9.5 OTHER AUXILIARY SYSTEMS

9.5.1 FIRE PROTECTION SYSTEM

Information concerning the Susquehanna Steam Electric Station Fire Protection Program is contained in the Fire Protection Review Report (FPRR) (FSAR Reference 9.5.1).

9.5.2 COMMUNICATION SYSTEMS

9.5.2.1 Design Bases

The communication systems have no safety-related functions.

Various communication systems are provided in the plant to ensure reliable communication. Table 9.5-4 shows communication systems available at the vital areas. The design bases of these systems are:

a) An intra-plant public address providing the following functions:

   1) A 5-channel page-talk handset intercom system for on-site communications between plant locations

   2) Broadcast accountability and fire alarms designed to warn personnel of emergency conditions

b) A private telephone system, with redundant and diversified cables from the plant to two diverse telephone company switching facilities, to permit plant-to-offsite communication on a continuous basis.

c) An intra-plant maintenance/test jack telephone system.

d) Security communication and alarm system.

e) Portable communication system.

f) Voice powered Appendix R communication system to support manual actions required for safe shutdown during Appendix R fire scenario.

g) Satellite telephone system.

9.5.2.2 Systems Description

The plant communication systems are illustrated in riser diagram form (see Dwgs. E-408, Sh. 1, E-408, Sh. 2, E-409, Sh. 1, E-409, Sh. 2, E-409, Sh. 3, E-409, Sh. 4, E-409, Sh. 5, E-409, Sh. 6, E-409, Sh. 7, E-411, Sh. 1, E-411, Sh. 2, and E-418, Sh. 1) and plant location diagrams (see Dwgs. EC-1, Sh. 1, EC-2, Sh. 1, EC-3, Sh. 1, EC-4, Sh. 1, EC-5, Sh. 1, EC-6, Sh. 1, EC-7, Sh. 1, and EC-8, Sh. 1).

9.5.2.2.1 Intra-Plant Public Address (PA)

The intra-plant public address system is a five-channel independent page-party communication system, consisting of telephone handsets, amplifiers and loudspeakers located at various selected areas throughout the plant.

The loudspeakers are powered from individual amplifiers contained in each handset station or from separate power amplifiers. The system provides two-way communication facilities for speech at all handset stations. Each station is capable of originating and receiving information by switching to either a page channel or to one of five non-interfering party-line channels. A desk type "Merge-Isolate," selector switch panel is located in the control room at the plant operating monitor console, and functions as the central control point for the system. Under normal operation six distribution loops of the PA system are "Merged" for complete site coverage. The "Isolate" position of the switch separates the three loops which primarily serve the Unit 1 side of the plant from the three loops which primarily serve the Unit 2 side. This function is seldom used. Buildings and areas outside of the power block are served by various of the six loops. These specifically include the diesel generator buildings, emergency service water pump house, make-up water pump house, circulating water pump house and radwaste building. The preferred power for the PA system is supplied from the Unit 1 vital AC bus, and the alternate power is fed from the Unit 2 vital AC bus. The PA system for the Diesel Generator 'E' facility is powered from a vital AC power supply located in the Diesel Generator 'E' Building. In case the PA system is not available, portable communication will be used.

The Public Address system also broadcasts Emergency Alarms to warn personnel of emergency conditions and provide instructions for site accountability for fire. The Emergency Alarm system consists of a tone generator and tone selector switch.

During emergency conditions the plant operator activates the system by selecting the designated alarm. The alarms and instructions are broadcasted via the PA system page lines to all speakers throughout the plant.

Power for individual P.A. handsets and amplifiers in some specific cases, can be from the plant normal 120V AC system when installed in plant locations other than vital areas as identified in Table 9.5-4.

9.5.2.2.2 Commercial Telephone System (PABX)

The private automatic branch exchange telephone system (PABX) is furnished and maintained by the Commonwealth Telephone Company. This system has switching capability of 4000 lines with more than 1300 in operation. The system includes thirty central office trunks, thirty Electronic Tandem Network Ties and 20 Centrex Ties through Bell Atlantic.

The various types of at least 1500 operating circuits accommodate a great variety of services: dedicated unswitched data transmission; dial-up modem linked data paths; dedicated circuits for video transmission, radio control, rf to audio links; video conferencing on 56k and T-1 long distance carriers.

Telephones and jack stations are located throughout the plant and outlying buildings. These support voice communications and special purpose devices served by the telephone system cable distribution. The power supply for the system consists of two high capacity chargers with a nominal 48 volt battery connected in parallel. This installation can operate the telephone system for a minimum of eight hours after loss of the normal AC supply to the chargers. In addition, an inverter powered by the battery supplies 120 volts AC to the few AC loads critical to the system.

A requirement for specific conventional telephone service (commercial) is mandated by the NRC in 10 CFR 73.55. This requirement is fully met by the installed system.

9.5.2.2.3 Intra-Plant Maintenance/Test Jack System

This system provides independent two-channel station to station communication for use during maintenance and testing activities, and consists of jack stations located at various selected areas throughout the plant. The paging channel is independent of the PA system paging channel. The party lines are connected to the "Jack Station" selector switch panel, which enables the operator to connect any combination of 100 separate stations. All jack stations except PM/test jack stations located on Unit 1 and 2 re-fuel platforms, have a low-level intensity red light to monitor the power supply. Power for this system is supplied from Instrument AC (refer to Subsection 8.3.1.8), except for PM/test jack stations mounted on the re-fuel platform which receive their operating voltage from re-fuel platform 120 VAC power. This system utilizes portable units which are provided with thirty-foot cables and plug type connectors. Each unit contains a power supply, speaker amplifier and speaker, handset amplifier and handset and a preamplifier and jack for use with an optional plug-in headset. The system has the capability, by interconnecting groups of jacks, to provide uninterrupted conversation between the control room and the following areas: control rod drive equipment area, refueling platform, and the turbine generator operating deck. This capability may be used to maintain direct communication between the control room and refueling floor personnel during core alterations as required by plant technical specifications.

9.5.2.2.4 Security Communication System

Refer to the Susquehanna SES Physical Security Plan for a description of the Security Communications System.

9.5.2.2.5 Portable Communication System

Onsite portable radio communication systems are described in the Susquehanna SES Physical Security Plan and in the Susquehanna SES Emergency Plan. Five UHF channels, each consisting of two frequencies for duplex operation through one of five in-plant repeaters, provide onsite portable radio communications. Security is assigned an operating channel and an emergency (backup) channel in accordance with 10 CFR 73. Security officers on continuous and random roving patrols are equipped with handheld two-way radios and/or vehicular mobile radios. The system is tested in accordance with 10 CFR 73.55(9)(3). Provisions of 10 CFR 73.55(f)(3) are accommodated by fixed base stations operating in both channels. Operations is assigned two channels; one channel is assigned to Unit 1 and one to Unit 2. Operators in the plant on rounds and on specific assignments are equipped with handheld two-way radios.

