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8 Electrical Power Systems

8.1 Normal Electrical Power Systems

8.1.1 Design Basis

The Electrical Distribution System is designed to supply all of the electrical power necessary to operate the NBSR during both normal and shutdown conditions. This includes all of the experiments, offices and other support spaces associated with the reactor. Electrical power is supplied to the NBSR by three independent, underground, 13.8kV primary feeders. Each primary feeder is connected to a separate 13.8kV/480V distribution transformer. The secondary of each transformer provides power to one of three specific sections of the main 480V switchgear buss (SSA, SSB and SSC). Other major components of the electrical distribution system include two Emergency Diesel Generators, a station battery, two un-interruptible power supplies (UPS), transformers, and associated distribution equipment. The redundancy of vital loads and the protective scheme of the breakers in the Electrical Distribution System prevent any single equipment failure from causing a total loss of power for the entire building. As described below, the electrical distribution system consists of three major sub-systems: the Facility (or Building Services) Distribution System, the Reactor Distribution System and the Emergency Distribution System.

8.1.2 System Description

8.1.2.1 High Voltage Input

Three independent 13.8 kV feeders supply the NBSR Electrical Distribution System from the NIST substation located near Gate D. The three underground feeders (FA-1, FB-1 and FC-1) enter Building 235 in the High Voltage Cage (Room A-02), located in the basement of the A-Wing. Each 13.8 kV line is connected to a load interrupter switch rated at 15 kV and 600 amperes. Each interrupter switch supplies a 2000 kVA oil cooled stepdown transformer rated at 13.8 kV - 480/277 V. The transformers are connected in a delta-wye configuration. A network protector and network disconnect switch are mounted on the load side of each transformer. The three network protectors supply the low voltage (480 V) input switchgear. The input switchgear supplies the various Motor Control Centers (MCCs), power panels and other loads through individual feeder breakers. The transformers, interrupter switches, network protectors and 480V switchgear are located outside confinement in the basement of the A-Wing (Room A02, El. 412’-0”).

8.1.2.1.1 Input Switchgear Busing Arrangement

The 480V input switchgear is arranged in a linear configuration and is divided into three sections, designated Bus A (SSA), B (SSB) and C (SSC). While each section can be separately powered from its associated input transformer, the three sections are normally cross-connected via electrically operated tie-breakers in a closed “delta” configuration. This results in the total

load being evenly split between the three input feeds. This arrangement also provides the capability to supply all of the loads within the facility from any one of the three input feeds.

A simplified diagram of the High Voltage Input Switchgear bussing arrangement is shown in Figure 8-1.

8.1.2.1.2 Loads Supplied from Each Bus

Switchgear Section SSA (Bus A) and Section SSB (Bus B) of the 480V input switchgear supply the loads associated with the reactor, experiments, and the offices and support spaces located in the A- and B-wings. Vital equipment necessary for both normal operation and safe shutdown of the reactor is duplicated. The redundant equipment is separately powered from either SSA or SSB. Equipment supplied by the Reactor MCC A-3 and the Pump Room MCC A-7 fed from SSA are duplicated by equipment supplied by the Reactor MCC B-4 and the Pump Room MCC B-8 fed from SSB. Loads supplied by Power & Lighting Distribution Panel "D" fed from SSA are duplicated by loads supplied by Power & Lighting Distribution Panel "E" fed from SSB. The NC-5 Spin Echo experimental magnet is supplied from SSA while the lighting and power panels in the Guide Hall are supplied form SSB. One additional load on the SSB Switchgear is the Non-Magnetic Facilities Building, Bldg. 237, located immediately to the west of the Building 235. Table 8-1A lists all of the loads on Switchgear SSA while Table 8-1B lists all of the loads on Switchgear SSB.

Switchgear section SSC (Section C) supplies the loads associated with the E-Wing offices and support spaces, the Guide Hall, the Compressor Building, and the South End Addition offices. It also supplies the Experimental UPS located in Room E-02 of the E-Wing basement. This UPS supplies all of the regulated power used by the experiments in both the Confinement Building and the Guide Hall. Table 8-1C lists all of the loads on Switchgear section SSC.

All of the equipment (input transformers, network protectors and disconnect switches, input switchgear and associated busways) located in the high voltage cage (Room A-02) was replaced in the fall of 2001. The new equipment met the requirements of the ANSI, NEMA and UL codes applicable at the time of manufacture and the requirements of the National Electrical Code (NEC) and local building codes applicable at the time of installation.

8.1.2.2 Facility Distribution System

The Facility Distribution System provides power to the offices and support spaces in the A-, B- and E-Wings of the building as well as to the Guide Hall. The portions of the electrical distribution system supplying the A- and B-Wings as well as the Confinement Building were installed when the reactor was first built in 1966. The portions that supply power to the E-Wing and Guide Hall were installed in 1988. And the portions that supply power to the South Wing Addition were installed in 1999. All equipment met the requirements of applicable ANSI, NEMA and UL codes at the time of manufacture and the applicable requirements of the National Electrical Code (NEC) and local building codes at the time of installation.

Switchgear section SSA feeds Building Service MCC A-1 through feeder breaker 3C. MCC A-1 is located in the A-Wing basement, (412'-0" El.), next to the Emergency Diesel cage (Room A-16). It supplies power to various supply and exhaust fans, pumps, the Standby Air Compressor, and welding outlets located in the A-Wing. Miscellaneous Power Panel A-1, located on MCC A-1, supplies various minor electrical loads. Table 8-2A lists the loads supplied by this load center. MCC A-1 also supplies power to Building Service MCC A-2 through breaker A-1. Building Service MCC A-2 is located on the second floor of the B-wing in room B-200. It supplies power to various supply and exhaust fans, Lab Power Panels P-4 and -5, a 20kVA UPS, and welding outlets located in the B-Wing. Miscellaneous Power Panel A-2, located on MCC A-2, supplies various minor electrical loads. Table 8-2B lists the loads supplied by this load center.

