System

Spot network systems are used in areas of high electrical load density such as metropolitan and suburban business districts because they provide increased distribution reliability where power interruptions can have serious consequences to public and personal safety by assuring electrical service continuity. The term "spot network" refers to any set (two or more) of network protectors and transformers which supply power to one specific location or spot through a common bus. A power interruption can only occur when there is a simultaneous failure off all primary feeders or when a fault occurs on the secondary bus. There are no momentary interruptions caused by the operation of the transfer switches that occur on this type of primary selective system. Spot network systems are employed in many of the buildings in National Institutes of Health (NIH) campus at Bethesda, Maryland. Spot network systems are expensive because of the extra cost of the network protectors, specialized switchgear, and duplication of transformer capacity.

The typical secondary spot network distribution system consists of multiple medium voltage feeders fed from one common substation that terminate in the subject building at individual primary isolation switches typically integral to each network transformer. The primary isolation switches then feed to network distribution transformers that convert the medium voltage distribution voltage to the local building's utilization voltage level. The network transformer impedances are required to be selected so that the maximum thru-fault rating does not exceed the interrupting rating of the network protector and should be as close as manufacturing tolerances permit to reduce circulating current.

Network transformers are sized to be able to carry the full building load with some spare capacity for future load growth, with the ability to fully remove one transformer completely from active service indefinitely. This is defined as an N+1 redundancy and this scheme is deployed in spot network in NIH campus at Bethesda. One negative feature of this configuration under normal operating conditions is that the transformers are typically lightly loaded, operating in a range where they are less efficient than if they were more closely loaded to their nameplate ratings.

The key element of secondary spot network systems is the utilization of network protectors to permit multiple primary feeders to be connected simultaneously in parallel to provide power to a common low-voltage bus. The network protector typically consists of a special air power breaker, a breaker operating mechanism, network relays, control equipment and fusing to provide back-up protection for clearing faults on the primary feeder in the unlikely event the network protector fails to operate normally. The specialized network relays continually monitor the voltage across the open breaker contacts and current through the closed breaker contacts. In the event of a fault on a primary electrical distribution system cable or transformer, the network protector opens due to reverse power flow, thus isolating the fault from the network bus and avoiding load power disturbances. The network protector will automatically reclose its contacts if the power flow is back into the network, when in the automatic mode. The network protector will trip, in the absence of a primary feeder failure, when the substation breaker is opened. The network relay must be sensitive enough to sense the reverse magnetizing current of its associated transformer primary windings. The connected load to the common bus never experiences an outage or even a serious voltage dip, due to the fact that the common bus is continuously supplied from alternate feeders.

The load sides of the network protectors are then connected to the respective main circuit breakers in specialized service switchgear for use with spot networks, typically using copper busduct, with busduct lengths sized within 10% to minimize impedance differences.

The service switchgear is sectionalized using tie circuit breakers between the individual bus sections based on the number of transformers utilized to limit the extent of outages in the event of any downstream electrical fault. The switchgear is the source for the individual electrical feeder distribution for the major loads within a building.

The specialized switchgear is required to be provided with a typical ground bus, an insulated ground bus (also referred to as a ground return neutral bus), individual sectionalized neutral busses and typical sectionalized phase bussing connected with normally closed tie circuit breakers between each switchgear section. The insulated ground bus has only one point of connection to the grounding conductor. The transformer neutrals are brought into the switchgear and grounded at one, and only one location. This scheme permits selective tripping of the tie circuit breaker(s) to sectionalize the phase bussing, and then the corresponding network protector.

The expected available fault currents of spot network systems are inherently high. The use of current limiting fuses may be necessary to reduce available fault currents to manageable levels.

The protective device settings goal is to provide both continuity of service and protection to allow the closest device near a fault to clear before other upstream devices trip. Faults in a spot network system have more than one source, with a normally closed tie circuit breaker. It is very important that the network protector relay setting be slower than the tie circuit breaker to allow for isolation of switchgear faults between one side of the tie circuit breaker and the load side of a network protector without taking the whole network down. The tie circuit breaker thus clears one transformer's fault contribution, while the non-faulted side remains energized, then the network protector experiencing the remaining fault current will trip open, thereby isolating one section of the network bus for subsequent repair. Transformer secondary winding faults may open both the tie circuit breaker and a network protector, depending upon the magnitude of the secondary fault event.

The network protector should open first taking six to seven cycles to operate upon any value of reverse power. The ground fault relays for the tie circuit breakers and network protectors are set slightly higher in pickup and longer in time than the ground fault for the feeder devices. Network protector and tie circuit breakers usually are set at the same levels. Ground fault current originating from switchgear or incoming cable faults is directly seen by the ground fault relays on the tie circuit breaker. Subsequently, the ground fault relays on the faulted network protector circuit open, isolating the fault completely. Downstream ground faults are cleared by downstream circuit devices or the feeder circuit breaker serving the faulted circuit.

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