8.0 ELECTRICAL SYSTEMS

The electrical systems include

1. the equipment required to generate power and deliver it to the high voltage system and
2. facilities for providing power to and controlling the operation of electrically driven plant auxiliary equipment and instrumentation.

Figures 8.1-1A and 8.1-1B show the Unit 1 auxiliary electrical one line diagram. Unless otherwise noted, the text, tables, and figures in this chapter apply to both units. Figures 8.1-2A and 8.1-2B show the interconnections between the plant and its offsite power sources. The main generator output of each unit is fed into the transmission network of the American Electric Power System. While generating, auxiliary power is normally supplied from the generator terminals through the unit auxiliary transformers (TR1AB and TR1CD for Unit 1 and TR2AB and TR2CD for Unit 2). Upon a trip of the main generator, the station auxiliaries are automatically and instantaneously transferred to the preferred offsite power source (that is, to reserve auxiliary transformers TR101AB and TR101CD for Unit 1 and TR201AB and TR201CD for Unit 2) to assure continued power to equipment when the main generator is off-line.

The preferred offsite power source for both units can be arranged so that Transformer No. 4 or Transformer No. 9 can supply reserve auxiliary transformers TR101CD and TR201CD and Transformer No. 5, or Transformer No. 9 supplies TR101AB and TR201AB. Under certain conditions, it is possible for either Transformer No. 4, Transformer No. 5, or Transformer No. 9 to feed the entire plant auxiliary load. In addition, an alternate offsite power source, a 69/4.16kV transformer (TR12EP-1), located at the plant site, has the necessary capacity to operate one train of the engineered safeguard equipment in one unit while supplying one train of the safe shutdown power in the other.

The plant electrical systems include an onsite, independent, and automatically starting emergency power source, which is available to supply power to essential auxiliaries if both the normal power source (through the unit auxiliary transformers) and the preferred offsite power source (through the reserve auxiliary transformers) are unavailable. The emergency power source consists of four diesel generators, two for each unit. Essential instrumentation, including the reactor protection system and the engineered safety features instrumentation, is fed from vital instrumentation buses to provide continuous monitoring and control. The station batteries provide circuit breaker control, control room emergency lighting, and operating power for certain electrically operated valves and vital bus inverters.

Rating descriptions of equipment discussed in this chapter are typically manufacturer nameplate ratings. This is normally the design voltage, amperage or capacity rating for the subject equipment. Nominal values are used in this chapter to describe parameters such as bus and system voltages.

8.1 DESIGN BASES

The plant electrical systems are designed to ensure a supply of electrical power to all essential plant equipment during normal operation and under abnormal conditions.

8.1.1 Application of Design Criteria

Applicable standards and codes as detailed in the Electrical Equipment Specifications for the D. C. Cook Nuclear Plant have been complied with in the design, manufacture, and testing of all electrical equipment vital to the operation of the engineered safety features. Accordingly, electrical equipment directly related to the operation of the engineered safety features, or to the safe shutdown of the units has been designated as Class I, which designation assures compliance with the seismic Class I criteria as defined for the Cook Nuclear Plant (Reference subchapter 2.9 of the FSAR).

The design of all cable trough (trays) and conduit systems vital to the operation of the engineered safety features has been analyzed and documented to assure compliance with the seismic Class I criteria as defined for the Cook Nuclear Plant. Power, control and instrumentation cabling, motors and other electrical equipment required for operation of the engineered safety features have been inherently designed to withstand the effects of a nuclear system accident or severe external phenomena, as required by their safety function, thus assuring a high degree of confidence in the operability of such components should their use be required.

The applicable portions of the Missile Protection Criteria as stated in Section 1.4 apply to Class I equipment in this chapter.

8.1.2 Functional Criteria

In addition to the aforementioned criteria, the following functional criteria will be employed to achieve maximum reliability and operating efficiency of the electrical systems.

a. The main turbine-generator for each unit, described in Section 10, feeds electrical power at 26 kV through the isolated phase bus to its main step-up transformer and the unit auxiliary transformers located adjacent to the turbine building.

b. The primary sides of the unit auxiliary transformers (TR1AB and TR1CD for Unit 1 and TR2AB and TR2CD for Unit 2) are connected to the isolated phase bus at a point between the generator terminals and the low voltage connection of the main step-up transformer. During normal operation, station auxiliary power is taken from these transformers. These transformers are each rated 21/28/35 MVA, 24.7/4.36 kV. The unit auxiliary transformer secondaries feed four independent 4160 volt auxiliary buses of each unit. The short circuit fault duty of each bus is limited to within the interrupting capability of the 4 kV circuit breakers.

c. The preferred offsite power source auxiliary system for both units can be arranged so that Transformer No. 4 or Transformer No. 9 supplies Reserve Auxiliary Transformers (RATs) TR101CD and TR201CD and Transformer No. 5 or Transformer No. 9 supplies RATs TR101AB and TR201AB. Each RAT is equipped with an automatic load tap changer (33 total steps, neutral, 16 raise, 16 lower) and has the following ratings: 18/24/30 MVA, 34.5/4.36kV. The automatic load tap changers are capable of varying the transformer secondary voltage by ± 15 % of the 4360V rated voltage. The ESF Loads are sequenced onto the RATs, under accident conditions, using the same timing relays and sequence as used for the EDG sequencing. The RATs supply the reserve auxiliary power for both units. The impact of open phase conditions on the capability of the Unit 1 and Unit 2 Reserve Auxiliary Transformers was evaluated. The conditions analyzed consisted of single (one of three) and double (two of three) open phase conductors on the high voltage 34.5kV side of the Reserve Auxiliary Transformers. An Open Phase Detection (OPD) system is installed on each Reserve Auxiliary Transformer (TR101AB and TR101CD for Unit 1, and TR201AB and TR201CD for Unit 2) that detects an open phase condition on the high side of its applicable transformer from the offsite 34.5kV transmission system. The OPD system was installed based on the NEI Open Phase Condition Initiative. Under certain plant conditions and grid loading conditions, and with proper precautions and limitations, it is possible for either Transformer No. 4, Transformer No. 5, or Transformer No. 9 to feed the entire plant auxiliary load.

d. A line from the 69kV Bus #2 of the Cook-Thornton Station feeds a 7500 kVA 69/4.16 kV transformer TR12EP-1 located at the plant site. This transformer has the necessary capacity to operate the engineered safeguard equipment of one train in one unit while supplying the safe shutdown power of one train in the other unit. This 4160 volt power is used as the alternate offsite power source to both units and is manually connected to 4160 volt buses T11A, T11B, T11C, and T11D (T21A, T21B, T21C, and T21D for Unit 2). The breakers which connect this source to the 4160 volt buses are interlocked so they will not close if any other 4160 volt bus source is closed. In addition, the availability of the 69 kV alternate offsite power source is constantly monitored and its loss annunciated.

e. The 4160 volt system for Unit 1 is divided into eight bus sections (1A, 1B, 1C, 1D and T11A, T11B, T11C and T11D). Buses 1A and 1B are normally supplied either from transformer TR1AB when the main generator is in operation or from transformer TR101AB when the main generator is not in operation. Buses 1C and 1D are supplied in a similar manner, from either transformer TR1CD or transformer TR101CD. Upon unit trip, 4160 volt bus 1A, 1B, 1C, and 1D automatically transfer from their normal auxiliary source to the preferred offsite power source. Buses T11A, T11B, T11C and T11D are supplied from buses 1A, 1B, 1C and 1D, respectively or by diesel generators 1AB or 1CD during a loss of power incident. T11A, T11B, T11C and T11D are also directly alignable to the alternate source of off-site power, the 69/4.16 kV transformer. An identical bus arrangement (2A, 2B, 2C, 2D and T21A, T21B, T21C and T21D) is provided for Unit 2.

f. The 600 volt system for Unit 1 is divided into eight bus sections. Four of these sections (11A, 11B, 11C and 11D) are fed from 4160 volt buses T11A, T11B, T11C and T11D, respectively, each through a 2000 kVA, 4160/600volt transformer. Four 600 volt bus sections (11BMC, 11BLC, 11CLC and 11CMC), are fed from 4160 volt buses 1B and 1C. Each bus is fed through a 1500/2000 kVA, 4000/600 volt transformer. A similar bus arrangement (21A, 2lB, 21C, 21D and 21BMC, 21BLC, 21CLC and 21CMC) is provided for Unit 2.

g. The 480 volt systems for each unit are divided into two bus sections (11PHA, 11PHC in Unit 1 and 21PHA, 21PHC in Unit 2) and are used to provide power to the pressurizer heaters. Buses 11PHA and 11PHC are fed from two 4160/480V, 1000 kVA transformers (TR11PHA and TR11PHC, respectively). These transformers are fed from 4160 volt buses T11A and T11D respectively. Buses 21PHA and 21PHC are fed from two 4160/480 volt, 1000 kVA transformers (TR21PHA and TR21PHC, respectively). These transformers are fed from 4160 volt buses T21A and T21D respectively.

h. Generally motors 400 hp or larger are fed from 4160 volt buses and all emergency motors of this size are fed from buses T11A or T11D. Normally motors between

100 hp and 400 hp are fed from 600 volt switchgear and motors 100 hp or less are fed from 600 volt motor control centers. 600 volt bus sections 11A, 11B, 11C, and 11D generally supply power to emergency equipment, while 600 volt bus sections 11BMC, 11BLC, 11CLC and 11CMC supply power to non-essential equipment.

i. The 4160 volt, 600 volt and 480 volt switchgear is of metal-clad construction with closing and tripping control power taken from the station batteries. Each breaker cubicle is isolated from the adjacent cubicle with metal barriers and each bus section is physically separated from all others, with the exception of buses 11A and 11C, 11B and 11D, and 11BMC, 11BLC, 11CLC and 11CMC which are separated by means of bus tie breakers and the metal barriers between the adjacent end cubicles.

j. The system has been so designed that a single failure of any electrical device to operate shall not prevent the protection and safety features from providing the required safety functions.

k. Power cables are distributed from the switchgear by means of steel conduit, plastic conduit imbedded in concrete and cable trays. Control cables are run in steel conduit or cable trays.

l. The feed from the generator terminals to the main step-up transformer bank is isolated phase, forced air-cooled, bus duct.

m. The main feeds and feeder motor cables in 4160 volt service are insulated cables rated at 5000 volts. The exact construction of the cables and method of support conform to the requirements of the individual service. Single conductor cables are shielded and provided with a fire retardant jacket. Three conductor cables are triplexed. Copper conductors are used within the containment.

n. Power cables for the 600 V service are insulated cables rated at 600 V in single or triplex construction as required. Copper conductors have been used within the containment.

o. Control cables are of single or multi-conductor copper construction rated at 600 V with overall flame retardant jacket.

p. Low voltage instrument cables are rated at 300 V. These cables have total coverage electrostatic shield and are flame retardant.

q. The normal current rating of all insulated conductors is limited to that continuous value which does not cause excessive insulation deterioration from heating. Selection of conductor sizes is based on "Power Cable Ampacities," published by the Insulated Power Cable Engineers Association (IPCEA).

r. Vital instrument buses are provided for essential instrumentation and reactor protection circuits. Each bus is fed from an inverter, which receives its normal source of power from the 250 VDC bus. If the 250 VDC bus or the dc to ac section of the inverter fails, the vital bus is transferred to a regulated 600/120 V AC Balance of Plant Source. This transfer from the 250 VDC bus to the Balance of Plant Source is accomplished without voltage variations. The output frequency of the inverter is synchronized to the normal plant ac source. The alternate source of power to the vital instrument buses is the unit auxiliary power system (see Figure 8.3-1).

s. Motor and electrical switchgear enclosures conform to the expected environmental conditions and are purchased in accordance with AEP specifications which require conformance to National Electrical Manufacturers Association (NEMA), Institute of Electrical and Electronics Engineers (IEEE), and other applicable industry standards in effect at the time of manufacture.

t. All electrical equipment and cables operate within their normal rating or temperature rise. Motor loading does not exceed nameplate rating, unless higher loading has been technically evaluated and accepted.

u. Thermal overload relay setpoints for GL 89-10 Motor Operated Valves (MOV) are selected to meet the requirements of Regulatory Guide 1.106 C.2.

v. Safety related distribution fuses and BOP distribution fuses essential to plant operation are procured either nuclear grade or commercial grade. They are dedicated for use in safety related applications and controlled in accordance with the plant fuse control program.