Radio communications for non-routine maintenance or testing by work groups other than Operations are accommodated by use of the fifth channel.

9.5.2.2.6 Voice Powered Appendix R Communication System

The Appendix R communication system is a voice powered communication system, consisting of head sets with either acoustic boom or noise-shielding microphone that plug into jack plates. The jack plates are located in various selected areas throughout the plant. Headsets are provided with a plug in, battery powered portable amplifier for enhanced transmission level to a high noise reception area.

The system provides communication for use during Appendix R fire scenario. No external power is required to operate the system. The system provides communications to perform manual operator actions associated with an Appendix R safe shutdown. Independent loops connect Unit 1 and Unit 2 remote Shutdown Panels with the Control Room and with other appropriate areas. Additionally, a separate loop connects Unit 1 and Unit 2 Remote Shutdown Panels. Annual testing of the system and periodic inventory of installed equipment are performed under the PM Program by Operations.

9.5.2.2.7 Satellite Telephone System

The Satellite Telephone System is a standalone non-Class 1E emergency communications system connected to analog phones located in the control structure, main control room and technical support center. The system provides a means for communication with off-site emergency response organizations under scenarios where normal communication systems are unavailable due to damage to local offsite infrastructure.

The system is powered from a Class 1E emergency standby diesel generator. The system includes a UPS to provide power for up to 8 hours should the diesel backed AC source be unavailable.

9.5.2.2.8 System Evaluation

System design considerations include diversity and operational reliability. The PA, radio, and telephone communication systems are provided with reliable and redundant power supplies for communications between all areas of the Plant.

The PA system and portable radios are the primary means of intra-plant communications for plant operations. The PABX telephone system is used as a backup. The PABX telephone system is also used for special communications requirements and normal offsite communications.

Physical and electrical separation is provided between primary and backup systems to minimize the possibility of a single occurrence affecting more than one system.

Wiring for the public address (PA) system, Intra-Plant Maintenance/Test Jack System, and the telephone (PABX) system is installed in separate and independent conduits. In addition, permanent telephone (PABX) cabling is permitted to be routed in free air.

The Communication Systems have adequate flexibility to keep the plant personnel informed of plant operational status at all times. If one handset station of the PA system would be damaged or inaccessible or if extreme background noise would prevent its use, multiple handset locations at each plant elevation provide easy access to an alternate handset of the PA system.

External communication under extreme environmental conditions is also provided through a satellite telephone system. The satellite telephone provides an additional and diverse method of communication with organizations outside of the plant should normal communication systems, e.g. land based telephone, cellular, be unavailable.

In areas where the ambient sound level could exceed the functional capability of the standard handset, provisions are made for the installation of acoustical enclosures to ensure proper sound levels. However, a maximum dB level for the vital areas identified in the Table 9.5-4 has not been established.

Cabling for the Appendix R voice powered communication system is installed in non-class 1E instrumentation cable tray and conduits. The Appendix R voice powered communication system consists of independent communication loops for safe shutdown from the control room or Remote Shutdown Panels.

9.5.2.3 Inspection and Testing Requirements

Systems described above are conventional and have a history of successful operation at similar existing plants. Most of these systems are in routine use and maintenance, and this ensures their availability. Infrequently used systems are tested on a scheduled basis to ensure operability. The emergency alarm functions are periodically tested. These tests include adequacy of signal level, availability of power sources, and proper function of all circuits.

All employees are familiar with the actual sound of the emergency signal. Notice is given to all plant personnel preceding any alarm test.

Communication equipment used for security is tested in accordance with the requirements of the security plan and 10 CFR 73.55.

Records will be maintained of the scheduled tests of infrequently used systems.

9.5.3 LIGHTING SYSTEM

9.5.3.1 Design Bases

The plant lighting system is designed to furnish illumination levels required for safe performance of plant operation, security, shutdown, and maintenance duties. Emergency DC lighting is provided in essential areas for the safety of personnel during an AC power failure.

a) Area lighting provides the illumination intensities required for the performance of the activities in that area, and shall follow the guidelines recommended by the Illuminating Engineering Society. Lighting fixtures have been selected with consideration for environmental conditions and ease of maintenance.

b) The control room lighting design includes a dimming control system to reduce glare and shadows on the operating control consoles. The structural supports of the lighting fixtures that serve the control room are designed in accordance with Seismic Category I requirements.

c) Incandescent and radiation hardened LED lamps are the only lamps used within the primary containment and the main steam pipe tunnel. High pressure sodium (HPS) or LED lamps are used at the refueling level of the reactor building. Mercury switches are not used within these areas. High-pressure sodium (HPS) lamps, incandescent, and LED lamps are used at the turbine building high bay operating floor. Mercury vapor, fluorescent, and LED lamps are used in the remaining plant areas.

d) High-pressure sodium lamps or LEDs are used for outdoor area lighting and provide illumination required for safe movement of plant personnel, and plant security. Lighting of the protected outdoor area is sufficient to permit effective visual inspection to facilitate surveillance and patrol of the perimeter fence.

e) The 1.5 hour rated emergency lighting systems provide the egress lighting intensities required for use during emergencies or shutdown and meets the requirements stated in the "Building Regulations for Protection from Fire and Panic", Commonwealth of Pennsylvania, Department of Labor and Industry. The eight hour rated emergency lighting system provides the lighting intensities in those areas required to bring the plant to a safe shutdown condition during emergencies and or under conditions for which the control room becomes uninhabitable. The eight-hour emergency lighting system meets the requirements of 10 CFR 50 Appendix R.

The combined 1.5-hour and 8-hour emergency lighting systems have been accepted via response to FSAR Questions 40.33 and 40.34 as a means to aid in bringing the plant to a safe shutdown for defined conditions as Control Room evacuation plus a loop and a single failure. In areas where 1.5 hour emergency lighting fixtures are not provided, 8-hour battery powered lighting is required if shutdown functions or control and maintenance of safety-related equipment are required to be performed.

9.5.3.2 System Description

The plant lighting system is composed of the following subsystems:

a) Normal (AC),
b) Essential (AC),
c) Emergency (DC)

9.5.3.2.1 Normal Lighting System (AC)

The normal AC lighting system receives power from the normal service buses of the plant auxiliary AC power distribution system described in Subsection 8.3.1.1. This system provides lighting for the following areas:

a) All area lighting in the service/administration building, guard house and main steam pipe tunnel
b) All outdoor area lighting (yard)

c) All high bay lighting (turbine building)

d) Approximately 80 to 90 percent of the lighting in all other operating and service areas except the main control room

The high pressure sodium, mercury vapor, metal halide, fluorescent, and LED lighting fixtures in this subsystem are fed from 480/277 V, three-phase, four wire, grounded neutral system distribution panels, which are fed from the normal 480 V motor control centers. The lighting fixtures on refueling platforms are fed from the 480/277 V, three-phase, four wire, grounded neutral system distribution panels, and the other lighting fixtures are fed from the dry-type transformers rated at 480-208/120 V, three-phase, four wire, grounded.