Switchgear section SSA also feeds several lighting and power sub-panels throughout the A- and B-Wings as well as in the Confinement Building. Breaker 4B feeds Power and Lighting Distribution Panel "D". This panel supplies 277 V phase-neutral lighting loads and 480 V 3-phase power loads. Breaker 4C feeds Cold Lab Distribution Power Panel "A", Warm Lab Distribution Power Panel "B", Cold Lab Instrument Power Distribution Panel "F", and Warm Lab Instrument Power Distribution Panel "G" via transformers T1, T2, T11 and T-12, respectively. T1 and T2 are 75 kVA, 3-phase, 60 Hz, 480-208Y/120V, Dry Type transformers connected delta-wye while T11 and T12 are 45 kVA, 3-phase, 60 Hz, 480-208Y/120V, Dry Type transformers connected delta-wye. These four panels supply 120 V phase-neutral loads and 208 V 3-phase power loads located in the A- and B-Wings.

Switchgear section SSB feeds several lighting and power sub-panels throughout the A-, B- and E- Wings as well as in the Confinement Building and in the Guide Hall. Breaker 12B feeds Power and Lighting Distribution Panel "E". This panel supplies 277 V phase-neutral lighting loads and 480 V 3-phase power loads located in the A- and B-Wings and in the Confinement Building. It also feeds Reactor Power Distribution Panel "C" and Reactor Instrument Power Distribution Panel "H" via transformers T3 and T13, respectively. T3 is a 75 kVA, 3-phase, 60 Hz, 480-208Y/120V, Dry Type transformer connected delta-wye while T13 is a 45 kVA, 3-phase, 60 Hz, 480-208Y/120V, Dry Type transformer connected delta-wye. These two panels supply 120 V phase-neutral loads and 208 V 3-phase power loads in the Confinement Building. Switchgear SSB also feeds the Guide Hall lighting and power sub-panels through feeder breaker 10B.

Switchgear section SSC feeds Power Panel A, and Power Load Centers B, C and D. These panels supply various electrical loads in the E-Wing and the Guide Hall and are located in the basement of the E-Wing in Room E-02. Switchgear section SSC also feeds South End Addition Power Panels PA-B-A5 and PA-B-B4. These power panels supply the lighting, supply and exhaust fans and other miscellaneous electrical loads in the B-Wing addition. Both panels are located in the basement of the B-Wing Addition.

8.1.2.3 Reactor Distribution System

All of the electrical loads associated with the normal and emergency operation of the reactor are powered from two parallel sets of Motor Control Centers. Switchgear section SSA feeds Reactor MCC A-3 through breaker 5B and Pump Room MCC A-7 through breaker 5C. Reactor MCC A-

3, in turn, feeds Emergency Power MCC A-5 through breaker A-6. Switchgear section SSB feeds Reactor MCC B-4 through breaker 8C and Pump Room MCC B-8 through breaker 8B. Reactor MCC B-4, in turn, feeds Emergency Power MCC B-6 through breaker B-1. Equipment necessary for the normal operation of the reactor is split between two sets of four Motor Control Centers (MCC A-3 and A-7), and (MCC B-4 and B-8). Equipment required for the safe shutdown of the reactor is split between two Emergency Power Motor Control Centers MCC A-5 and MCC B-6. The Emergency Power MCCs are discussed in Section 8.1.2.6, Emergency Distribution System, below. MCC A-3 and MCC B-4 are located on the Basement level of the Confinement Building; MCC A-5 and MCC B-6 are located in Room C-01 on the Mezzanine level of the Confinement Building; and, MCC A-7 and MCC B-8 are located on the second floor of the Pump House in room D-200.

Reactor MCC A-3 is fed from 480V Input Switchgear section SSA while Reactor MCC B-4 is fed from 480V Input Switchgear section SSB. These two redundant Motor Control Centers may be electrically cross-tied through a normally locked open tie-breaker. The tie-breaker is key-interlocked with the feeder breakers to each MCC (breaker 5B on SSA and breaker 8C on SSB). This tie-breaker is physically located in cubicle A-1 of Reactor MCC B-4. The key-interlock requires that one of the two feeder breakers be opened prior to closing the tie-breaker.

MCC A-3 and MCC B-4 provide power to equipment necessary for the normal operation of the reactor. Loads on these MCCs include: Main D_2O Circulation Pumps, Storage Pool pumps, supply and exhaust fans, C-100 and C-200 cranes, Condensate Pumps, CO_2 Purge Fan, and the Storage Pool sub-panel. These two MCCs also feed Emergency Power MCC A-5 and MCC B-6, respectively. Miscellaneous Power Panel A-3, located on MCC A-3, supplies various minor electrical loads. Table 8-2C lists the loads supplied by MCC A-3 while Table 8-2D lists the loads supplied by MCC B-4.

Pump House MCC A-7 is fed from Switchgear SSA while Pump House MCC B-8 is fed from Switchgear SSB. These two redundant Motor Control Centers are electrically tied together through a normally locked open tie-breaker. The tie-breaker between Pump House MCC A-7 and MCC B-8 is key-interlocked with their respective feeder breakers, 5C on Switchgear SSA and 8B on Switchgear SSB. This tie-breaker is physically located in Pump House MCC A-7, cubicle C-7. The key-interlock requires that one of the two feeder breakers be opened prior to closing the tie-breaker.