8.2 NETWORK INTERCONNECTIONS

Electrical energy generated at 26kV by the unit generators is stepped up to 345kV or 765kV by the main power transformers of Unit 1 or Unit 2 respectively. Each main transformer is connected to the respective switchyard by overhead transmission lines. Figure 8.1-2A shows the unit connections to the switchyards and the general switchyard arrangements.

Unit 1 is connected to a 345kV switchyard consisting of fifteen 345kV circuit breakers. These connect the unit to six 345kV transmission lines and substation transformers No. 4, 5 and 9. The breakers are arranged in a breaker and a half bus scheme.

Unit 2 is connected to a 765kV switchyard consisting of three 765kV circuit breakers. These connect the unit to a 765kV transmission line and to transformer No. 4, a 765/345kV auto-transformer that connects the 765kV and 345kV switchyards. The 765kV transmission line terminates on a ring bus at an offsite location through two circuit breakers. Figure 8.2-1 shows the transmission line interconnections and switching arrangements.

Switchyard equipment, conductors, and switchyard breakers are sized to withstand credible voltages, loads and fault currents with additional margin to address future system expansion.

The facility is designed such that loss of one or both units will not perturb the external grid to the extent that offsite power will be unavailable.

The DC control power systems for the 345kV and 765kV switchyards are completely independent of the 250 VDC battery systems for the units. The failure of any of the switchyard DC supplies will not affect the unit 250-volt DC systems. The trip and close coils for the switchyard breakers are independent of one another and must be energized to operate. Loss of switchyard breaker DC control power will not initiate a breaker operation. The DC control power systems for the 345kV and 765kV switchyards are separate and independent. However, it is possible to manually arrange for any switchyard DC system to be supplied by an alternate switchyard battery.

8.3 STATION SERVICE SYSTEMS

8.3.1 4160 Volt System

Unit auxiliary power is distributed from the 4160 volt switchgear which is energized from the main generator through unit auxiliary transformers TR1AB and TR1CD during normal operation, and from Preferred Offsite Power Source reserve auxiliary transformers TR101AB and TR101CD during start-up or shutdown operations. The 4160 volt system is duplicated for Unit No. 2.

During shutdown and outage conditions (modes 5, 6, and defueled), the 4160 V buses are capable of being energized from the offsite source through the main power transformer and the unit auxiliary transformers. The electrical configuration is the same as for on-line power operation except that the generator is off-line and the generator disconnect links are removed to prevent “motoring” of the generator. This configuration is referred to as “backfeed”.

The 4160 volt switchgear is arranged in eight bus sections. Buses 1A, 1B, 1C, 1D, T11A and T11D each have a capacity of 2000 amperes. Buses T11B and T11C, which serve only transformers TR11B and TR11C, have a capacity of 1200 amperes. Motors 400 hp or larger operate from the 4160 volt buses. All feeder and motor circuits are protected by:

a. Overcurrent relays which trip the associated breaker in the event of a sustained overload or fault.

b. Instantaneous relays for ground fault and motor cable faults.

During start-up, the total unit power demand is supplied from preferred offsite power source via reserve auxiliary transformers TR101AB and TR101CD. This source may also be used to supply all or part of the unit auxiliary load when the unit is on line. However, the auxiliary load is normally transferred to unit auxiliary transformers TR1AB and TR1CD after the turbine generator has been synchronized and connected to the system. The transfer of load from the preferred offsite power source to the unit auxiliary transformers of load from the preferred offsite power source to the unit auxiliary transformers is effected without a power interruption, by momentarily feeding the 4160 volt switchgear from both the reserve and unit transformers. Once the transfer is complete, each turbine-generator supplies its own auxiliaries. During a planned shutdown, this process is reversed and the auxiliary load is transferred to the Preferred Offsite Power Source before the generator is disconnected from the system. A trip of the unit automatically trips the normal source breakers (unit auxiliary transformers) and transfers the auxiliary loads to the preferred offsite power source.

The 4160 volt buses (T11A, T11B, T11C and T11D) may also be fed from a 4160 volt diesel generator, to supply power to the engineered safety features and other necessary equipment in the event of a loss of offsite power. There are two diesel generators associated with each unit. Each diesel generator is connected to two 4160 volt buses, one to buses T11A and T11B and one to buses T11C and T11D. Upon loss-of-power to a 4160 volt bus, the associated diesel generator starts automatically. The circuit breaker, which normally supplies power to that bus from the main 4160 bus, is tripped. A 4160 volt circuit breaker in each bus is automatically closed when each diesel generator's voltage and speed approach rated values, and re-energizes the bus. The diesel generators will then supply all equipment, which must operate under emergency conditions. The diesel generator system is described in detail in Sub-chapter 8.4.

The alternate offsite power source has been provided (Ref. Figures 8.1-1a, 8.1-1b and 8.1-2b) by a line from the 69kV Bus #2 of the Cook-Thornton Station. This line feeds the 69/4.16 kV transformer TR12EP-1 and the 4160 volt main bus cables are run underground to connect to buses T11A, T11B, T11C, T11D and T21A, T21B, T21C and T21D. This transformer has been sized to provide necessary capacity to operate one train of the engineered safeguards equipment in one unit while supplying one train of safe shutdown power in the other. The breakers which connect this source to the 4160 volt bus are manually operated and interlocked to prevent parallel operation with any other 4160 volt source.

Another alternate on-site power source is available if the Unit Emergency Diesel Generators fail to start. This alternate power source is from the non-safety related Supplemental Diesel Generators (SDGs). There are two SDGs (2,250/4,500 kW total) that operate in parallel to supply power to maintain RCS inventory control.

The new SDGs will start automatically upon a sustained loss of voltage on 4.16 kV Bus 1. Bus 1 is then available for the operator to manually load to any of the safety related 4.16 kV Buses.

8.3.2 Low Voltage Power Systems

The 600 volt auxiliary system distributes power for all low voltage station service demands other than the pressurizer heaters.

The 600 volt system is divided into 8 bus sections, four of which (11A, 11B, 11C and 11D) supply power to emergency equipment. The power source for each of these four buses is a 2000 kVA, 4160/600 volt transformer whose primary is connected to 4160 volt buses T11A, T11B, T11C and T11D respectively. Bus tie breakers between buses 11A and 11C and buses 11B and 11D are normally open and racked out.

The other four 600 volt buses, 11BMC and 11BLC are fed from 4160 volt 1B bus, and the 11CLC and 11CMC are fed from 4160 volt 1C bus via 1500/2000 kVA, 4000/600 volt transformers. A bus tie breaker enables one 1500/2000 kVA transformer to feed both buses should the other transformer fail. 11BMC and 11CMC are connected via bus tie breaker, and 11BLC and 11CLC are connected via bus tie breaker. The switchgear is metal-clad with 250 volt dc operated circuit breakers. The 4160/600 volt transformers are dry-type.

Two (2) 480 volt buses, 11PHA and 11PHC, are fed from two of the 4160V buses, T11A and T11D respectively via two 1000 kVA, 4160/480 volt transformers. These buses supply power to the pressurizer heater loads.

8.3.3 120 Volt AC Vital Instrument Bus System

The 120 volt ac vital instrument bus system consists of four separate vital buses which are supplied by four independent 7.5 kVA, single phase static inverters, as shown in Figure 8.3-1. Two of the inverters connect to one of the station batteries, the other two connect to a second station battery. Each inverter cabinet output may derive its input from any of three sources:

a. The output of a battery charger whose input is a 600 volt Engineered Safety System (ESS) source.

b. A 250 volt station battery, should the ac powered battery charger fail.

c. The output of a balance of plant regulating transformer whose input is a 600 volt ESS source separate from the battery charger source.

Transfers between sources are automatic and will not disturb vital bus voltage and frequency.

The inverter voltage output is regulated automatically at 118 volt ac. The output frequency is synchronized with the frequency of the ac supply voltage when the ac source is energized.

The vital buses constitute a very reliable electrical system. The four vital buses provide a continuous source of power to vital instruments and equipment, independent of any momentary interruption of the ac power system.

The output of each inverter is connected to a distribution cabinet through a normally closed circuit breaker. The distribution cabinets have 15 and 20 ampere branch circuit breakers to feed reactor protection and other vital instrument channels. Reactor protective schemes have redundant channels and the power sources are provided from redundant vital bus cabinets. Because of the fail-safe circuitry of the reactor protective instrumentation, a power source failure to an instrument channel results in a reactor trip signal from the affected channel.

The Unit 1 channel III bus supplies a Unit 2 source range neutron flux monitor N-23 on a local shutdown panel and the channel III Unit 2 bus supplies power to the Unit 1 N-23 monitor. This provides indication of unit reactor shutdown for emergency remote shutdown from an alternate control/monitoring station outside of the associated control room.

8.3.4 250 Volt DC System (Safety Related)

The 250 volt AB & CD batteries supply dc power for operation of switchgear, annunciators, vital bus inverters, motor operated valves and emergency lighting. The battery system shown in Figure 8.3-2 for each unit consists of two separately located sets of 116 lead acid cells. Each AB & CD battery has its own active normal charger and a wired standby charger. Each charger is connected to a different 600 volt ac bus. Transfer from one charger to the other is manual. No automatic transfer between chargers is provided. Two batteries and their chargers are located in each unit.

The batteries are central power station type designed for continuous duty, and each consists of 116 cells connected in series. Each cell is of the sealed type, assembled in a shock absorbing, clear plastic container, with covers bonded-in-place to form a leak-proof seal. The batteries are mounted on protected, corrosion resistant steel racks for security and to facilitate maintenance. The battery rooms are separately ventilated. In the event of fire, the AB and CD battery rooms are isolated from adjacent areas to prevent fire from migrating in or out of the rooms.

Each active charger maintains a nominal floating charge of 260 volts on its associated battery, and can supply an equalizing charge of up to 280 volts when necessary. The normal and standby chargers are identical and have an output of 260 volt dc from an input of 600 volt ac, 3-phase, and are equipped with a direct current voltmeter, ammeter, and alternating and direct current failure relays. Malfunction of an operating charger activates an annunciated alarm in the unit control room. Following a loss of station normal power, the battery chargers are energized from the emergency diesel generators.