The outdoor yard lighting is a high mast lighting system that includes fixtures mounted on 100 ft. lighting poles having a lowering system with a portable drive unit. The transformer yard utilizes a similar system on 40-ft. lighting poles without a lowering system. The location of these poles is shown on Dwg. E-412, Sh. 1.

The power for the Protected Area yard lighting is provided by three non-Safety Related 480/277 Vac, 3 Phase, 4-Wire, lighting distribution panels, each fed from an uninterruptible power supply (UPS). The Protected Area yard lighting is normally automatically energized and de-energized via photo electrically controlled lighting contractors. Each UPS is provided with normal ac input power and bypass ac input power from a security system motor control center via a security system load center that is normally fed by an offsite power supply. In the event of total loss of offsite power (LOOP), the security system diesel generator will provide backup power to the yard lighting via the UPSs. Each UPS provides uninterrupted power to the yard lighting during LOOP and connection of diesel generator backup power.

The yard lighting is designed to provide the minimum lumination requirement of the closed circuit TV cameras.

9.5.3.2.2 Essential Lighting System (AC)

The essential AC lighting subsystem is designed to provide a minimum level of illumination distributed to selected areas of the plant, to aid in safe shutdown, or to aid in restoring the plant to normal operation. This subsystem consists of fluorescent lighting or LED fixtures fed from 480/277 V, 3Ø, 4 wire, grounded neutral system lighting distribution panels, which are normally supplied. The areas served by this subsystem are as follows:

a) Main control room.

b) Approximately 10 to 20 percent of the lighting in all operating and service areas in selected areas at the plant.

The essential lighting distribution panels also serve as the preferred power supply to the 8-hour emergency lighting centers and units described in Subsections 9.5.3.2.3.2.2 and 9.5.3.2.3.2.3 and the preferred power supply to the control structure 120V AC/125V DC emergency lighting system described in Subsection 9.5.3.2.3.1 and the stair lighting units described in Subsection 9.5.3.2.3.2.4.

The essential lighting system is connected to the Class 1E 480V MCCs at all times. No load shedding is provided for this lighting system in the event of total loss of offsite power. The total essential lighting load is shown in Table 8.3-1a assuming all four diesel generators are in operation. The essential lighting load is not divided equally among the four diesel generators due to plant utilization. Therefore, the total lighting loads for each case (assuming one diesel generator not available) as shown by Tables 8.3-2, 8.3-3, and 8.3-5 are different.

9.5.3.2.3 Emergency Lighting System (DC)

Refer to Table 9.5-3 for locations.

9.5.3.2.3.1 125 V DC Emergency Lighting System

Fixtures of the emergency DC lighting subsystem within the plant complex are normally energized from the normal AC subsystem described in Subsection 9.5.3.2.1 except for the control structure fixtures which are normally energized from the essential lighting subsystem described in Subsection 9.5.3.2.2. This DC lighting subsystem is normally supplied from branch circuits of the 120/208 V lighting panels via a transfer switch to the AC/DC lighting panels. Upon loss of the preferred AC source the AC/DC panels will be fed automatically from the 125V DC emergency lighting power system described in Subsection 8.3.2.1.1.8. Continued energization of the lamp with AC during normal operation reduces the load on the battery chargers and maintains the lamp filament at a temperature that limits the initial current surge when the DC voltage is applied to the lamp, and also allows the lights to be monitored continuously.

9.5.3.2.3.2 Self-Contained Emergency Lighting System

9.5.3.2.3.2.1 Exit Lights

Emergency exit lighting in remote buildings and areas where the 125 V DC emergency lighting power system service is not available consists of battery powered self-contained "exit" light units. Each of these units consists of a 2-1/2 hr 6 V battery, a battery charger, and exit sign and are normally energized by the normal 277 volt AC lighting system power supply. The exits lights in the Diesel Generator 'E' Facility have a 1-1/2 hour battery.

9.5.3.2.3.2.2 Emergency Lighting Centers

The emergency lighting centers are designed to provide emergency lighting instantaneously and automatically upon the failure or interruption of the essential lighting power supply (see Subsection 9.5.3.2.2). Each emergency lighting center consists of a battery, a charger, control and monitoring circuits, and devices enclosed as a self-contained unit. Each emergency lighting center is capable of supplying 2 remotely mounted sealed beam lamps for 8 hrs. without the charger.

9.5.3.2.3.2.3 Emergency Lighting Units

Emergency lighting units are similar to the emergency lighting centers as discussed in Subsection 9.5.3.2.3.2.2 except that there are no more than 3 sealed beam lamps locally mounted on the battery pack unit, remotely mounted near the battery pack unit or a combination thereof.

9.5.3.2.3.2.4 Stair Lighting Units

Each of the stair lighting units consists of a 1.5 hr. 6 V battery, a charger, and 2 sealed beam lamps, except where 8-hour battery powered emergency lighting units are required. The units are normally energized by the essential lighting power supply (Subsection 9.5.3.2.2). The stair lighting units in the Diesel Generator 'E' Facility are the same as the emergency lighting units as discussed in Subsection 9.5.3.2.3.2.3.

9.5.3.3 Safety Evaluation

Components of the lighting systems associated with safety-related systems are housed within Seismic Category I structures. Wind and tornado protection is discussed in Section 3.3. Flood design is discussed in Section 3.4. Missile protection is discussed in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design considerations are discussed in Section 3.11. Lighting is provided to permit the operators to shut down the plant safely and maintain it in a safe shutdown condition at all times. The lighting system is designed to provide lighting at all times in areas used during reactor shutdown or emergency.

During normal plant operation, all plant lighting systems are energized from the respective on-site buses and off-site feeders.

In the event of AC power loss from both non-Class 1E on-site buses (unit auxiliary), the normal lighting system is inoperable. The essential lighting system remains operable being energized from the Class 1E AC on-site buses. The emergency lighting system remains operable from the non-Class 1E 125V DC emergency lighting power system; the units self-contained battery or the essential lighting power supply to selected emergency lighting fixtures.

In the event of AC power loss from both non-Class 1E off-site feeders, the standby diesel generators will start and energize the respective Class 1E buses within 10 seconds. During the 10 second delay (diesel start-up time) the DC emergency lighting system remains energized from the Emergency Lighting system which is discussed in Subsection 9.5.3.2.3.