Additional equipment necessary for the normal operation of the reactor is powered from these two MCCs. Loads on these MCCs include: Main Secondary Cooling Pumps, Helium Compressor Secondary Cooling Pumps, Secondary Auxiliary Heat Exchanger Booster Cooling Pumps, Cooling Tower loads, supply and exhaust fans, Backwash Pump, and NG-5 Spin Echo Experiment. Miscellaneous Power Panel B-8, located on MCC B-8, supplies various minor electrical loads. Table 8-2G lists the loads supplied by MCC A-7 while Table 8-2H lists the loads supplied by MCC B-8.

A simplified diagram of the Reactor Distribution System bussing arrangement is shown in Figure 8-2.

8.1.2.4 Emergency Distribution System

Emergency Power MCC A-5 is fed from Reactor MCC A-3, Breaker A-6, through Automatic Circuit Breaker (ACB) No. 1, located in cubicle D-4. Emergency Power MCC B-6 is fed from Reactor MCC B-4, breaker B-1, through ACB No. 4, located in cubicle D-2. The two Emergency Power MCCs are tied together through a normally closed tie-breaker. This tie-breaker is physically located in Cubicle A-1of MCC B-6. MCC A-5 and B-6 are located in Room C-01, on the Mezzanine level of the Confinement Building.

The normal lineup has ACB No. 1 closed and ACB No. 4 open in stand-by. In this configuration, SSA Switchgear supplies both MCC A-5 and B-6 via Reactor MCC A-3. Since equipment powered from Emergency Power MCC A-5 and MCC B-6 is considered to be necessary for reactor operation, provisions are made to automatically provide emergency power to these loads. An under-voltage device monitors the status of Emergency Power MCC A-5. If this device senses a loss of voltage, it automatically trips open ACB No. 1 and closes ACB No. 4. This transfers the feed for Emergency Power MCC A-5 and B-6 to the SSB Switchgear via Reactor MCC B-4.

If power is not restored to Emergency Power MCC A-5 and B-6, this same under-voltage device trips open ACB No. 4 and initiates the starting sequence of the AC Emergency Diesel Generators. Once the diesel generator achieves normal operating speed and output voltage, its associated Feeder Breaker, ACB No. 2 for Emergency Generator A or ACB No. 3 for Emergency Generator B, closes to restore power to Emergency Power MCC A-5 and B-6. The Emergency Generators are discussed in Section 8.2, Emergency Electrical Power Systems.

MCC A-5 and B-6 provide power to all of the equipment necessary for the shutdown of the reactor. Loads on these MCCs include: D_2O Shutdown Pumps, D_2O Storage Tank Pumps, D_2O Experimental Cooling Pumps, Secondary Shutdown Pump, Emergency Sump Pump, Sump Pump to Hot Waste, Hot Waste Sump Pumps, Control Air Compressors, Reactor Uninterruptible Power Supplies (UPS) T9 and T10, Helium Blowers, Experimental Demineralized Cooling Pumps, Thermal Shield Circulation Pumps, Shuttle Blower, Rabbit Blower, Normal and Irradiated Air Exhaust Fans, Recirculation Supply Fan, Dilution and Hood Exhaust Fans, Reactor Inlet and Outlet Isolation Valves, Secondary Inlet Isolation Valve, and Tritium Blower. Miscellaneous Power Panel P-5, located on MCC A-5, supplies various minor electrical loads. Table 8-2E lists the loads supplied by MCC A-5 while Table 8-2F lists the loads supplied by MCC B-6.

During normal operation, either the T-9 Reactor UPS or the T-10 Reactor UPS supplies AC power to Critical Power Panels CP-1, CP-2 and CP-3, DC power to the DC Distribution Panel, and maintains a trickle charge on the Station Battery. The other UPS is secured and acts as an installed spare. The Critical Power Panels supply power to the Reactor Control and Safety Systems. Tables 8-4A, -4B and -4C list the loads on Critical Power Panels CP-1, CP-2 and CP-3, respectively. The DC Distribution Panel supplies power to DC Valve Power, Scram Relays, Moderator Dump Controls, ventilation dampers, Control Power for Emergency Power MCC undervoltage device, and Control Room Annunciators. Tables 8-3A, -3B and -3C list the loads on the DC Distribution Panel, DCP-1 and DCP-2, respectively.

If AC power is lost to the input of the on-line UPS, the trickle charge of the Station Battery ceases and the battery automatically supplies the loads on the DC Distribution Panel directly and the Critical Power Panel loads indirectly through the inverter of the UPS. When AC power is restored, either from the diesel generator or from another source, the UPS rectifier automatically resumes charging the battery and the UPS automatically resumes supplying power to the Critical Power Panel and the DC Distribution Panel.

Emergency Lighting Panels X-1 and X-2 supply selected incandescent lights with either AC power or DC power. Panel X-1 powers emergency lights in the office spaces in the A- and B-Wings. Normally, this panel receives AC power from CP-3. Upon loss of AC power, automatic transfer switch TS-1 transfers the feed from CP-3 to DCP-1. Panel X-2 powers emergency lights in the Confinement Building. Normally, this panel receives AC power from Emergency Power MCC A-5 via Miscellaneous Power Panel P-5, located in cubicle B-1 of MCC A-5. Upon loss of AC power, automatic transfer switch TS-2 transfers the feed from MCC A-5 to DCP-1.

A simplified diagram of the Emergency Distribution System bussing arrangement is shown in Figure 8-2.

8.1.3 Electrical Power Capability

The normal electrical demand varies over the course of the year, with the summer months yielding the highest loads. The electrical loads for normal full power operation during the summer are approximately 2,700 amps at 480 volts AC and 60 Hz. This equates to 2,245 kW and 2,806 kVA at a 0.8 power factor (pf). The electrical loads for normal shutdown operations are approximately 1,700 amps at 480 volts AC and 60 Hz. This equates to 1,413 kW and 1, 767 kVA at a 0.8 pf. The three electrical feeds that supply the facility are each capable of supplying 2,000kVA (6,000 kVA total). While two input feeds are needed to support full power operation, only one input feed is needed to support normal shutdown of the facility. Power supplied from the three High Voltage Input Feeders is not needed to achieve and maintain safe shutdown conditions.