Each battery distribution cabinet consists of several metal-clad structures, with a 250 volt dc, 2-wire ungrounded main bus, and 2-pole manually operated fused disconnecting switches. The 250 volt dc distribution cabinets which supply power to the critical solenoid valves ("CCV-AB," "SSV-B," CCV-CD," "SSV-A1," and "SSV-A2") are similar to the above cabinets but do not have disconnecting switches.

During normal operation, the 250 volt dc load is fed from the battery chargers, with the batteries floating on the system. Upon loss of ac power, the entire dc load is drawn from the batteries.

There are two separate criteria, which size the station batteries; the Loss of Offsite Power (LOOP) event, in which the emergency diesel generators are available, and the Loss of ALL AC (Station Blackout; described in section 8.7) event, in which no source of AC power is available. For the LOOP event, the batteries are sized for three hours of continuous operation, predicated upon the continuous operation of all required DC emergency equipment. Upon start-up of the emergency diesel generators, the battery chargers are energized to take over the load and recharge their associated battery. For the Station Blackout (SBO) event, the batteries are sized for four hours of continuous operation, predicated upon the continuous operation of all required DC emergency equipment. (The loads for the LOOP and the SBO events are not identical and therefore both profiles are considered in battery sizing.)

All direct current loads associated with engineered safeguards equipment are fully redundant. These loads are so arranged that redundant functions are supplied each from one battery.

Each battery system is equipped with monitoring instruments and alarms to provide information on battery condition. These instruments include: battery voltmeters, battery ammeter, emergency load voltmeters, emergency load ammeters, charger voltmeters, charger ammeters, ground detection alarm, low battery voltage alarm, high battery voltage alarm, charger failure alarm, and a charger abnormal alarm.

A circuit is provided to cross tie the AB and CD plant batteries and loads on each unit. This circuit has redundant manual isolating switches, one at each point of connection to the two battery systems. Under normal conditions, both of these switches are kept open and the circuit de-energized. Should either of these switches be closed, an annunciator, will operate in the main control room indicating that the cross tie is energized.

The battery, racks, and chargers are all seismically qualified. The 250 Volt dc system has been designed as a Class 1E power source.

8.3.5 250 Volt DC System (Balance of Plant)

The 250 Volt dc Balance of Plant (BOP) battery system supplies dc power for the operation of non-safety related dc motors, their control circuitry and Main Turbine/Feedpump Turbine Digital

Control System. This battery system consists of one set of 120-cell lead acid battery, two battery chargers, power distribution panels, monitoring instruments and alarms, and non-safety related dc loads. The battery system is designed as non-safety and non-seismic. It is physically and electrically isolated from other plant battery systems.

The battery is a central power station type designed for continuous duty. The battery consists of 120 cells connected in series, and each cell is of the sealed type, assembled in a shock absorbing, clear plastic container, with covers bonded in place to form a leak proof seal. The battery is mounted on protected, corrosion resistant steel racks for security and to facilitate maintenance.

The battery system contains two battery chargers. One is normally active and one is normally on standby. Transfer from one charger to the other is manual. No automatic transfer between chargers is provided. The normal and standby chargers are identical and have a rated output of 260 volts dc. The active charger maintains a nominal floating charge of 270 volts dc and can supply a nominal equalizing charge of 280 volts dc. The output voltage is regulated. Each battery charger receives 3-phase, 600 volts ac power from a separate, non-safety related 600 Volt Motor Control Center (MCC). Each charger is equipped with a direct current voltmeter, ammeter, and alternating and direct current failure relays. Malfunction of an active charger activates an annunciated alarm in the unit control room.

The major non-safety related dc loads are associated with the Main Turbine, Feed Pump Turbine, and the Main Generator. They are supplied from the battery distribution cabinet, which consists of one metal-clad structure with a 250 volt dc, 2-wire ungrounded main bus, and 2-pole manually operated fused disconnecting switches. Monitoring instruments and alarms provide information on the condition of the battery system, locally at the distribution panel and in the control room. These instruments include: battery bus voltmeters, battery ammeter, charger voltmeters, charger ammeters, ground detection alarm, low battery voltage alarm, both chargers energized alarm, and a no charger energized alarm.

During normal operation when ac power is available, power for the BOP battery system is supplied from the active battery charger, with the battery floating on the system. Upon loss of station ac power, the battery supplies power to the dc loads. The battery is sized to provide continuous power to all dc loads in the system for two hours. However, with timely de-energizing of unnecessary equipment, the battery can last up to approximately eight hours.

8.3.6 250 Volt DC System (N-Train)

The 250 volt N train battery supplies dc power for the operation of the turbine driven auxiliary feedwater (AFW) system and the AMSAC (ATWS Mitigation System Actuation Circuitry) inverter. This battery system, shown in Figure 8.3-3, (per unit) consists of one battery (one set of 117 lead acid cells) and two battery chargers (normal and standby) each supplied from a separate 600 volt safety train ac bus. Transfer from one charger to the other is manual. No automatic transfer between chargers is provided. This N battery is physically and electrically isolated from the other plant batteries. The battery is a central power station type designed for continuous duty, and consists of 117 cells connected in series. The battery is of the sealed type, assembled in a shock absorbing, clear plastic container, with covers bonded in place to form a leak proof seal. The battery is mounted on protected, corrosion resistant steel racks for security and to facilitate maintenance. The battery rooms are separately ventilated. In the event of fire, the N-Train battery rooms are isolated from adjacent areas to prevent fire from migrating in or out of the rooms.

The active charger maintains a nominal floating charge of 262 volts on the battery, and can supply an equalizing charge of up to 275 volts when necessary. The normal and standby chargers are identical and have a nominal output of 260 volt dc from an input of 600 volt ac, 3-phase, and are equipped with a direct current voltmeter, ammeter and alternating and direct current failure relays. Malfunction of an operating charger activates an annunciated alarm in the unit control room. Following a loss of station normal power, the battery charger is automatically disconnected from the emergency diesel generator. Power to the charger can be manually restored after verification that diesel generator capacity is available.

The battery distribution cabinet consists of one metal-clad structure with a 250 volt dc, 2-wire ungrounded main bus, and 2-pole manually operated fused disconnecting switches.

During normal operation, the 250 volt dc load is fed from the battery charger, with the battery floating on the system. Upon loss of station ac power, the entire dc load is drawn from the battery. For the loop event, the battery is capable of serving the turbine driven auxiliary feed pump for as long as the steam supply to the turbine is available. For the Station Blackout (SBO) event, the battery is sized for four hours of continuous operation of all required dc emergency equipment.

Each battery system is equipped with monitoring instruments and alarms to provide information on battery condition. These instruments include: battery bus voltmeters, battery ammeter, charger voltmeters, charger ammeters, ground detection alarm, low battery voltage alarm, both chargers energized alarm, and a no charger energized alarm.

The battery charger output voltage is regulated to maintain the desired output voltage for either float or equalize operation.

The battery, racks, and chargers are all seismically qualified. The N train power system has been designed as a Class IE power source.

8.3.7 Lighting System

Lighting for turbine areas, reactor containments, and auxiliary and fuel service buildings is supplied from the 600 volt station service system through 3 phase, 600-120/208 volt dry-type transformers. This service system also supplies standby lighting in the service and office buildings. Each lighting distribution cabinet is divided into two parts: one, which supplies the major portion of the lighting, is fed from the normal lighting transformer; the other part which supplies the remainder, is fed from the standby lighting transformer. Emergency lighting for fire brigade access-egress and emergency shutdown capability areas is provided by self-contained battery packs (BATLITs), which will energize in the event of failure of the normal ac supply. There are also specified emergency BATLITs that have a Station Blackout Support Design Basis Function and are included in Table 8. 7-1 Station Blackout Equipment List.

Power for the control room emergency lighting is supplied from the plant battery and is electrically independent of the normal control room lighting. In the event of both normal and standby power failure, the fixtures are automatically energized from a 250 volt dc station battery. Operation of the emergency lights will also energize an annunciator in the unit control room.

8.4 EMERGENCY POWER SYSTEM

The plant power system includes on-site, independent, automatically starting emergency power, which supplies power to essential auxiliaries if normal and preferred offsite power sources are unavailable.

The emergency power source for each unit consists of two 4160 volt, 3-phase, 60 cycle, 3500 kW diesel generators as shown in Figures 8.1-1a and 8.1-1b. The arrangement of the emergency diesel generators and their fuel oil system is shown in Figure 8.4-1. Each diesel engine is equipped with its own auxiliaries. These include starting air, fuel oil, lube oil, cooling water, intake and exhaust system, voltage regulator and controls. Cooling water is provided from the Essential Service Water System while electric power for each engine's auxiliaries is provided by its own generator.

Cranking power for each diesel is supplied from its respective high pressure starting air system. Energy for starting a diesel is derived from two (2) air receivers each containing enough high-pressure compressed air to provide for two starting sequences.

Following the successful start of an emergency diesel generator, the safety-related starting air compressor(s) will operate as needed to continuously supply control air to the diesel engines while simultaneously recharging the starting air receivers, thus allowing the emergency diesel generators to operate for an extended period of time.

There are two diesel fuel oil storage tanks on site, physically separated from each other. The piping is arranged so that each storage tank supplies fuel to one emergency diesel generator in each unit. Each storage tank contains enough fuel oil to run one emergency diesel generator at full load continuously for greater than seven days.

The emergency power sources for the two units are similar and are electrically and physically isolated from one another, as are the diesel generator sets for each unit. Each diesel generator is full capacity with one supplying power to buses T11A and T11B, (T21A and T21B for Unit 2) and the other supplying power to T11C and T11D (T21C and T21D for Unit 2).

Loss of voltage to the 4160 volt buses above is sensed by loss of voltage relays. Upon sensing, master relays automatically start the emergency generators, trip the normal feed circuit breakers for the 4160 volt buses and trips all motor feeder breakers and 480 volt bus transformer feeder breakers on the buses, the 600 volt bus tie breaker, all non-essential 600 volt feeder breakers and 480 volt bus breakers. The emergency generator bus input circuit breakers which connect the diesel generator output to the 4160/600 volt bus system are automatically closed when voltage and speed approach rated values. The diesel generators supply power to 600 volt buses, 11A, 11B, 11C and 11D (21A, 21B, 21C and 21D for Unit 2) through the 4160 volt buses T11A, T11B, T11C, and T11D (T21A, T21B, T21C, and T21D for Unit 2) and transformers TR11A, TR11B, TR11C and TR11D (TR21A, TR21B, TR21C and TR21D for Unit 2) respectively. The 600 volt bus cross-tie breakers cannot close automatically after the diesel generator start and closure of associated EDG output breakers, thus eliminating the possibility of parallel operation of diesel generators.

Each emergency generator comes up to speed and is capable of accepting load within 10 seconds. If either diesel fails to start, the remaining one is capable of supplying the required engineered safeguard load. A safety injection signal will also start the diesels. To avoid overloading of the Emergency Diesel Generators (EDG), the non-essential loads are shed when a Safety Injection occurs and the safety busses are energized from the EDGs.