9.5.3.4 Tests and Inspections

The AC lighting systems are normally energized and maintained continuously and require no periodic testing. The emergency lighting system is provided with the capability for full functional tests to ensure the operability of the automatic switches and other components of the system.

9.5.4 DIESEL GENERATOR FUEL OIL STORAGE AND TRANSFER SYSTEM

9.5.4.1 Design Basis

a) Provides onsite storage and delivery of fuel oil to the diesel generators for at least seven days of operation. This provides emergency power to meet the load requirements for the engineered safety features following loss of offsite power and a DBA.

b) To remain functional during and after a Safe Shutdown Earthquake (SSE) and to withstand the effects of wind, tornadoes, flooding and missiles.

c) To meet single failure criterion, in that if a failure in the fuel oil system prevents satisfactory operation of the associated diesel generator, the other three diesel generators will provide adequate power to safely shut down the plant or mitigate the consequences of any postulated accidents.

d) Designed to permit inspection and testing during plant operation.

The diesel generator fuel oil system is designed in accordance with the codes and standards listed in Table 3.2-1. The design complies with ANSI Standard N195-1976.

9.5.4.2 System Description

The diesel generator fuel oil system is located in and below grade adjacent to the diesel generator buildings. The system is shown on Dwgs. M-120, Sh. 1, and M-134, Sh. 1, for Diesel Generators A, B, C and D and Dwgs. M-120, Sh. 2, and M-134, Sh. 7, for Diesel Generator 'E'.

The fuel oil system components are as follows:

Diesel Generator Fuel Oil Storage Tanks - Four 50,000 gal nominal capacity storage tanks are provided for Diesel Generators A, B, C and D and one 80,000 gal nominal capacity storage tank is provided for Diesel Generator 'E'. One storage tank is provided for each diesel generator. The No. 2 fuel oil stored in each tank is sufficient for seven days full load continuous generator operation. The tanks for Diesel Generators A, B, C, and D are buried underground adjacent to the diesel generator building as shown on Dwg. C-1006, Sh. 1. The tank for Diesel Generator 'E' is buried underground adjacent to the Diesel Generator 'E' Building as shown on Figure 9.5-26B. For Diesel Generators A, B, C, and D tanks, connections, as shown on Dwg. C-1007, Sh. 1, for level instruments, manhole, day tank overflow pump support flanges, water removal, oil sampling and oil filtration lines are provided on top of the tanks and are all ASME Section III Class 3 material. The vent pipes for these tanks are designed to Seismic Category I. The water removal lines, oil sample and return lines, and oil filtration suction and return lines are Seismic Category I out to the ASME Section III code break valve. For the Diesel Generator 'E' tank, connections as shown on Figure 9.5-26B for pump suction, level instruments, manhole, day-time overflow, water removal, oil sampling, oil filtration, and fill connection are provided on top of the tank. The tank design and material is per ASME Section III, Class 3. The vent pipe for the tank is designed to Seismic Category I. The water removal lines, oil sample and return lines, and oil filtration suction and return lines are Seismic Category I out to the ASME Section III code break valve.

A concrete vault is provided for each tank from grade to the tank connections for access, maintenance, inspection and repair and to provide missile protection of the tank connections. The vault cover at grade level is made of steel plate. The Diesel Generator A, B, C, and D tanks exterior is painted with enamel and wrapped with fiberglass pipe wrapping for corrosion protection. The tank interior bottom is coated for protection against corrosion due to water accumulation. In addition, a rust preventative is applied over the interior surface. The Diesel Generator 'E' tank exterior is coated with polyester resin and wrapped with a fiberglass mat for corrosion protection. The interior surface of the tank sump and the wetted bottom of the tank up to an elevation of seven feet below the horizontal centerline is coated with a two-coat epoxy. Each tank is provided with a sump area for water and solids collection. A tube for water removal is installed within each sump. The tubing runs to the grade level sampling station where water is removed from the sumps by the water removal – oil sampling pump. Fuel oil additives are used to inhibit biogrowth in the diesel fuel storage tanks. Tubes are installed at three different levels within each diesel fuel oil storage tank for drawing oil samples. The tubing runs to the grade level sample station. Oil filtration suction and return pipes are installed in each fuel oil storage tank. The filtration piping for A-D fuel oil storage tanks terminate in below grade missile-protected valve boxes. The E fuel oil storage tank filtration pipes terminate in the above grade sample station. The tanks have a corrosion allowance and are furnished with cathodic protection. The storage tanks are vented through a flame arrestor above grade. This vent does not require missile protection. The only vulnerable section of the vent is a 6 inch

(4 inch for Diesel Generator 'E' tank) portion above grade. In the event that this above grade section of the vent is damaged, it would not render the fuel oil tank inoperable. The water removal, oil sampling and oil filtration lines outside of the tank vault are run below grade to the filtration valve boxes and the above grade sample stations. The below grade lines are missile protected and seismically analyzed to provide assurance that they will remain intact after Design Basis Events. The water removal and oil sampling lines in the above grade sample stations, and the above grade Diesel Fuel Oil Storage Tank E filtration lines, do not require missile protection. Any missile damage to the above grade portions of these lines will not render the diesel fuel oil system inoperable. There is no piping under the fuel storage tank concrete mat; therefore the tank's safety function is not endangered by a possible pipe break. The buried tanks and yard pipes for Diesel Generators A, B, C and D are shown in Dwgs. C-1006, Sh. 1, C-1007, Sh. 1, C-1007, Sh. 2, C-1032, Sh. 1, C-46, Sh. 1, C-901, Sh. 1, C-905, Sh. 1, C-1029, Sh. 1 and C-1029, Sh. 2. The buried tanks and yard pipe for Diesel Generator 'E' are shown in Figure 9.5-26B.

Diesel Generator Fuel Oil Transfer Pumps for Diesel Generators A, B, C and D

One fuel oil transfer pump is provided for each storage tank. The pump and motor are both submerged in the fuel oil storage tank and suspended from the pump support flange located on the tank top. Each pump is a horizontal, centrifugal type and is rated at 25 gpm at 30 psi differential head. The fuel oil transfer pump discharge lines run directly to the fuel oil day tanks.

The diesel oil transfer pumps are provided with a suction strainer at the pump inlet located at 5 9/16” above tank bottom. The pump centerline is 10 ¾” above tank bottom. The total volume of the storage tanks is 49328 gallons, which has been corrected for tank internals. The usable volume of fuel oil available in the storage tanks is 47438 gallons. The difference between the total volume and the usable volume in these storage tanks (1890 gallons) is the result of the following considerations:

1. Inaccessible volume of fuel oil at bottom of tank = 1380 gallons
2. Space at top of tank after filling = 210 gallons
3. Tank Manufacturing Tolerances = 300 gallons

The specific Diesel Generator fuel oil volumes contained in the Diesel Fuel Oil Storage Tanks necessary to ensure that DG run-duration requirements are met are calculated using Section 5.4 of ANSI N195-1976, “Fuel Oil Systems for Standby Diesel-Generators,” and are based on applying the conservative assumption that the Diesel Generator is operated continuously at capacity. This fuel oil calculation methodology is one of the two approved methods specified in Regulatory Guide 1.137, Revision 0, “Fuel Oil Systems for Standby Diesel Generators,” Regulatory Position C. The required fuel for seven day operation at full load is 45864 gallons. The spare volume is 1574 gallons, which provides adequate margin for diesel testing.