8.1.4 Codes and Standards

All electrical equipment associated with the NBSR is free of PCBs. The NBSR facility has undergone several major additions since it was first built in 1966. The distribution system in the A- and B-Wings and in the Confinement Building conformed to the requirements of the 1965 Edition of the National Electrical Code (NEC). All additions/modifications to the distribution system were installed in accordance with the code requirements applicable at the time of the addition/modification. None of the system has been exempted from any code requirements.

8.1.5 Lightning Protection

The facility is furnished with a complete lightning protection system consisting of air terminals connected by copper conductors to the main grounding system. The air terminals are located at the top of the stack and at other high points around the building. The terminals are electrically connected together by means of bare copper cables that form a closed loop. Down conductors connect the closed loop to the copper conductors of the main grounding system. A separate lightning protection system is installed on the Cooling Tower.

8.1.6 Grounding

Two separate grounding systems are provided. All of the electrical equipment, switchgear, motor control centers, panelboards and motors, in addition to the building steel, are connected to the main grounding loop. The Reactor Console and Control Boards are connected to a separate insulated copper grounding system with its own separate ground rods. This grounding system is not looped and is insulated from the main grounding system.

8.1.7 Technical Specification

There are no Technical Specifications applicable to the Normal Electrical Distribution System. Technical Specifications for the Emergency Electrical Power System are discussed in Section 8.2.4.

8.2 Emergency Electrical Power Systems

8.2.1 Design Basis

The Emergency Electrical Power Distribution System is designed to provide emergency power to the nuclear instruments, the emergency exhaust fans and to the shutdown cooling pumps should a complete loss of off-site power occur. One of the two diesel generators is capable of supplying emergency power to all necessary emergency equipment. The station battery is also capable of independently supplying these emergency loads for a minimum of four (4) hours. By requiring the operability of at least one of the two diesel generators and the station battery, adequate emergency power sources will always be available. Technical Specification 3.10 requires that the battery and one EDG be operable for operation of the reactor at power. This permits outages of the second EDG for maintenance and repairs. This assures that the reactor can be shutdown as designed and that the core will receive adequate cooling.

8.2.2 System Description

This system consists of:

a. Two 150 kW diesel powered emergency AC generators and associated support equipment. Four automatic circuit breakers (located in MCC-A5 and MCC-B6) and adequate automation to ensure the proper transfer of power supply from normal electrical power supply to diesel generator electrical power supply in case of an off site electrical outage.
b. A 125 volt DC bus which is energized via the DC output of either of two 20 kVA UPS connected to MCC-A5 or MCC-B6. The power to the DC Bus is backed up by a 125 volt DC station battery. The DC bus can supply power to a distribution network which includes the two 20 kVA UPS and vital loads for emergency situations. The purpose of this system is to ensure that power is available to the reactor emergency equipment on a total loss of AC power.

In order to ensure a safe shutdown condition and to give an adequate response in emergency situations, essential loads are powered by the DC bus. In case of a total loss of off site power and the on site backup power supplied by the diesel generators, the DC bus would provide the necessary power for the reactor emergency equipment. The DC bus is powered from the station battery. The station battery can supply all emergency equipment for a minimum of four hours.

This equipment includes the following: DC shutdown cooling pumps, Emergency Ventilation System DC powered fans and controls, valve control power, emergency lighting, UPS Inverter (T9 mode or T10 mode), the reactor rod control, reactor process instrumentation and nuclear instrumentation.

Normally the rectifier of one of the two 20 kVA UPS will convert and condition the commercial AC power to carry the loads of the DC bus and provide a "floating" power charge to the station battery. The station battery consists of sixty, two-volt, lead acid type batteries with a capacity of 880 ampere-hours. This capacity allows the supply of the DC bus loads, which total ~100 amperes, for eight hours--twice the 4 hours required by the technical specifications.

Since equipment powered from Emergency Power MCC A-5 and MCC B-6 is considered to be vital to reactor operation, provisions are made to automatically provide emergency power to these loads. These provisions include two diesel-powered generators located on the B2 level. Each diesel engine set is connected to a single bearing AC generator rated at 150 kW, 226 amps with a 0.8 power factor, 480 volts, 3 phase, and 60 cycles. Each control panel is equipped with: automatic voltage regulator, voltage regulator switch, manual field rheostat control, generator voltmeter, generator ammeter, frequency meter, and an AUTO/STANDBY selector switch. Upon a loss of power to the emergency motor control center (MCC-A5 and MCC-B6) 480-volt bus, a control circuit will close a contact to open the diesel fuel valves, and initiate the cranking cycle for the diesel in AUTO. This cycle is 15 seconds crank and 15 seconds rest.

After the fourth unsuccessful attempt the circuit will actuate the DIESEL "A" (B) FAILURE TO START annunciator in the Control Room. At that time it will call for the diesel in STANDBY to start. After the diesel driven generator reaches normal voltage and frequency, the diesel output will automatically close the associated circuit breaker on the emergency motor control center to power the MCC load from the generator.

8.2.3 Electrical Power Capability

The emergency electric power system provides electrical power to vital loads in the event of a complete loss of outside power. The Station Battery is capable of supplying all of the emergency loads for a minimum of four (4) hours. There are sixty 2-volt lead-acid type batteries with a rated output of 880 amp-hrs at 8-hour rate of discharge to a 1.75 volts/cell and 110 amp-hrs at 1-hour rate of discharge. In addition to the battery, the facility has two Emergency Diesels. Each diesel is rated at 150 kW at 480 volts AC, 3-phase and 60 Hz with a pf of 0.85. The diesel is capable of supplying 180 amps at full rated load. The two Emergency Diesels share a common Diesel Fuel Oil Day Tank with a design capacity of 75 gallons and a Diesel Fuel Oil Supply Tank with a design capacity of 2,000 gallons. At full load (135 amps) the diesel consumes 8 gal./hr of diesel fuel.