The diesel generators are sized at 3500 kW each to assure available power to operate the following equipment assuming a loss-of-power concurrent with a loss-of-coolant accident with or without containment spray:

Number	Component	Rating (Horsepower)	Nominal Start Time After Safety Injection Signal and LOOP (sec)	Nominal Start Time After Safety Injection Signal with Containment Spray and LOOP (sec)
	Block 600 Volt Safety Related Load	------	10	10
1	Centrifugal Charging Pump	600	13	13
1	Safety Injection Pump	400	17	17
1	Residual Heat Removal Pump	400	21	21
1	Component Cooling Water Pump	500	25	25
1	Essential Service Water Pump	450	30	30
1	Motor Driven Auxiliary Feedwater Pump	500	35	35
1	Containment Spray Pump	600	*	41
1	Non-Essential Service Water Pump	250	47	47**

* Not Automatically Started

** Breaker is sequenced closed but is then automatically tripped due to load conservation interlock associated with a containment spray signal.

The motors listed previously start automatically in sequence as determined by the initiating event after the diesel generator has energized the appropriate buses. In addition, other plant electrical loads fed from these buses may be energized manually provided the operating diesel generators capacity is not exceeded.

All safety equipment is duplicated with one connected to an A or B emergency bus and the other connected to a C or D emergency bus. Should one bus section fail to energize, or one diesel generator fail to start, safety is maintained by the continued integrity of the duplicate system. All switching flexibility of the 600 volt system as previously described, is also maintained. If any safety feature fails to operate automatically, manual operation is possible from the control room.

The emergency power system and the diesel generators are equipped with monitors and annunciators to insure adequate information on system status. Suitable protective devices are provided to initiate prompt automatic detection and isolation of defective or faulted equipment. All annunciators and protective devices are in service as applicable during diesel generator testing. Only the diesel generator differential protection and overspeed trips are operative during actual or simulated emergency conditions.

Diesel generator testing is facilitated by load banks, test circuit breakers and switching equipment that make it possible to load the diesel generators without the need of paralleling the diesel generator to the energized safety buses.

The diesel generators can be started, stopped and their voltage and speed controlled locally via sub-panels in each diesel generator room. In this mode of operation, diesel generator control is independent of the control room.

8.5 DESIGN EVALUATION

All plant electrical systems are designed to ensure maximum operating efficiency and reliability under all conditions. The plant is connected to seven independent external circuits, (six via the 345 kV switchyard and one via the 765 kV switchyard). The switchyards are interconnected and all switchyard equipment is protected from lightning.

Transformer ratios and tap settings in addition to administrative controls are used to insure that safety system electrical equipment connected to or powered from the auxiliary system is operated within acceptable voltage ranges.

During normal operation, auxiliary bus voltages are controlled by the main generator automatic voltage regulator. The main generator may be switched to manual voltage regulation and manually regulated by the control room operator.

All 4160 volt and 600 volt safety buses that serve motor loads have been equipped with undervoltage relays to alert the control room operator to low bus voltage via control panel alarms. Routine surveillances are also used to monitor the voltage on the safety buses. The alarms and bus surveillances facilitate detection of abnormal conditions and initiation of operator action to maintain the bus voltage within allowable limits.

When either of the main generators is on line, a computerized real-time load flow program is used to predict grid voltage levels following the loss of the operating CNP Unit(s). The system dispatchers operate this computer program in order to maintain adequate voltage at Cook switchyards. The CNP operators also review the information.

The preferred offsite transmission network provides adequate power for the engineered safeguards equipment during normal and abnormal conditions. System contingency studies have demonstrated the adequacy of the preferred offsite power source and a low likelihood of low voltage occurrences. In order to prevent an unexpected degradation of the offsite power grid from reducing safety bus voltage beyond equipment ratings while the preferred offsite power source is in use, degraded voltage relaying will disconnect the safety buses and automatically transfer them to the onsite emergency diesel generators. When the plant auxiliaries are being fed from the UATs, the degraded voltage relaying will automatically transfer the safety buses to the preferred offsite power source [automatic load tap changer reserve auxiliary transformers]. If the 4kV bus voltages are not restored to acceptable levels after an additional time delay, the buses will then be automatically transferred to the onsite emergency diesel generators. A safety injection or steam generator lo-lo level signal coincident with a degraded voltage signal will automatically bypass the transfer of the safety busses to the preferred offsite power source and cause the safety busses to directly transfer to the onsite emergency diesel generators. The setpoint and time delay settings established for these relays are chosen to avoid spurious tripping from an adequate offsite power grid during transient voltage disturbances.

Plant auxiliary electrical systems are designed so each bus may be fed from several sources. Components, which perform duplicate functions, receive their power from different buses to ensure functional reliability. Inherent in system design is the ability to accept a single component failure or fault without jeopardizing plant safety or causing undue risk to public health and safety.

Redundancy in the Emergency Power System ensures the availability of adequate power needed to effect an orderly shutdown under a loss-of-power condition or a concurrent loss-of-power, loss-of-coolant accident. Both emergency diesel generators associated with each unit are protected from natural phenomena, are capable of supplying required power should either generator fail to start, and can be operated locally independent from the control room should that become necessary.

8.6 TESTS AND INSPECTION

All electrical equipment was specified for manufacture in accordance with the latest requirement of NEMA (National Electrical Manufacturers Association), IEEE (Institute of Electrical & Electronic Engineers), or ANSI (American National Standards Institute, Inc.) standards, where applicable.

Electrical equipment was suitably protected during shipment and upon arrival at the job site was properly stored, prior to, and during construction. Installation of all equipment was under the supervision of a qualified electrical construction engineer, with special attention given to mechanical alignment and electrical ground connection. The dielectric of all power equipment insulation was measured and corrected if necessary before equipment was energized.

Electrical Equipment protective relays are set and calibrated by trained and qualified personnel.

Each standby power system was installed and checked out several months prior to criticality. Prior to acceptance the diesel generator units were tested to verify their starting time and loading ability. The units are periodically tested to ensure the availability of standby power. The diesel fuel oil transfer pumps are tested commensurate with their safety functions as augmented tests in accordance with the applicable edition of the ASME Operation and Maintenance (OM) Code.

Automatic starting and loading of emergency generators is an essential feature of the Engineered Safeguards, therefore periodically tested. Loss of voltage on the bus under test automatically starts the emergency generator, closes the generator breaker, and re-energizes that emergency bus system.

Simulated Safety Injection actuation is also used to start the diesel generators and to verify correct load sequencing if accompanied by loss of bus voltage. During testing of a given emergency generator system, its redundant system remains available if needed.

A maintenance program shall be established to test non-safety related molded case circuit breakers that are not shed following a loss of offsite power, and are fed from safety-related buses.

The station batteries provide control power for operating switchgear and must maintain an adequate charge. To achieve this, the batteries are continuously monitored for voltage variations or undesired ground connections.

During power operation, the station batteries are periodically checked for specific gravity and individual cell voltages. An equalizing or over-voltage charge is applied when required to bring all cells up to an equal voltage. A disconnected battery or broken cell connector would be revealed during these equalizing charges. Periodically, the battery charger is disconnected and the ability of the battery to maintain voltage and assume the direct current load verified. This test will divulge any high resistance connections or cell internal malfunction. Over a period of time these tests also reveal a weak or weakening trend in any cell and corrective measures can be instituted.

8.7 STATION BLACKOUT

Station Blackout (SBO) refers to the complete loss of alternating current (AC) electric power to the essential and non-essential switchgear buses in a nuclear power plant (i.e. loss of off-site electric power system concurrent with turbine trip and unavailability of on-site emergency AC power system). SBO does not include the loss of available AC power to buses fed by station batteries through inverters or by alternate AC power sources, nor does it assume a concurrent single failure or a design basis accident. At the Cook Nuclear Plant, which is a two unit nuclear station, SBO is postulated to occur in only one unit since the emergency AC power sources are not completely shared by the two units.

8.7.1 Coping Period Determination

The determination of the specified period that the plant is required to cope with a SBO is based on the probability of a SBO at the site as well as the capability for restoring power. Using NUMARC 87-00 (Reference 2) guidance, and based on the categorization of the Cook Nuclear Plant within Off-site Power Group 2 and EAC Power Supply System Configuration Group C, and an EDG Target Reliability of 0.975, the calculated minimum acceptable SBO coping duration is determined to be four (4) hours for the Cook Nuclear Plant (Reference 15).

8.7.2 SBO Coping Analyses

Cook Nuclear Plant has adopted the AC Independent approach for coping with an SBO event as delineated in Regulatory Guide 1.155 (Reference 4). The Cook Nuclear Plant can sustain the SBO event for the coping duration of 4 hours by utilizing the available structures, systems, and equipment. The ability of plant systems to withstand and recover from a SBO event is based on evaluations that were previously performed (also, referred to as coping analysis) of the following:

1. Condensate inventory for decay heat removal
2. Class 1E battery capability
3. Compressed air availability for air operated valves
4. Effects of loss of ventilation
5. Containment integrity and isolation capability
6. Reactor Coolant Inventory.

Each of the above items was evaluated following the guidance of NUMARC 87-00, except where RG 1.155 took precedence. The results of these evaluations are summarized below.

8.7.2.1 Evaluation of Condensate Inventory for Decay Heat Removal

For a four hour SBO event, it was determined by a calculation that the amount of Condensate Storage Tank (CST) water required for decay heat removal, as well as for primary/secondary side pressure reduction to reduce RCP seal leakage, is considerably less than the technical specification minimum dedicated water inventory in the CST. Hence, the reactor will be in a safe condition during a SBO for the duration and satisfy the SBO safe shutdown functional requirements.

Additionally, in order to avoid the turbine-driven auxiliary feedwater (AFW) pump runout condition, the Emergency Operating Procedures (EOP) for the SBO event controls the flow from the turbine-driven AFW pump by throttling the valves FMO-211, 221, 231 and 241.

8.7.2.2 Evaluation of Class 1E Station Batteries

To meet the required emergency loads for a four hour SBO event, the three 250 VDC Class IE batteries, namely the Train A and the Train B station batteries and the “N” train battery have adequate capacity provided certain loads are shed by operator manual action. The following electrical loads will be shed for the Cook Nuclear Plant unit under SBO during the first hour into the SBO event:

- AMSAC inverter power supply on the “N” train battery

The following major criteria are used in the SBO analysis of the station batteries:

- Utilize IEEE-STD-485 to determine load profile and the required battery sizes.
- The SBO battery sizing includes an aging factor, design margin, and temperature compensation factors.
- This SBO analysis utilizes the latest loading data including the aforementioned load shedding scheme to establish the SBO battery duty cycle and determine the required battery size.
- The battery calculations use a 60°F minimum battery electrolyte temperature for train A&B batteries. The battery electrolyte temperatures are administratively maintained above 70°F. Operating procedures have been revised to include

battery room surveillances to alert operators to low battery room and /or electrolyte temperatures.

The SBO battery analysis concludes that all existing batteries are adequately sized for the anticipated load for a four hour SBO event with load stripping. Applicable plant EOP procedures require this stripping of electrical loads during a SBO event.

8.7.2.3 Evaluation of Availability Compressed Air

The only air-operated valves relied upon to cope with a SBO are the steam generator Power Operated Relief Valves (PORVs). Steam generator PORVs fail closed on loss of air, and are provided with backup nitrogen bottles and equipped with handwheels for manual operation under plant procedures.