The required Net Positive Suction Head (NPSH) is 4.5' according to the pump test curves. The available NPSH is approximately 39’ at the lowest fuel level at the center line of the pump. This figure is based on the following:

NPSH = abs. barometric pressure (34') + static liquid head (0' at center line) - friction loss in suction line (negligible) - vapor pressure of liquid (negligible) = 34' abs. of water.

The 34' is to be corrected for Diesel fuel No. 2 having a specific gravity of 0.87, 34’ / 0.87 = 39'.

Diesel Generator Fuel Oil Transfer Pump for Diesel Generator 'E' - A horizontal self-priming fuel oil transfer pump is provided for the Diesel Generator 'E' fuel oil storage tank. The pump and motor are located in the Diesel Generator 'E' Building on floor elevation 656'-6" and the pump centerline is at elevation 658'-4-11/16". The pump is mounted on a common base with the motor and is rated at 20 gpm and 50 feet of water TDH. The pump takes suction from a pipe internal to the tank which projects down the 16 foot diameter tank. The tank bottom is at elevation 651'-0". The total volume of the “E” diesel storage tanks is 76888 gallons, which has been corrected for tank internals. The usable volume of fuel oil available in the “E” diesel storage tank is 73,253 gallons. The difference between the total volume and the usable volume in this storage tank (3635 gallons) is the result of the following considerations:

1. Inaccessible volume of fuel oil at bottom of tank = 1814 gallons
2. Space at top of tank after filling = 1301 gallons
3. Tank Manufacturing Tolerances = 520 gallons

The specific Diesel Generator fuel oil volumes contained in the Diesel Fuel Oil Storage Tanks necessary to ensure that DG run-duration requirements are met are calculated using Section 5.4 of ANSI N195-1976, “Fuel Oil Systems for Standby Diesel-Generators,” and are based on applying the conservative assumption that the Diesel Generator is operated continuously at capacity. This fuel oil calculation methodology is one of the two approved methods specified in Regulatory Guide 1.137, Revision 1, “Fuel Oil Systems for Standby Diesel Generators,” Regulatory Position C.1.c. The required fuel for seven day operation at full load is 56,683 gallons. The spare volume is 16,570 gallons, which is more than adequate to support diesel testing.

Diesel Generator Fuel Oil Day Tanks – Four 550 gallon fuel oil day tanks are provided for Diesel Generators A, B, C and D, one tank for each diesel generator. A 650 gallon fuel oil day tank is provided for Diesel Generator E. Each fuel oil day tank is located on its respective diesel generator auxiliary skid inside the diesel generator buildings. Connections for filling, overflow return, recirculation, level instrumentation, venting, and emptying are provided. A manhole is provided on each tank for inspection. The day tank contains fuel oil sufficient for approximately one hour continuous diesel generator operation at its continuous rated load. The day tanks are vented outside the diesel generator buildings, through a flame arrestor.

Fuel Oil Booster Pumps - Each diesel generator is provided with two positive displacement fuel oil booster pumps. One pump is diesel engine driven and the second pump is DC motor driven. Relief valves and line filters are furnished on the discharge of each pump. The pumps, valves, and associated piping are all located on the diesel engine skid in the diesel generator buildings. The DC motor driven pump starts when the diesel generator starts. The suction of the motor driven pump is located below the day tank low level elevation; thus, its suction remains flooded at all times. While the diesel is starting, the motor driven pump also primes the engine-driven pump. A check valve is provided in the suction line of the engine-driven pump to assist in maintaining a flooded pump suction.

Associated Piping - The diesel fuel oil system piping is carbon steel and designed for a primary rating of 150 psig and 500°F.

The diesel generator A, B, C and D fuel oil storage tanks are filled and replenished from trucks through the fill connection which branches to each of the four tanks. The fuel oil storage tank for Diesel Generator 'E' has a separate fill station. During refilling, the fuel oil system is designed to minimize contamination from the entrance of deleterious material in the event of either an operator error or natural phenomena. All tank fill connections are protected inside a missile protected concrete vault (Dwgs. C-1032, Sh. 1, and C-5028, Sh. 1, for Diesel Generator 'E'), and the interconnecting fuel transfer piping is routed below grade to the buried tanks (Dwg. C-1006, Sh. 1, and Figure 9.5-26B for Diesel Generator 'E'). The tank vents are goose necked and provided with screens to keep out potential above grade fuel contamination. Periodic sampling shall be taken to determine if the fuel oil is within acceptable limits when checked for viscosity, water, and sediment. If for some reason fuel oil cannot be replenished through the truck fill connection each of the five tanks have the capability to be directly refilled with fuel oil, independent of each other. A duplex type basket strainer is provided in each fill line to prevent solid particles or debris from entering the storage tank.

Each transfer pump takes suction from its fuel oil storage tank and pumps the oil directly to the day tank. Because the capacity of the transfer pump is greater than the fuel oil consumption of the diesel engine, the pump can supply fuel oil to the diesel and simultaneously increase the inventory of the day tank. For Diesel Generators A, B, C and D, the fuel oil transfer pumps are started and stopped automatically by day tank level switches. For Diesel Generator 'E', the fuel oil transfer pump is started and stopped automatically by day tank level switches except when an emergency start signal is received. In this mode of operation, the Diesel Generator 'E' fuel oil transfer pump runs continuously. An overflow line from the day tank to the storage tank is furnished for each diesel generator and its capacity exceeds that of the transfer pump.

The diesel fuel oil booster pumps take suction from the day tank and pump fuel oil to the injector pumps. The DC motor driven pump starts first when the diesels are started and shuts off automatically when the engine maintains a speed above 540 rpm. The engine driven booster pump then furnishes the fuel oil to the diesel engine. The DC motor driven pump can also be started manually and provides a backup to the engine driven pump during normal operation. The DC motor driven pump starts automatically on low fuel oil pressure.

The diesel fuel oil storage tank fill lines and valves, outside the fuel oil storage tank vaults, are seismically analyzed to provide assurance that the installation will remain intact after a Design Basis Earthquake. A missile-protected Filler Valve Vault houses the fill hose connection and the normally closed boundary valves. Valves are shown on Dwgs. M-120, Sh. 1, and M-120, Sh. 2. The tank connections are ASME, Section III, Class 3. The vent pipes are B31.1 and have been seismically analyzed.