8.2.4 Technical Specifications

8.2.4.1 Technical Specification 3.10, Emergency Power Systems

This Technical Specification applies to the emergency electrical power supplies. The objective of this Technical Specification is to ensure emergency power for vital equipment. The reactor is not operated unless at least one of the two diesel generators, including the associated distribution equipment, and the station battery, including its distribution equipment, is operable. One diesel generator is capable of supplying emergency power to all necessary emergency equipment. The second diesel generator permits outages for maintenance and repairs. The station battery provides an additional source of emergency power for the nuclear instruments, the emergency exhaust fans and the shutdown cooling pumps. These fans and pumps are provided with DC as well as AC motors. The battery is capable of supplying the emergency load for a minimum of four (4) hours. By allowing this amount of time and by requiring operability of at least one diesel generator and the station battery, assurance is provided that adequate emergency power sources will always be available.

8.2.4.2 Technical Specification 4.7, Emergency Power System

This Technical Specification applies to the emergency electrical power equipment. The objective of this Technical Specification is to ensure the availability of emergency power equipment. Each diesel generator is tested for automatic starting and operation at least monthly. Should one of the diesel generators become inoperative, the operable generator is then tested for starting at least weekly. All emergency power equipment is tested annually under a simulated complete loss of outside power. The voltage and specific gravity of each cell of the station

battery is tested semiannually. In addition, a discharge test of the entire battery is performed once every five (5) years.

The NBSR is equipped with two diesel generators, each capable of supplying full emergency load. Therefore, only one of the two generators is required. The monthly test frequencies are consistent with industry practice and are considered adequate to ensure continued reliable emergency power for necessary emergency equipment. In addition, an annual test of necessary emergency power equipment under simulated complete loss of outside electrical power is also specified.

Specific gravity and voltage checks of individual cells are the accepted method of ensuring that all cells are in satisfactory condition. The semiannual frequency for these detailed checks is considered adequate to detect any significant changes in the ability of the battery to retain its charge.

During initial installation, the station battery was discharge tested to measure its capacity. Experience has shown this test should be repeated at 5-year intervals to detect deterioration of cells.

Table 8.1A: Load List Switchgear SSA ("A" Feed)

Cubicle	Load
1A	480V Feed from FA-1
2B	Installed spare.
2C	Installed spare.
3B	NC-5 Spin Echo
3C	MCC A-1, Building Service
4B	Power & Lighting Distribution Panel "D"
4C	T1, T2, T11 & T12 Transformers
5B	MCC A-3, Reactor Power
5C	MCC A-7, Pump Room
6A	SSA Connection to SSC Cub 14B
7A	SSA Connection to SSB Cub 7B

Table 8.1B: Load List Switchgear SSB ("B" Feed)

Cubicle	Load
7B	SSB Connection to SSA Cub 7A
8B	MCC B-8, Pump Room
8C	MCC B-4, Reactor Power
9A	480V Feed from FB-1
10B	Guide Hall Panel
11B	Installed spare.
11C	Installed spare.
12B	Power & Lighting Distribution Panel "E"
12C	Non-Magnetic Facilities Building 237
12D	Installed spare.
13A	SSB Connection to SSC Cub 13B

Table 8.1C: Load List Switchgear SSC ("C" Feed)

Cubicle	Load
14A and B	SSC Connection to SSA Cub 6A
15B	South End Addition
15C	Compressor Building
16B	Power Load Center "D" (E-Wing Office/Labs)
16C	Power Load Center "C" (Guide Hall)
17B	Motor Control Center "B" E-Wing
17C	Power Panel "A" E-Wing UPS
18B	Installed spare.
18C	Installed spare.

Table 8.2A: Load List MCC A-1, Building Service

Cubicle	Load
A-1	Feed to MCC A-2, Building Service
B-1	Supply Fan SF-6
C-1	Supply Fan SF-4
D-1	Supply Fan SF-5
A-2L	B-2 Roll Up Door
A-2R	Standby Air Compressor
C-2	Supply Fan SF-15
D-2	Supply Fan SF-16
E-2	Supply Fan SF-8
A-3L	Welding Receptacle Room A-06
A-3R	Hot Waste Tank Pumps
B-3R	Condensate Pumps 3A & 3B
C-3	Exhaust Fan EF-8
D-3	Exhaust Fan EF-9
E-3	Supply Fan SF-7
A-4L	Welding Receptacle 6
A-4R	Welding Receptacle 7
C-4	Chilled Water Supply Pump
A-5L	Welding Receptacle Room A-115
A-5R	15 kVA Transformer (Misc. Power Panel A-1)
B-5	Misc. Power Panel A-1
B-7	Chilled Water Pump

Table 8.2B: Load List MCC A-2, Building Service

Cubicle	Load
B-1	Supply Fan SF-9
C-1	Supply Fan SF-17
D-1	Supply Fan SF-18
E-1	Supply Fan SF-10
A-2	Supply Fan SF-14
B-2	Exhaust Fan EF-13
C-2	Exhaust Fan EF-14
B-3	Exhaust Fan EF-1
C-3	Exhaust Fan EF-17
D-3	Exhaust Fan EF-25
E-3	Exhaust Fan EF-26
A-4	Exhaust Fan EF-15
B-4L	Lab Power Panels P-4 & P-5
D-4L	Welding Receptacles
D-4R	Welding Receptacles
E-4L	Building Test Supply Fan
E-4R	15 kVA Transformer (Misc. Power Panel A-2)
A-5L	20kVA UPS
C-5	Misc. Power Panel A-2