8.7.2.4 Evaluation of Effects of Loss of Ventilation

Dominant areas of concern (DAC) are defined by NUMARC 87-00 as areas that have a significant heat load during a SBO, and contain safe shutdown equipment. For Cook Nuclear Plant, the DACs and the main Control Room are listed in the tabulation below along with their associated final (4 hour) SBO temperature. Additionally, consideration of the Class 1E battery rooms are included as DACs. Battery rooms are concerns during low outside temperature conditions while the remaining areas are concerns during high outside temperature conditions.

AREA	FINAL TEMP
Steam-driven Auxiliary Feedwater Pump	131°F
Main Control Room	118.7°F
CRID Inverter Room	115.5°F
Battery Room "AB"	69°F
Battery Room "CD"	60.3°F
East Main Steam Valve Stop Enclosure	150°F
West Main Steam Valve Stop Enclosure	150°F
Unit 1 N-Train Battery Room	55°F
Unit 2 N-Train Battery Room	53°F

The SBO response equipment located in these areas will remain operable for the duration of the SBO. However, the opening of Control Room cabinet doors associated with SBO equipment is required and is administratively controlled by plant procedures.

8.7.2.5 Evaluation of Containment Isolation

Containment integrity is defined such that the capability for valve position indication and closure of certain containment isolation valves (CIV) is provided independent of the preferred or Class 1E power supplies. The CIVs requiring this capability are valves that may be in the open position at the onset of a SBO. Acceptable means of position indication includes local mechanical indication, dc powered indication (including ac powered indicators powered through inverters), and Alternate AC (AAC) indication. Acceptable means of closure include manual operation, air operation (including air-operated valves that are mechanically closed on loss of air), dc powered operation or AAC powered operation.

Fourteen CIVs were identified per unit and are listed in the table below. Based on the evaluation, these CIVs pose no adverse impact on the containment integrity since they perform a specific function to remain open during a SBO or procedures establish methods to manually close these valves (namely, QCM-350; and MCM-221 & -231) during a SBO, if needed.

Valve	Valve Description
ICM-311 and -321	8" RHR RCS Injection MOVs
ICM-260 and -265	4" SI Pump Discharge MOVs
ICM-111	12" Normal RHR RCS Injection MOV
ICM-250 and -251	4" BIT Outlet MOVs
ICM-129	14" RCS RHR Supply MOV
ICM-305 and -306	18" Recirculation Sump RHR MOVs
MCM-221 and -231	4" TDAFP Turbine Main Steam Supply MOVs
QCM-250 and-350	4" RCP Seal Water Return MOVs

8.7.2.6 Reactor Coolant Inventory

For a four hour SBO event, the Cook Nuclear Plant maintains adequate reactor coolant system (RCS) inventory to ensure that the core is sufficiently cooled following an SBO. The SBO analysis assumes an expected loss of 25 gpm from each RCS pump and a normal system leakage at technical specification allowances. In addition, the SBO analysis assumes a letdown flow rate of 120 gpm for the first 10 seconds of the event (letdown is assumed to be isolated in 10 seconds due to a loss of air/power to valves QCR-300 and QCR-301). This analysis concludes that there is sufficient RCS inventory to keep the reactor core covered following the 4-hour SBO coping period.

Additional plant specific analysis has confirmed that the assumption of 25 gpm from each RCS pump (seal leak-off flow) is valid. The analysis further verified that the loss of RCP seal injection flow during an SBO would not impact charging pump operability or CCW system operability when power is restored. Seal leak-off piping pressure integrity was also demonstrated to be maintained following an SBO.

8.7.3 Station Blackout Equipment List

Engineering review determines the plant equipment necessary to cope with a station blackout event. The station blackout event is assumed to end once AC power (onsite or offsite) is restored. All equipment is assumed to function properly (i.e., the station blackout equipment list does not assume the need for contingency equipment to compensate for potential equipment failures). Specified Emergency BATLITs provide credited illumination for the Station Blackout Coping Period. Table 8.7-1 is the list of equipment required to cope with a station blackout event. The equipment referenced is applicable to both Units 1 and 2.

8.7.4 References

1. DB-12-SBO, Station Blackout.
2. NUMARC 87-00, Revision 1 (August 1991).
3. 10 CFR 50.63, Loss of All AC Power.
4. Regulatory Guide 1.155, Station Blackout.
5. AEP:NRC:0537D Generic Response To Station Blackout Rule For Plants Using AC Independent Station Blackout Response Power

6. AEP:NRC:0537G, Response To Station Blackout (SBO) Safety Evaluation Report
7. AEP:NRC:0537H, Additional Information Concerning Conformance With Station Blackout Rule (10CFR50.63)
8. Brown Bag Letter to Gene Carpenter (NRC) dated March 21, 1991.
9. NRC Safety Evaluation Report dated October 31, 1991.
10. NRC Safety Evaluation Report dated April 23, 1992.
11. AEP:NRC:0537E, Additional Information For Station Blackout (SBO).
12. 01,02-OHP 4023.ECA.0.0, 0.1 and 0.2.
13. Memo from M. Finissi/E. Gilabert to G. Roulett dated September 30, 1992 (SBO Equipment list).
14. Calculation MD-12-MSC-054-N, Dominant Areas Of Concern For Station Blackout Evaluation
15. Calculation 12-E-N-SBO-COP-001, Station Blackout Required Coping Duration
16. Calculation MD-12-CST- 001-N, Condensate Storage Tank Usable Volume And Vortexing.
17. Calculation MD-12-HV-026-N, CD Battery Room Steady State And Station Blackout Transient Temperatures
18. Calculation MD-12-HV-29-N, N Battery Room Station Blackout Temperature Analysis
19. Calculation MD-12-HV-037-N, Control Room Temperature Transient During Station Blackout
20. Calculation TH-99-01, Reactor Coolant Inventory After Station Blackout.
21. Calculation TH-99-05, Steam Generator Compartment Flow path And Volume Data For The TMD Code Analysis Of Steam Generator Compartment Pressure Distribution
22. Calculation TH-99-07, Reactor Coolant Pump No. 1 Seal Leakage During Station Blackout Conditions

23. Calculation TH-99-10, Evaluation Of Components Impacted By RCS Fluid Leakage Past The Reactor Coolant Pump No. 1 Seal During Station Blackout
24. Calculation TH-99-12, Effects On Station Blackout Coping Due To Loss Of Control Air Supply To AOV's
25. Calculation TH-99-13, Condensate Storage Tank Inventory
26. Calculation TH-99-14, Effects Of Loss Of Ventilation In Containment During Station Blackout Coping Period
27. US NRC IN 95-42, Commission Decision on the Resolution of Generic Issue 23, “Reactor Coolant Pump Seal Failure”.
28. MPR-2083, Rev. 1, April 2000, “D.C. Cook Nuclear Plant Reactor Coolant Pump Seal Leak-Off Response to Station Blackout”.
29. Calculation 1-E-N-ELCP-250-006, 250 VDC Battery 1 CD System Analysis
30. Calculation 1-E-N-ELCP-250-007, 250 VDC Battery 1 AB System Analysis
31. Calculation 1-E-N-ELCP-250-008, 250 VDC Battery 1 N System Analysis
32. Calculation 2-E-N-ELCP-250-006, 250 VDC Battery 2 CD System Analysis
33. Calculation 2-E-N-ELCP-250-007, 250 VDC Battery 2 AB System Analysis
34. Calculation 2-E-N-ELCP-250-008, 250 VDC Battery 2 N System Analysis

STATION BLACKOUT EQUIPMENT LIST

Comp No.	Component Description
BATT-AB	Plant Battery AB
BATT-CD	Plant Battery CD
BLP-110	Steam Generator OME 3-1 Channel IV RPS Input Narrow Range Level Transmitter
BLP-111	Steam Generator OME 3-1 Channel II RPS Input Narrow Range Level Transmitter
BLP-112	Steam Generator OME 3-1 Channel III RPS Input Narrow Range Level Transmitter
BLP-120	Steam Generator OME 3-2 Channel IV RPS Input Narrow Range Level Transmitter
BLP-121	Steam Generator OME 3-2 Channel I RPS Input Narrow Range Level Transmitter
BLP-122	Steam Generator OME 3-2 Channel III RPS Input Narrow Range Level Transmitter
BLP-130	Steam Generator OME 3-3 Channel IV RPS Input Narrow Range Level Transmitter
BLP-131	Steam Generator OME 3-3 Channel I RPS Input Narrow Range Level Transmitter
BLP-132	Steam Generator OME 3-3 Channel III RPS Input Narrow Range Level Transmitter
BLP-140	Steam Generator OME 3-4 Channel IV RPS Input Narrow Range Level Transmitter
BLP-141	Steam Generator OME 3-4 Channel II RPS Input Narrow Range Level Transmitter
BLP-142	Steam Generator OME 3-4 Channel III RPS Input Narrow Range Level Transmitter
CRID-I	120 VAC CRID Channel I Distribution Panel
CRID-II	120 VAC CRID Channel II Distribution Panel
CRID-III	120 VAC CRID Channel III Distribution Panel
CRID-IV	120 VAC CRID Channel IV Distribution Panel
FFI-210	AFW to Steam Generator OME 3-1 Flow Indicator Transmitter
FFI-220	AFW to Steam Generator OME 3-2 Flow Indicator Transmitter
FFI-230	AFW to Steam Generator OME 3-3 Flow Indicator Transmitter

STATION BLACKOUT EQUIPMENT LIST

Comp No.	Component Description
FFI-240	AFW to Steam Generator OME 3-4 Flow Indicator Transmitter
MCM-221	Main Steam Lead#2 to Auxiliary Feedwater Pump Turbine Shutoff Valve
MCM-231	Main Steam Lead#3 to Auxiliary Feedwater Pump Turbine Shutoff Valve
FMO-211	TDAFW Pump PP-4 Discharge to Steam Generator OME 3-1 Control Valve
FMO-221	TDAFW Pump PP-4 Discharge to Steam Generator OME 3-2 Control Valve
FMO-231	TDAFW Pump PP-4 Discharge to Steam Generator OME 3-3 Control Valve
FMO-241	TDAFW Pump PP-4 Discharge to Steam Generator OME 3-4 Control Valve
NPS-110	Reactor Vessel Train “A” Wide Range Pressure Transmitter
NPS-111	Reactor Vessel Train “B” Wide Range Pressure Transmitter
TK-32	Condensate Storage Tank
C-261	Condensate Storage Tank to and from Condensers Shutoff Valve
MRV-213	Steam Generator OME 3-1 PORV
MRV-223	Steam Generator OME 3-2 PORV
MRV-233	Steam Generator OME 3-3 PORV
MRV-243	Steam Generator OME 3-4 PORV
NTR-210	Reactor Coolant Loop#1 Cold Leg Wide Range Temperature Recorder Thermal Sensor
NTR-230	Reactor Coolant Loop#3 Cold Leg Wide Range Temperature Recorder Thermal Sensor
PP-4	Turbine Driven Auxiliary Feedwater Pump
QCM-350	Reactor Coolant Pump Seal Water Return Train “B” Containment Isolation Valve
BATT-N	Train “N” Plant Battery
1/2 BATLIT	Specified Station Blackout Emergency Battery Lighting Units