FUEL OIL TANK WATER REMOVAL, OIL SAMPLING AND OIL FILTRATION SYSTEM

The system provides the means for water removal from each of the diesel fuel oil storage tanks, the capability to sample fuel oil at three elevations within each of the diesel fuel oil storage tanks, and connections to attach a portable oil filtration system to each of the diesel fuel oil storage tanks. These functions can be conducted without entry into the diesel fuel oil storage tank vaults.

The system for the A, B, C, and D tanks consists of a common water removal – oil sampling panel (OC5101) installed on grade near the tanks as shown on Dwg. C-1006, Sh. 1, and tubing from within the tanks to the sample panel as indicated on Dwgs. M-120, Sh. 1, and M-120, Sh. 3. The system for the E tank consists of a water removal – oil sampling panel (OC5101E) installed on grade near the tank as shown on Figure 9.5-26B and tubing from within the tank to the sample panel as indicated on Dwg. M-120, Sh. 2. A tube for water removal is installed within each diesel fuel oil storage tank sump. The tube runs to the sampling station where water is removed from the sumps by the water removal – oil sampling pump. Tubes are installed at three different elevations within each tank for drawing off oil samples. This tubing runs to the sampling station where grab samples can be withdrawn from the tank from each of the three sampling elevations by the water removal – oil sampling pump.

Each of the two sample stations has a water removal – oil sampling pump, installed in the sample panel that is capable of drawing water or oil from the bottom of the diesel fuel oil storage tank. A manifold system in each sample station is used to select the water removal line or soil sample level to be processed. Removed water is collected locally and disposed of. Oil samples can be returned to the tank via a return line or collected locally for disposal.

Oil filtration suction and return lines are installed within each tank. In the event oil samples indicate the need for oil filtration, a portable oil filtration unit can be connected to the oil filtration lines. Oil will be drawn from the bottom of the tank, filtered and returned to the top of the tank to assure that thorough filtration occurs. The diesel fuel oil tank filtration connections are located in below grade missile – protected valve boxes for Diesel Fuel Oil Storage Tanks A-D and in above grade Sample Station OC5101E for Diesel Fuel Oil Storage Tank E.

The water removal tubing, oil sample tubing and oil filtration piping are ASME Section III, Class 3, Seismic Category I lines from their point of origin inside the tank up to and including an ASME Section III, Class 3 isolation valve located inside the tank vault. The remainder of the installation is B31.1, which as been seismically analyzed to provide assurance that the installation will remain intact after a Design Basis Earthquake. The ASME III valves in the tank vault are normally open with normally closed valves in the filtration valve boxes or sample stations providing the isolation boundary for the storage tanks.

A, B, C, D STORAGE TANK VAULT SUMP WATER REMOVAL SYSTEM

The sump in each of the A, B, C and D Diesel Fuel Oil Storage Tank Vaults has water removal tubing installed that runs from the sump up the sampling panel as indicated on Dwgs. M-120, Sh. 3, and C-1006, Sh. 1. A portable pump can be connected to each tube in the sample panel to draw water from the bottom of the vault sump and thus remove the water that may have accumulated within the vault. The removed water is collected locally and disposed of.

9.5.4.3 Safety Evaluation

The diesel generator fuel oil storage and transfer system is housed within either the Seismic Category I diesel generator building or below grade. Wind and tornado protection is discussed in Section 3.3. Flood design is discussed in Section 3.4. Missile protection is discussed in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design considerations are discussed in Section 3.11. Fire Protection is discussed in Subsection 9.5.1. Exposure of the fuel oil system to ignition by flame or hot surfaces is minimized by underground burial of the piping and storage tanks outside the buildings; and by separation of the individual subsystems inside the building in pipe tunnels below the diesel generators except for a short run of piping on the diesel generator elevation to connect to the day tank on the engine auxiliary skid.

The safety evaluations that follow correspond to the design bases stated in Subsection 9.5.4.1.

a) The total capacity of underground diesel generator fuel oil storage tanks and day tanks is sufficient for seven days' operation of the diesel generators at 4000 kW continuous operation which is sufficient capacity for a DBA in one unit and a concurrent safe shutdown of the intact unit. Within this period, additional fuel could be delivered to the plant site by truck or rail. Excessive splashing and sediment turbulence is prevented by a low exit velocity, perforated, vertical sparger discharging fuel through a series of 3/4" diameter holes. Exit velocity at the holes is limited to about 2 ft/sec by design. The max-discharge rate is approximately 310 gpm. The bottom of the fill pipe is capped. The lowest and highest row of holes are 3 ft. and 10 ft. above the tank bottom respectively for Diesel Generators A, B, C and D. For Diesel Generator 'E', the lowest and highest row of holes are 3'-6" and 14'-6" above the tank bottom respectively. If minor sediment turbulence occurs, fuel filters will keep the overall quality of the fuel oil acceptable during refilling. Filters are provided upstream of the day tank in the buried tank fuel transfer pump intake. The filters provided down stream of the day tank are one set of duplex basket strainers and one set of duplex in line strainers. Both sets have high differential pressure alarms across them to monitor filter effectiveness (see Dwgs. M-134, Sh. 1, and M-134, Sh. 7).

b) There is physical redundancy of active components in the diesel generator fuel oil system. An independent fuel oil supply subsystem is provided for each diesel generator. Each transfer pump is powered from the bus to which the diesel generator it serves is connected. Failure of one pump or diesel generator will not affect the operability of any component in another train. Three diesel generators are required during loss of offsite power and DBA to meet the engineered safety feature load requirements. The transfer pump discharge headers have a common connection line to permit fuel oil from one storage tank to be pumped to any diesel generator if required. These cross connections are valved and require manual initiation for operation. The rupture of any portion of the transfer piping would affect the supply of oil of only one diesel generator.

c) The diesel generator fuel oil system is designed in accordance with Seismic Category I requirements as specified in Section 3.2.

9.5.4.4 Tests and Inspections

The components of the diesel generator fuel oil system received an NDT examination in accordance with the ASME Boiler and Pressure Vessel Code, Section III, Class 3 prior to routine construction tests and inspections. System operability can be demonstrated during regularly scheduled tests of the diesel generators. At this time the fuel oil volume and quality will be monitored.

The fuel oil storage tanks are provided with manholes that permit access to the tank connections for periodic inspection of the tanks, pumps, and instrumentation. The day tanks, booster pumps, and associated piping and valves are in the diesel generator buildings and are accessible for inspection during testing and operation.

The fuel oil inventory in the storage tanks and day tanks is continuously monitored and the level is indicated at the local control panels in the applicable diesel generator buildings.