Table 8.2C: Load List MCC A-3, Reactor

Cubicle	Load
A-1	Main D_2O Circulation Pump DP-1
A-2	Main D_2O Circulation Pump DP-3
B-3L	Condensate Pump 1
B-3R	Condensate Pump 1A
D-3	Storage Pool Circulation Pump No. 1
A-4L	Crane No. 2, First Floor (C-100)
A-4R	30 kVA Transformer
B-4	Supply Fan SF-11
C-4	Recirculation Fan EF-27
D-4R	Storage Pool 480V Sub Panel
E-4	CO_2 Purge Fan
A-5L	Welding Receptacle
A-5R	15 kVA Transformer (Misc. Power Panel A-3)
B-5	Misc. Power Panel A-3
A-6	Feed to MCC A-5, Emergency Power
B-6	Supply Fan SF-3
C-6	Supply Fan SF-12

Table 8.2D: Load List MCC B-4, Reactor

Cubicle	Load
A-1	MCC B-4 to MCC A-3 Tie Breaker (locked open)
B-1	Feed to MCC B-6, Emergency Power
C-1	Crane No. 1, Second Floor (C-200)
A-2	Main D_2O Circulation Pump DP-4
A-3	Main D_2O Circulation Pump DP-2
C-4	Storage Pool Purification Booster Pump
D-4	Storage Pool Circulation Pump No. 2
A-5R	Welding Receptacle
B-5	Turbo Compressor No. 2 (Shuttle Blower)
D-5	Supply Fan SF-1
E-5	Supply Fan SF-2

Table 8.2E: Load List MCC A-5, Emergency Power

Cubicle	Load
A-0	D_2O Storage Tank Pump DP-7
B-0	SCV-50 Secondary Header Inlet Isolation Valve
A-1L	15 kVA Transformer (Misc. Power Panel P-5)
A-1R	T-10 20 kVA Reactor UPS
B-1	Misc. Power Panel P-5
A-2	Helium Blower HB-1
B-2	Normal Exhaust Fan EF-3
C-2	Irradiated Air Exhaust Fan EF-4
D-2L	Elevator & Door Control Panels
D-2R	Reactor Door Panel P-9
E-2	Turbo Compressor No. 1 (Rabbit Blower)
A-3	D_2O Experimental Cooling Pumps ECP-1
B-3	D_2O Shutdown Pump DP-5
C-3	Secondary Shutdown Pump
D-3	Emergency Sump Pump
E-3L	Control Air Compressor No. 2
A-4R	DWV-2 10” Inlet Isolation Valve
B-4	Exp. Demin. Cooling Pump No. 1
C-4	Thermal Shield Circulation Pump No. 1
D-4	Feed from MCC A-3, Reactor
D-5	Feed from Emergency Diesel Generator A

Table 8.2F: Load List MCC B-6, Emergency Power

Cubicle	Load
A-1	MCC B-6 to MCC A-5 Tie Breaker (closed)
D-1	Feed from Emergency Diesel Generator B
A-2	D_2O Experimental Cooling Pumps ECP-2
B-2	Exp. Demin. Cooling Pump No. 2
C-2	Thermal Shield Circulation Pump No. 2
D-2	Feed from MCC B-4, Reactor
A-3L	DWV-1 14” Inlet Isolation Valve
A-3R	Hot Waste Sump Pumps 1A & 1B
B-3	D_2O Shutdown Pump DP-6
C-3L	DWV-19 Reactor Outlet Isolation Valve
D-3	Emergency Sump Pump
E-3L	Control Air Compressor No. 1
A-4	Tritium Blower
B-4	Recirculation Supply Fan SF-19
C-4	Dilution Exhaust Fan EF-2
D-4	Hood Exhaust Fan EF-23
E-4	Thermal Column Pump No. 2
A-5	D_2O Storage Tank Pump DP-8
B-5L	T-9 20 kVA Reactor UPS
D-5	Helium Blower HB-2
E-5	Thermal Column Pump No. 1

Table 8.2G: Load List MCC A-7, Pump Room

Cubicle	Load
B-1L	Welding Receptacles
C-1	He Compressor Secondary Cooling Pump No. 1
D-1	Cooling Tower “A” Feed
B-2	Main Secondary Cooling Pump No. 4
B-3	Main Secondary Cooling Pump No. 5
B-4	Main Secondary Cooling Pump No. 1
B-5	Main Secondary Cooling Pump No. 3
A-6	Supply Fan SF-13
B-6	Backwash Pump
C-6	Exhaust Fan EF-7
D-6	Sec. Aux. HX Booster Cooling Pump No. 1
C-7	MCC A-7 to MCC B-8 Tie Breaker (locked open)

Table 8.2H: Load List MCC B-8, Pump Room

Cubicle	Load
A-1	He Compressor Secondary Cooling Pump No. 2
B-1	Sec. Aux. HX Booster Cooling Pump No. 2
B-2	Main Secondary Cooling Pump No. 6
B-5	Main Secondary Cooling Pump No. 2
A-6L	Welding Receptacles
A-6R	15 kVA Transformer (Misc. Power Panel B-8)
D-6	NG-5 Spin Echo Experiment
A-7	Cooling Tower “B” Feed
C-7	Misc. Power Panel B-8

Table 8.2I: Load List MCC DC

Cubicle	Load
A-1	DC Power Panel 2 (DCP-2)
B-1	Exhaust Fan EF-5 (DC Motor)
C-1	Exhaust Fan EF-6 (DC Motor)
D-1	Exhaust Fan EF-5 (AC Motor)
E-1	Exhaust Fan EF-6 (AC Motor)
A-3	D_2O Shutdown Pumps DP-5
B-3	D_2O Shutdown Pumps DP-6