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INDIANA MICHIGAN POWER COMPANY

DONALD C. COOK

NUCLEAR PLANT

BRIDGMAN MICHIGAN

MAIN AUXILIARY ONE-LINE DIAGRAM
BUS "A" & "B"
ENGINEERED SAFETY SYSTEM
(TRAIN "B")

UNIT #1 CIA 42373

DWG. NO. FSAR FIG. 8.1-1A

ARCH		ELEC		MECH		STR	

SCALE: NONE
DR:
DATE:
CH:

DESIGN ENGINEERING DIVISION:

AEP AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

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INDIANA MICHIGAN POWER COMPANY

DONALD C. COOK

NUCLEAR PLANT

BRIDGMAN **MICHIGAN**

MAIN AUXILIARY ONE-LINE DIAGRAM
BUS "C" & "D"
ENGINEERED SAFETY SYSTEM

(TRAIN "A")

UNIT #1 CIA 42373

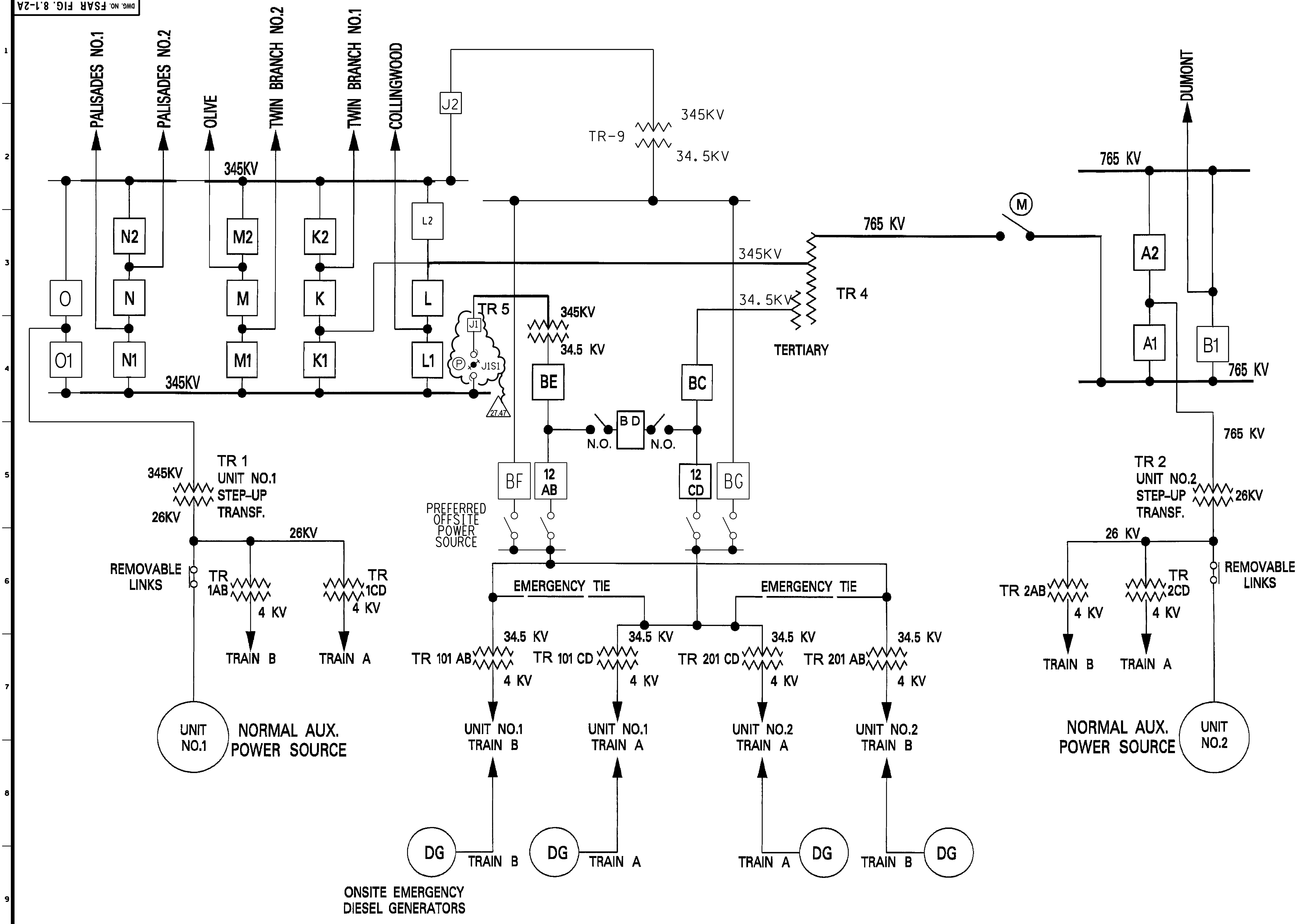
DWG. NO. **FSAR FIG. 8.1-1B**

ARCH		ELEC		MECH		STR	

SCALE: · DR: ·
DATE: · CH: ·
DESIGN ENGINEERING DIVISION:

AEP AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215



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INDIANA MICHIGAN POWER COMPANY

DONALD C. COOK

NUCLEAR PLANT

BRIDGMAN MICHIGAN

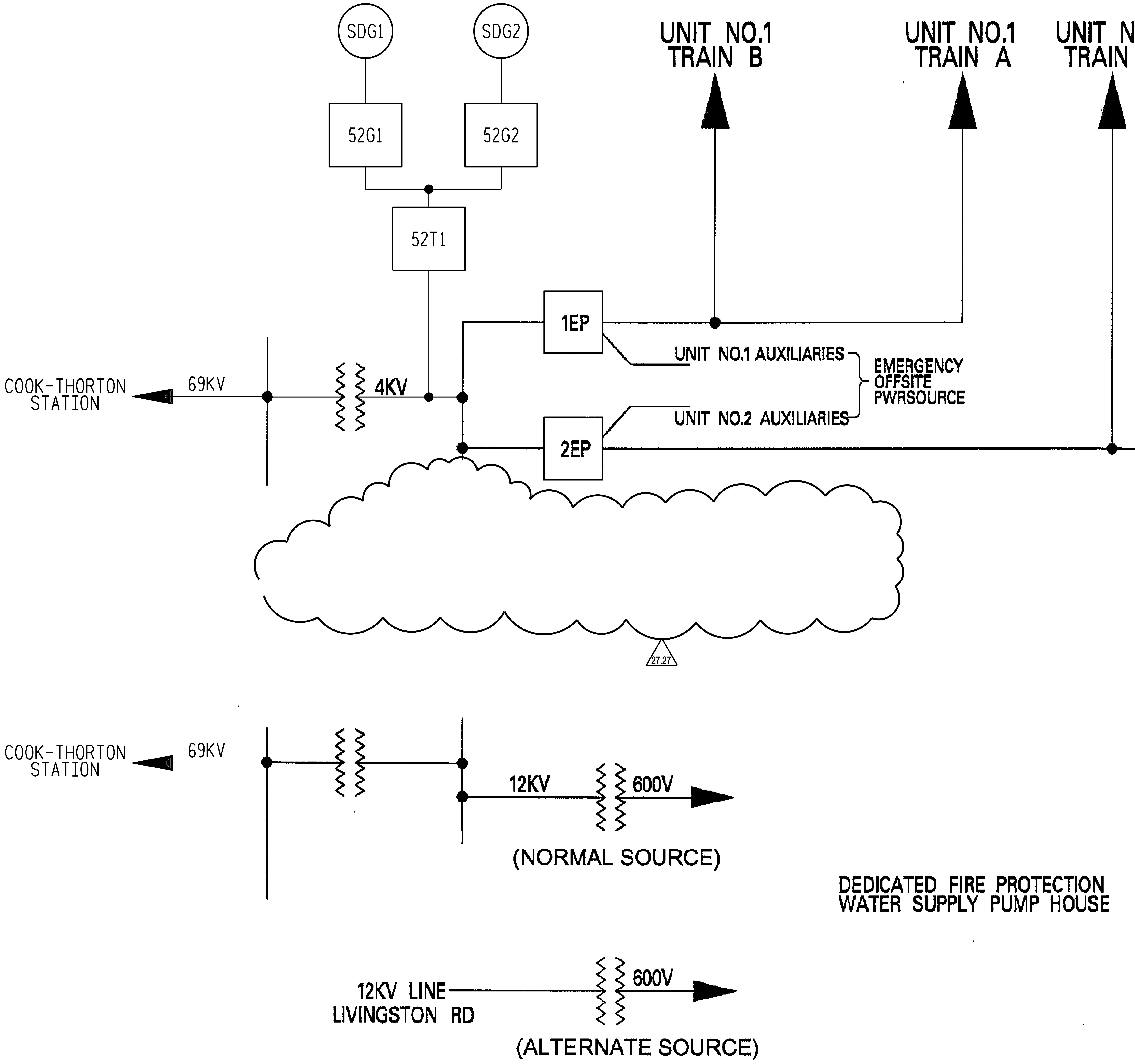
SIMPLIFIED OFFSITE
POWER SOURCES

DWG. NO. **FSAR FIG. 8.1-2A**

ARCH		ELEC		MECH		STR	
SCALE:				DR:			
DATE:				CH:			

DESIGN ENGINEERING DIVISION:
REFER TO ORIGINAL ISSUE
MICROFILM FOR SIGNATURES

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215



REFERENCES:
OP-1-12007
30292-1000A

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INDIANA MICHIGAN POWER COMPANY