To insure the quality and reliability of fuel oil supply to the diesel generators, diesel fuel oil will be purchased which conforms to the limits specified for No. 2D fuel in ASTM – D975. Procurement and receipt inspection of the diesel generator fuel oil will be conducted under the Susquehanna Diesel Fuel Oil Test Program. Fuel shipments will not be offloaded until samples have been analyzed and the results accepted by PPL Susquehanna, LLC. Fuel shipments will be inspected and sampled upon delivery to assure that the fuel has not degraded in transit. Samples from the station's underground storage tanks will be tested to verify conformance to the water and sediment limits of the above standards on a frequency as described in the Technical Specifications.
The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.5.4.5 Instrumentation Applications

The fuel oil transfer pumps are operated automatically by level switches at the day tank with the exception of the Diesel Generator 'E' transfer pump which operates continuously when an emergency start signal is received and is controlled by level switches during all other modes of operation. The pumps can also be operated manually by control switches on the diesel generator control panels. Indications of tank levels and high and low level alarms are displayed at the local control panels. A secondary means of storage tank level determination is provided by a dipstick. The fuel oil transfer pump discharge head is also displayed at the local control panels. As the fuel oil tanks and piping are within the Diesel Generator Buildings or buried in the ground, the diesel fuel oil (No. 2) temperature will be between 50°F and 120°F, with the exception of fuel oil in lines mounted on or near the engine, which is acceptable for operation of the diesel generators. Consequently, monitoring of fuel oil temperature is not required.

All valves in the fuel oil system are manually operated. The valves in the fuel oil transfer lines are locked open except for 'E' D/G valve 0-20-302 which is locked throttled.

9.5.5 DIESEL GENERATOR COOLING WATER SYSTEM

9.5.5.1 Design Bases

The Diesel Generator Cooling Water System has a safety-related function. The design bases of the Diesel Generator Cooling Water (DGCW) system are as follows:

a) To cool the engine cylinder jackets, lube oil, combustion air, fuel oil (Diesel Generator E only) and jacket water sufficiently to permit continuous diesel generator operation at its continuous rated load.

b) To remain functional during and after a Safe Shutdown Earthquake (SSE).

c) To meet single failure criterion, in that if a failure in the cooling water system prevents satisfactory operation of the associated diesel generator, the other three diesel generators will provide adequate power to safely shut down the plant or mitigate the consequences of any postulated accidents.

d) Designed to permit inspection and testing during plant operation in accordance with 10CFR50, General Design Criterion 45 and 46.

Codes and standards applicable to the diesel generator cooling water system are listed in

Table 3.2-1. The system is designed and constructed in accordance with Quality Group classifications specified in Table 3.2-1 and is designed to meet seismic Category I requirements.

9.5.5.2 System Description

Two separate systems are used to cool the various engine components and systems. These are the Jacket Water System and the Emergency Service Water System.

Jacket Water System

The jacket water system is a closed system using demineralized water as the coolant. Its prime function is to provide water to the jackets of the engine cylinders and also to the jacket of the combustion air turbocharger for cooling purposes. In addition, the jacket water system circulates water through the governor oil cooler and hot water through the small core of each intercooler to heat the air discharging from the turbocharger should the temperature in the combustion air header fall below 105°F. This occurs mostly at startup to help ensure rapid starting and loading.

The jacket water system consists of the following:

1) A standpipe that serves as a reservoir, deaerator, and an expansion tank

2) An engine driven main water pump

3) A motor driven standby water pump

4) A circulation pump and heater to keep the engine warm during shutdown periods

5) An automatic thermostatic control valve

6) A cooler to dissipate the heat in the jacket water

7) For Diesel Generators A, B, C and D, control valves to direct warm jacket water through the combustion air watercoolers when the temperature in the combustion air header falls below 105°F. Warm jacket water flows continuously to the combustion air intercooler/heaters for Diesel Generator E.

8) Alarms, trips, indicators, valves & piping

When the engine is running, the engine driven water pump takes water from the standpipe and pumps it through the thermostatic control valve and jacket water cooler. From here the jacket water flows into the main jacket water headers. From the left bank header a small header directs water to the jacket of the turbocharger and both left and right bank headers have small branch headers that direct water to the intercoolers. The latter is only used when the temperature of the combustion air is less than 105°F. Individual connections from both the left and right bank headers carry water to their respective cylinder jackets. If the jacket water temperature reaches 190°F or its pressure falls to 12 psi the motor driven standby pump will start automatically (10 psi for Diesel Generator 'E').

Diesel engines A, B, C and D jacket water cooling systems have a capacity of approximately 710 gallons. The Diesel Engine 'E' jacket water cooling system has a capacity of approximately 1,480 gallons. The standpipe, located on the auxiliary skid immediately adjacent to the engine's forward end, is vented to the atmosphere and serves as the system's reservoir, deaerator and expansion tank. For Diesel Engines A, B, C and D, the standpipe is 13 feet 9 inches tall and extends two feet above the top of the engine. The top section is one foot in diameter and 5 feet 9 inches in length. The capacity of the standpipe when filled to its proper operating level is 217 gallons. Similarly for Diesel Engine 'E', the standpipe is 15'-7-3/4" tall and is 3 feet 1-1/2 inches in diameter. The capacity of this standpipe when filled to its proper operating level is approximately 700 gallons. The vent, located at the top of the standpipe is the cooling system high point. The low level alarm set point on the standpipe is located at a point above the engine thus assuring that the system is always flooded. The motor driven standby jacket water pump and the jacket water circulating water pump are located on the skid at the same level as the bottom of the standpipe. The engine driven jacket water pump for Diesel Engines A, B, C and D located 7'-0 1/4" above the base of the standpipe require 10 to 11 feet of NPSH. Available NPSH is 25 ft-9 ins. The design is similar for Diesel Generator 'E'. The jacket water cooling pumps have mechanical seals to minimize leakage to less than 0.1 gal per month. Water loss from the system over a seven day period will be much less than the available supply in the standpipe.

When the diesel engine is shutdown the circulation pump operates and takes water from the standpipe and pumps it through the heater to both the left and right bank jacket water headers. The water is then directed to the individual cylinder jackets to keep them warm for easier starting.

Makeup to the jacket water system is provided by the Makeup Demineralizer.

The jacket water system for Diesel Generators A, B, C and D is shown in Dwgs. M-134, Sh. 1, and M30-69, Sh. 1, and M-134, Sh. 5 for Diesel Generator 'E'.

Emergency Service Water System

The emergency service water system is used to supply cooling water to the following components of the diesel generator:

1) Lube oil coolers
2) Fuel Oil Cooler (Diesel Generator E Only)
3) Jacket Water Cooler
4) Combustion air intercoolers except when air temperature is below 105°F as described under Jacket Water System

The diesel generator cooling water schematic is shown on Dwg. M30-71, Sh. 1 for Diesel Generators A, B, C and D and Dwg. FF61604, Sh. 7 for Diesel Generator 'E'. The emergency service water system is described in Subsection 9.2.5.