Table 8.3A: Load List DC Distribution Panel

Breaker	Load
2	Battery Disconnect Breaker
3	Feed to MCC DC Load Center
4	T-9 20kVA UPS
8	DC Power Panel 1 (DCP-1)
10	T-10 20kVA UPS

Table 8.3B: Load List DC Power Panel 1 (DCP-1)

Breaker	Load
1	Emergency Lighting
4	Plant Annunciator Panel
8	Lobby Annunciator Panel
12	Health Physics Office Annunciator Panel
16	PS-108

Table 8.3C: Load List DC Power Panel 2 (DCP-2)

Breaker	Load
1	Emergency Lighting
3	Scram Relays (FSR & DSR) & Moderator Dump
6	ACV-5 & -9
7	ACV-4, -8, & -10
10	MCC A-5 Control Power for Breakers 1 & 2 and "A" Diesel
11	RWV-1, -2, -3, -13, & -16
12	DC Valve Power
13	MCC B-6 Control Power for Breakers 3 & 4 and "B" Diesel
15	ACV-12 and PC-151

Table 8.4A: Load List Critical Power Panel 1 (CP-1)

Breaker	Load
1	Main Control Panel Outlets
2	Main Control Panel Lights
3	48 VDC Safety System Power Supply
4	48 VDC Safety System Power Supply
5	Nuclear Instrumentation Power Supplies (Standby)
6	Annunciator Panel
7	Critical Power Panel 3 (CP-3)
8	Critical Power Panel 2 (CP-2)
9	Neutron Guide Isolation Valve (NGIV) Control Panel and Building Evacuation Alarms.
10	Nuclear Instrumentation Power Supplies (Main)
11	Sub-Pile Room and Storage Pool Electronics
12	AC Valve Power
13	Main Control Panel Section “B” Outlets and 24 VDC Process Instrument Power Supply
14	Page System
15	Area Monitors, Duct Filter Monitors, Remote Electronics Panel, Main Control Panel Section “A” Outlets, and 24 VDC Process Instrument Power Supply
16	Pneumatic Rabbit System
17	Conductivity Rack

Table 8.4B: Load List Critical Power Panel 2 (CP-2)

Breaker	Load
1	Radiation Monitors RM3-1, RM3-2 and RM4-1
2	Building Pressure Transmitter & Building Exhaust Flow
3	Radiation Monitor RM3-4
4	ACV-30/37
5	Radiation Monitor RM3-4 & RM3-5 Vacuum Pump No. 1
6	Rabbit System Control Panel
7	Radiation Monitor RM3-4 & RM3-5 Vacuum Pump No. 2
9	Gas Holder Level Controls (He & CO_2 Make-Up)
11	Body Monitor
13	Radiation Monitor RM3-5

Table 8.4C: Load List Critical Power Panel 3 (CP-3)

Breaker	Load
11	Building Fire Alarm
15	Simplex Panel
16	Emergency Diesel Battery Chargers
17	Emergency Lighting Panel X-1
18	Electronic Relay Cabinet (Lobby Computer)
19	Building Services Annunciator Panel
20	Mechanical Relay Cabinet
22	NIST Security Relay Cabinet
23	Hot Waste Control Panel
24	Clock Relay Cabinet
27	Diesel Oil Transfer Pump
28	H/F CTR A-134

Table 8.4D: Load List Power Panel P-9

Breaker	Load
3	Elevator Door
4	North Personnel Door
9	South Personnel Door
10	SW Personnel Door (Back Door)

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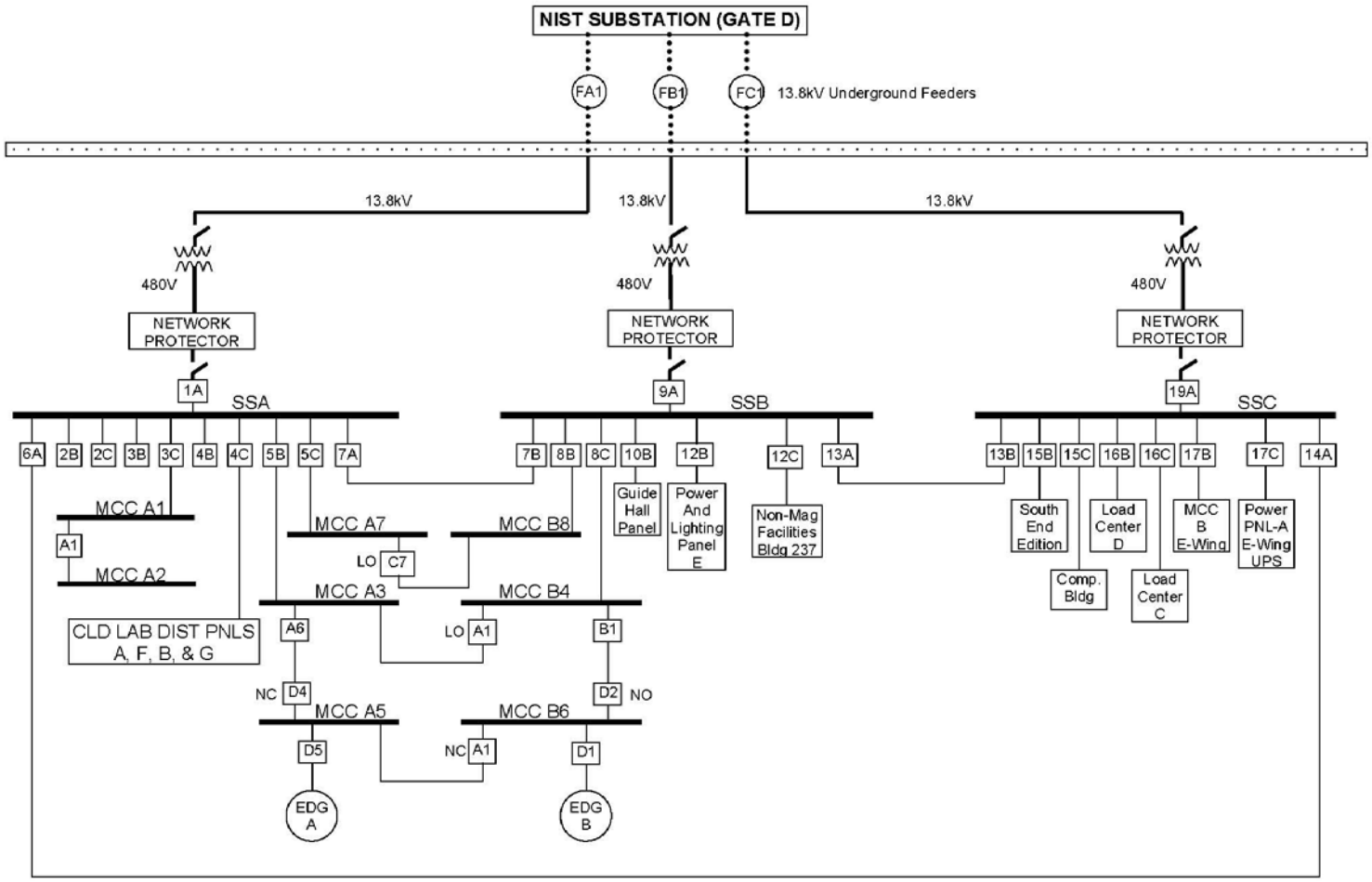