DONALD C. COOK
NUCLEAR PLANT
BRIDGMAN MICHIGAN

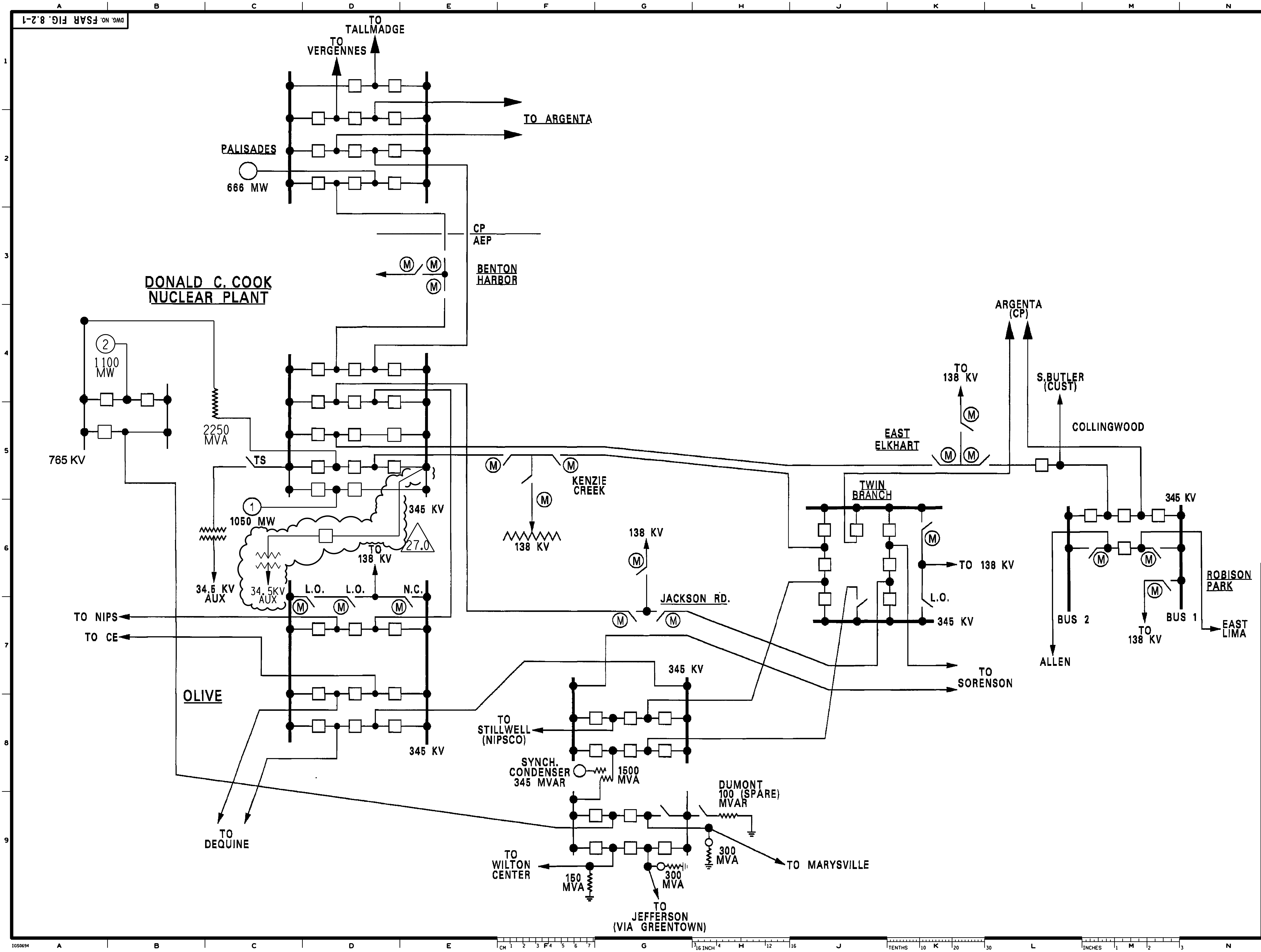
SIMPLIFIED OFFSITE
POWER SOURCES

DWG. NO. FSAR FIG. 8.1-2B

ARCH ELEC MECH STR

SCALE: NONE
DR:
DATE:
CH:
DESIGN ENGINEERING DIVISION:

AMERICAN ELECTRIC POWER
AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215



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INDIANA MICHIGAN POWER COMPANY

DONALD C. COOK

NUCLEAR PLANT

BRIDGMAN MICHIGAN

SWITCHING ARRANGEMENTS
DONALD C. COOK NUCLEAR
PLANT AND NEIGHBORING
STATIONS

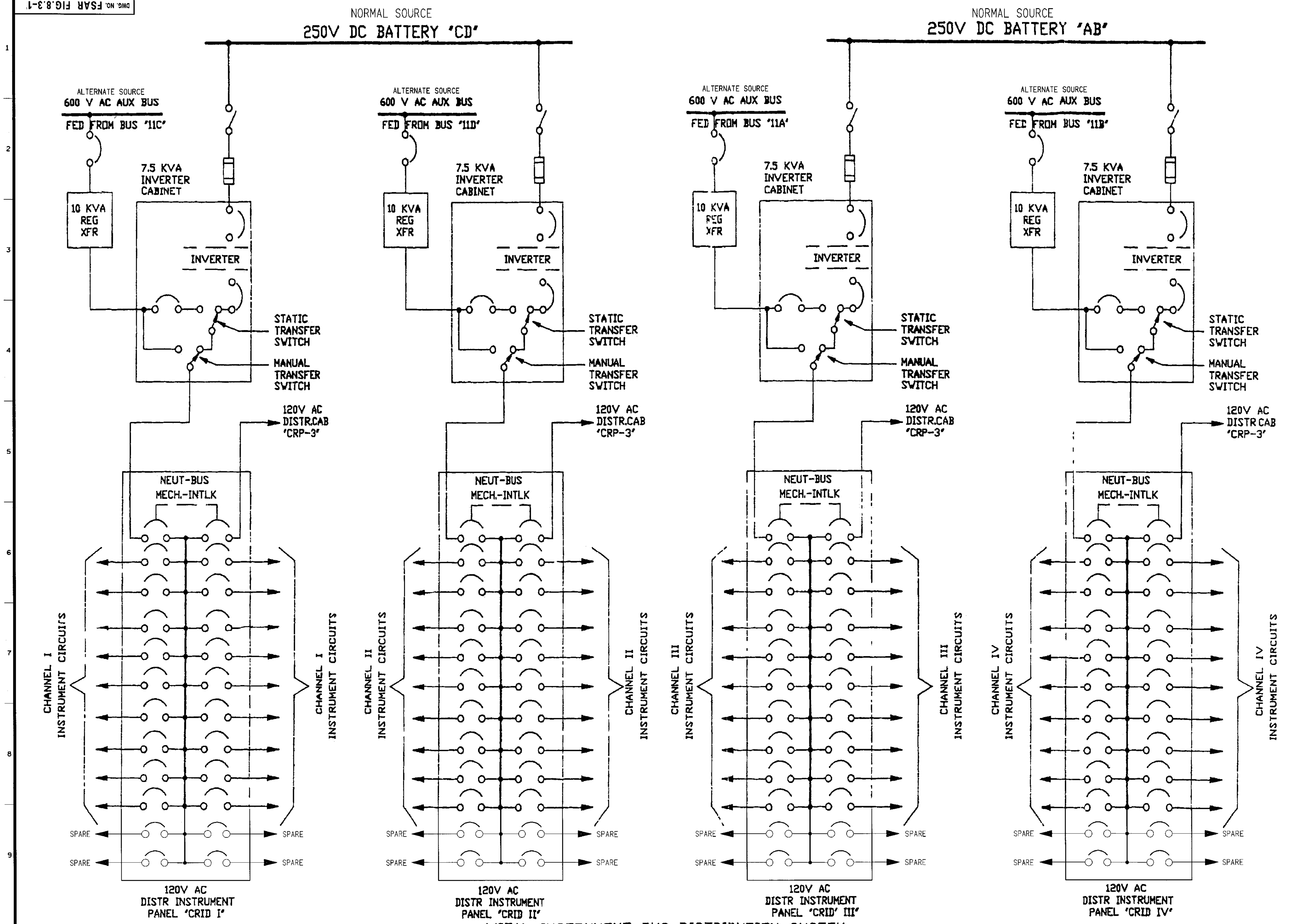
DWG. NO. FSAR FIG. 8.2-1

ARCH		ELEC		MECH		STR	

SCALE: · DR: ·
DATE: · CH: ·
DESIGN ENGINEERING DIVISION:

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

DWG. NO. FSAR FIG. 8.3-1



VITAL INSTRUMENT BUS DISTRIBUTION SYSTEM FSAR FIG. 8.3-1

REFERENCES:
OP-1-12050

DATE	NO.	DESCRIPTION	APPD.
	163	REVISED:PER PS 4099 TASK 9912, FOR UFSAR CHANGE PACKAGE 98-UFSAR-0443, 98-UFSAR-0580	

REVISIONS

FILENAME: fsar-fig-8-3-1.163
(raster file): fsar-fig-8-3-1 163.cit

INDIANA MICHIGAN POWER COMPANY
DONALD C. COOK
NUCLEAR PLANT
BRIDGMAN MICHIGAN

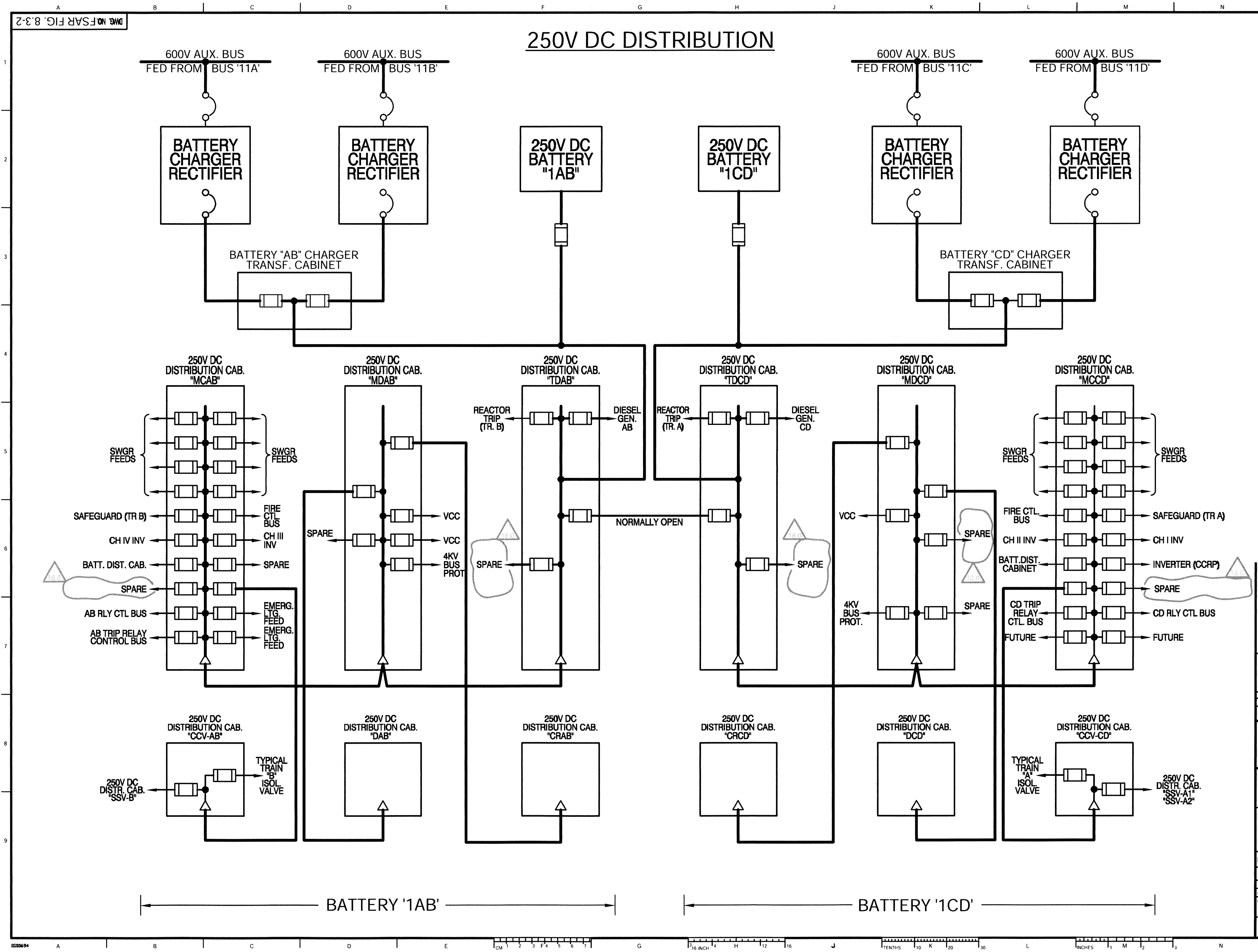
VITAL INSTRUMENT BUS
DISTRIBUTION SYSTEM

DWG. NO. **FSAR FIG. 8.3 - 1**

ARCH ELEC MECH STR
SCALE: DR:
DATE: CH:
DESIGN ENGINEERING DIVISION:

AMERICAN ELECTRIC POWER
AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

250V DC DISTRIBUTION



REFERENCES:
OP-1-12003

DATE	NO	DESCRIPTION	APPD
	18.0	REVISED PER UCR-1603 W.S.	