Figure 8.1: Simplified Diagram – High Voltage Input Switchgear and Bussing Arrangement

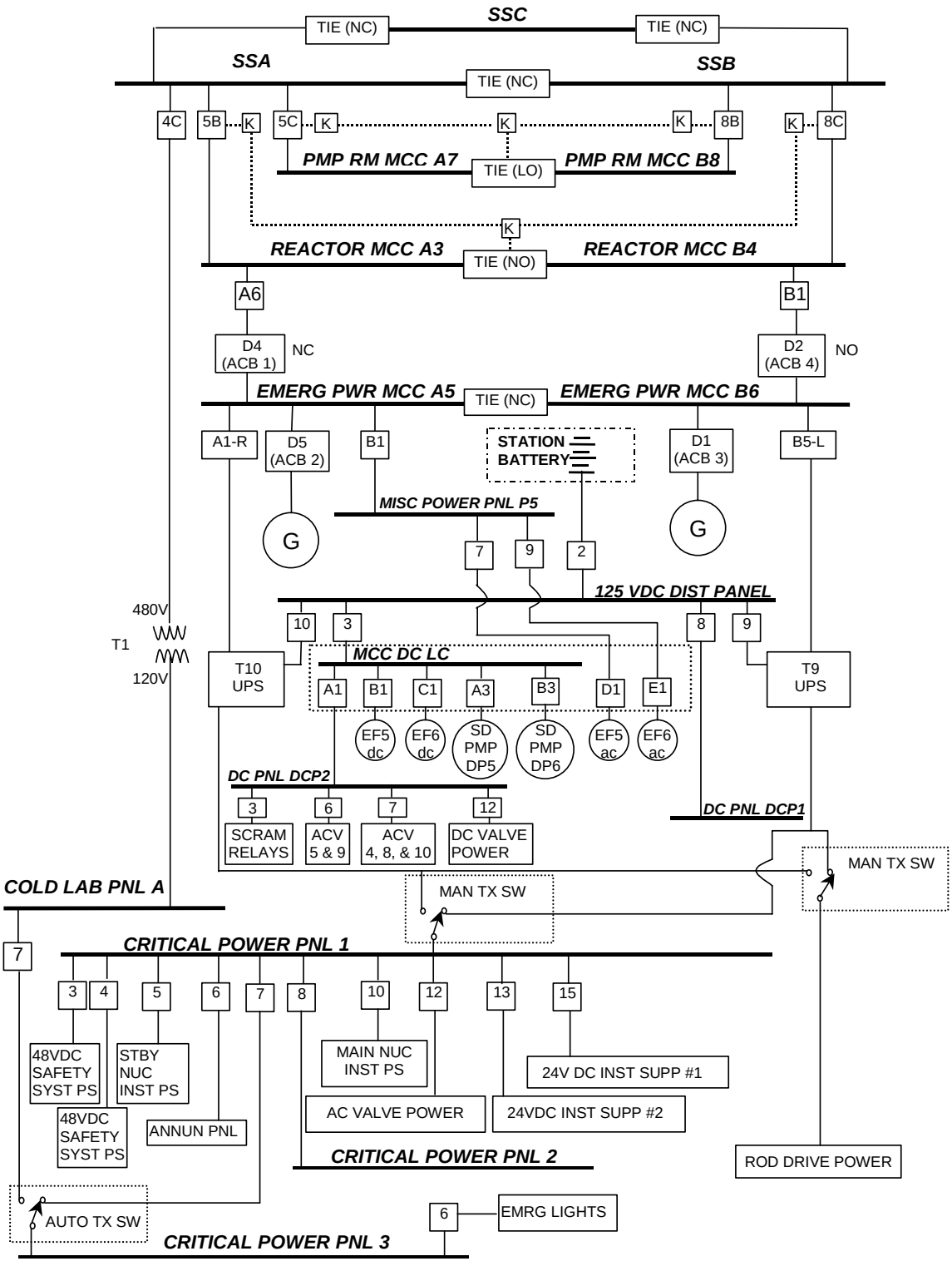

Figure 8.2: Simplified One-Line Diagram for the Reactor and Emergency Power Distribution System (Normal/Preferred Lineup and Vital Loads)