REVISIONS

FILENAME : fsar-fig-8-3-2_18-0.dwg

INDIANA MICHIGAN POWER COMPANY
DONALD C. COOK
NUCLEAR PLANT
BRIDGMAN MICHIGAN

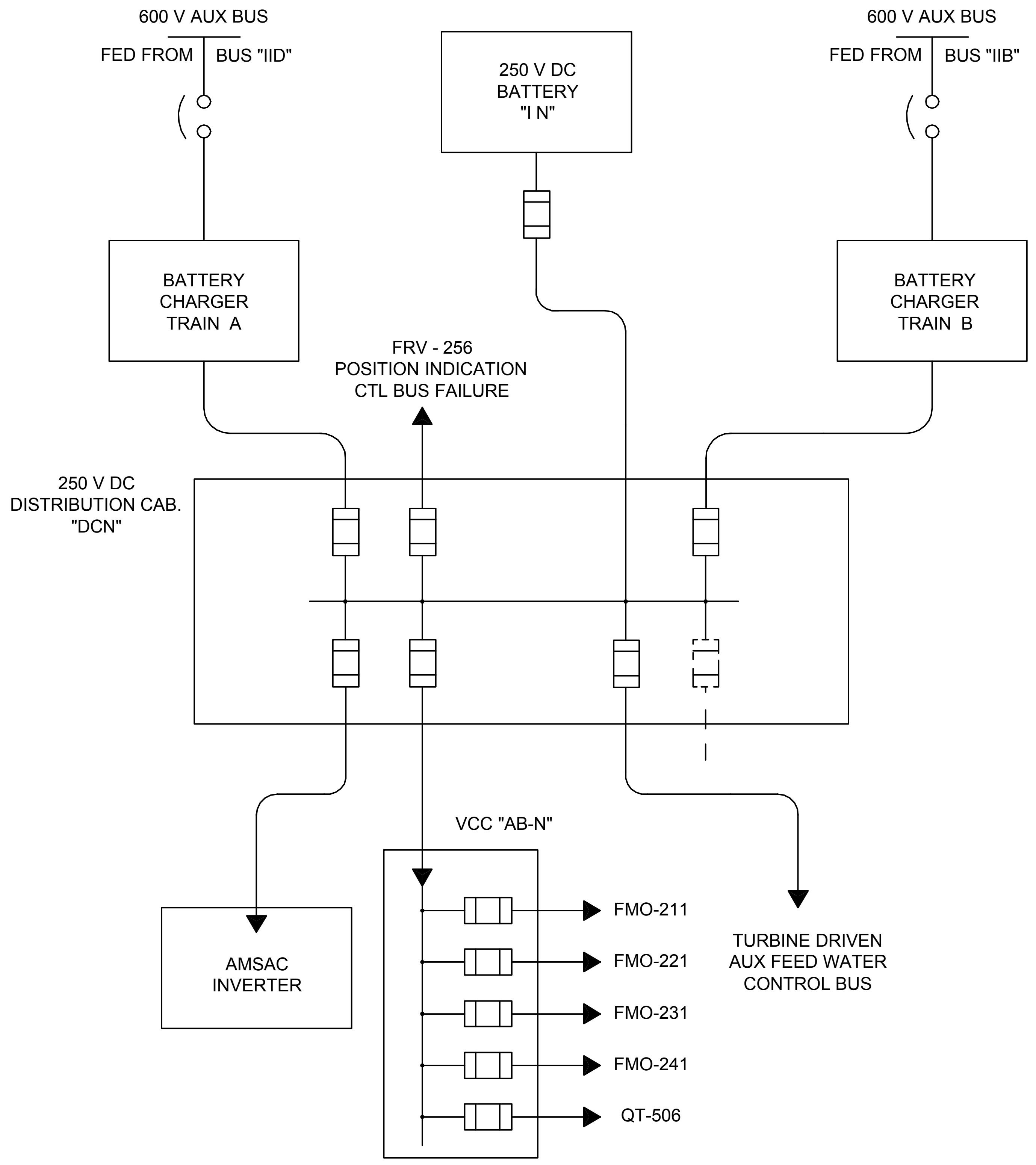
250 VDC DISTRIBUTION

DWG. NO. FSAR FIG. 8.3-2

ARCH ELEC MECH STR
SCALE NONE DR
DATE CH
DESIGN ENGINEERING DIVISION:

AMERICAN ELECTRIC POWER
AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

DWG. NO. FSAR FIG.



DATE	NO.	DESCRIPTION	APPD.
	17	REVISED PER UCR 620	

REVISIONS

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INDIANA MICHIGAN POWER COMPANY
DONALD C. COOK
NUCLEAR PLANT
BRIDGMAN MICHIGAN

UNITS NO. 1 & 2
250 V Distribution
"IN" N Battery

DWG. NO. **FSAR FIG. 8.3 - 3**

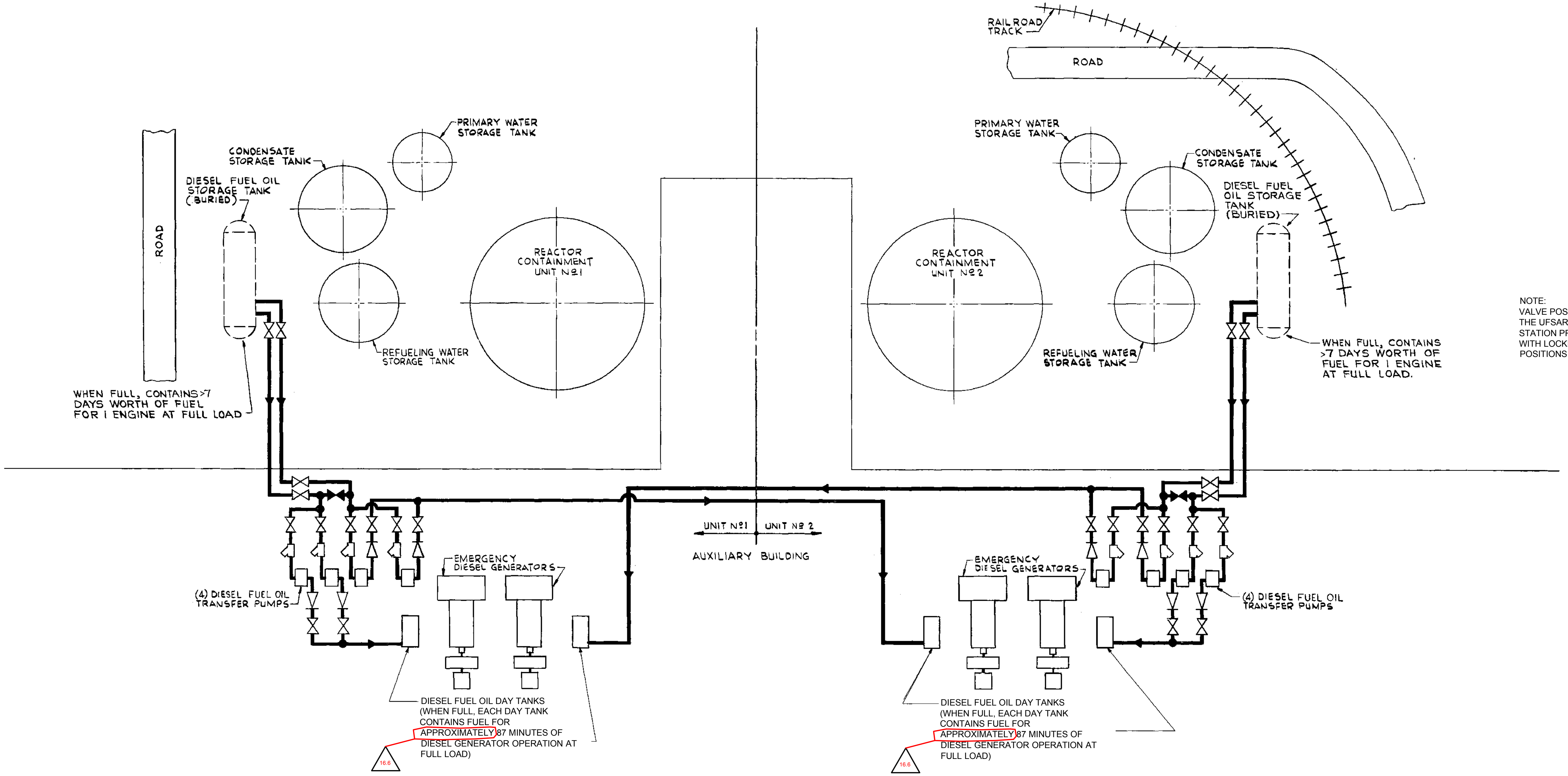
ARCH | ELEC | MECH | STR

SCALE:
DR:
DATE:
CH:
DESIGN ENGINEERING DIVISION:

AEP AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

DWG. NO. FSAR FIG.8.4-1



DIESEL FUEL OIL DAY TANKS (WHEN FULL, EACH DAY TANK CONTAINS FUEL FOR APPROXIMATELY 87 MINUTES OF DIESEL GENERATOR OPERATION AT FULL LOAD)

DIESEL FUEL OIL DAY TANKS (WHEN FULL, EACH DAY TANK CONTAINS FUEL FOR APPROXIMATELY 87 MINUTES OF DIESEL GENERATOR OPERATION AT FULL LOAD)

NOTE:
VALVE POSITIONS ARE NOT GOVERNED BY THE UFSAR FIGURES BUT RATHER BY STATION PROCEDURES (EXCEPT VALVES WITH LOCKED OR SEALED, AND FAILURE POSITIONS AS INDICATED).

REFERENCES:

NOTE:
LOCAL FUEL SUPPLIERS HAVE TOTAL STORAGE CAPACITY OF 5.5 MILLION GALLONS DELIVERY TRUCKS RANGE IN CAPACITY FROM 9,000 TO 15,000 GALONS
THIS INFORMATION IS CONSIDERED HISTORICAL AND IS NOT INTENDED OR EXPECTED TO BE UPDATED FOR THE LIFE OF THE PLANT.

DATE	NO.	DESCRIPTION	APPD.
	16.6	Revised Per UCR 98-UFSAR-0458	

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(raster file): fsar-fig-8-4-1 163.cit

INDIANA MICHIGAN POWER COMPANY

DONALD C. COOK
NUCLEAR PLANT
BRIDGMAN **MICHIGAN**

EMERGENCY DIESEL
GENERATOR
FUEL OIL SUPPLY
UNITS NO. 1 & 2

DWG. NO. **FSAR FIG. 8.4 - 1**

ARCH ELEC MECH STR
SCALE: DR:
DATE: CH:
DESIGN ENGINEERING DIVISION:

AMERICAN ELECTRIC POWER
AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215