9.5.5.3 Safety Evaluation

The cooling water systems are housed with their respective diesel generator unit in the Seismic Category I diesel generator buildings. Wind and tornado protection is discussed in Section 3.3. Flood design is discussed in Section 3.4.

Missile protection is discussed in Section 3.5. Protection against dynamic effects associated with the postulated rupture of piping is discussed in Section 3.6. Environmental design considerations are discussed in Section 3.11.

Diesel Generators A, B, C and D are completely isolated from each other in their own concrete, missile protected cells. Diesel Generator 'E' is enclosed in its own missile protected seismic category I building.

9.5.5.4 Tests and Inspections

Visual inspections, pressure and leakage tests, and operational checks of the cooling system components were performed following installation. The operability of the diesel generator cooling water system is demonstrated during scheduled testing and inspection of the diesel generator.

The operation of the jacket water warning system is checked during diesel generator shutdown periods.

Testing of the diesel generator systems is discussed in Subsection 8.3.1.

The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.5.5.5 Instrument Applications

High temperature and low pressure alarm switches are provided that will automatically start the motor driven jacket water pump if either the jacket water temperature rises to 190°F or its pressure drops to 12 psi (10 psi for diesel generator 'E'). A low jacket water temperature alarm switch is also provided. A high-high temperature switch will shutdown the diesel engine if the jacket water temperature reaches 205°F. However this high-high temperature switch will only trip the engine when it is being tested. During emergency conditions, the trip signal from the high-high temperature switch is bypassed. During the emergency mode of operation the diesel generator can only be tripped by engine overspeed, low lube oil pressure, or generator differential current.

Jacket water temperature from the engine is controlled by a three-way thermostatic valve downstream of both the engine driven jacket water pump and the motor driven standby pump. The valve maintains jacket water temperature out of the engine at approximately 170°F by directing jacket water flow through or around the cooler as necessary.

The standpipe is provided with a level indicator, a low level alarm and a high level alarm. The vent located at the top of the standpipe is the engine cooling water system high point. The low level alarm set point on the standpipe is also located at a point above the top of the engine. This ensures that all components and piping are filled with water.

9.5.6 DIESEL GENERATOR STARTING AIR SYSTEM

9.5.6.1 Design Bases

The Diesel Generator Starting Air System has safety-related functions. The design bases of the diesel generator starting air system are as follows:

a) To initiate an engine start so that within 10 seconds after receipt of the start signal the diesel generator has attained rated speed and is ready to receive electrical loads

b) To remain functional during and after a SSE

c) To meet single failure criterion, in that if a failure in the starting air system prevents satisfactory operation of the associated diesel generator, the other three diesel generators will provide adequate power to safely shut down the plant or mitigate the consequences of any postulated accidents.

d) Designed to permit inspection testing during plant operation.

Codes and standards applicable to the diesel generator starting air system are listed in Table 3.2-1. Portions of the Diesel Generator Starting Air Systems that are safety related are designed to seismic Category I requirements.

The starting system air receiver tanks, valves, and piping from the receiver inlet check valve to the engine skid are designed and constructed in accordance with quality group C specifications. The remaining components are designed and constructed in accordance with the manufacturer's standard.

9.5.6.2 System Description

Each diesel engine is furnished with a starting air system that includes the following:

a) Two air compressors each driven by an AC motor

b) Two air receiver tanks for Diesel Generators A, B, C and D and four air receiver tanks for Diesel Generator 'E'

c) Two entrainment separators

d) Piping, valves, strainers, air dryers, pressure switches, safety valves and controls, and all accessories as required.

For Diesel Generators A, B, C and D, the system is designed to crank the engine using air from both receiver tanks. The starting air system contains sufficient air to provide five (5) consecutive cold engine starts without recharging the receiver(s). For Diesel Generator E, the system is designed to crank the engine using air from all four (4) air receivers. Each bank of two (2) receivers contains sufficient air to provide five (5) consecutive cold engine starts without recharging the air receiver(s). Each bank of receivers is normally replenished by one (1) of the two (2) air compressors. A pressure switch provided on each bank of receivers for Diesel Generator 'E' and for each air receiver tank for Diesel Generator A through D will start the appropriate air compressor to replenish the tanks. If only one (1) of the two (2) required air compressors start, it is possible to replenish all tanks associated with a diesel generator by opening normally closed valves on the interconnecting piping between banks of receivers (Diesel Generator 'E') or between receivers (Diesel Generators A through D).

For Diesel Generators A, B, C and D, a drain trap is provided below each air receiver tank for expelling moisture. As the liquid level rises in the trap, a float will lift and uncover an orified outlet blowing the trap until the float level drops. For Diesel Generator 'E' this drain trap assembly is not required since the air compressor skids associated with Diesel Generator 'E' are designed to provide clean dry air to the air receivers through the use of filters, moisture separators and air dryers. The diesel generator 'E' air receivers do have manual drain valves located off the bottom of the receivers. These drain valves are opened periodically as a check to ensure that no moisture exists and to verify proper operation of the air compressor skid equipment.

On leaving the tanks, the starting air passes to the starting air valves and air distributor. For Diesel Generators A, B, C and D, a strainer is provided between the tanks and starting air valves. Filters are provided upstream of the air distributor on all engines. The air distributors provide pilot air to the air start valves at the correct sequence.

Further protection from fouling is provided by filters/separators in the control lines which supply air to the starting air solenoids and the starting air control valve pilot.

On each side of the engine, a line with a check valve is connected from the turbocharger warm air discharge to the starting air header. The purpose of this is to continuously purge the piping, preventing an explosion and preventing condensation in the piping on the engine.

The starting air system is shown schematically on Dwg. M-738, Sh. 1 for Diesel Generators A, B, C and D and Dwgs. M-134, Sh. 5, and M-134, Sh. 6 for Diesel Generator 'E'.

9.5.6.3 Safety Evaluation

The starting air systems are housed with their respective diesel generator units in reinforced concrete Seismic Category I structures.

Each of the Diesel Generator A-D units is enclosed in its own concrete, missile protected cell that is isolated from the other units. Diesel Generator 'E' is enclosed in its own Seismic Category I building.

Tornado, flood, and missile protection are discussed in Sections 3.3, 3.4, and 3.5, respectively. Protection against the dynamic effects associated with a postulated rupture of piping is discussed in Section 3.6. Environmental design is discussed in Section 3.11.

Each air receiver tank for Diesel Generators A-D is provided with a relief valve set at 265 psi. For Diesel Generator 'E', each air receiver is provided with a relief valve set at 275 psig.

9.5.6.4 Tests and Inspections

Visual inspections, pressure and leakage tests, and operational checks of the starting air system components were performed after installation. The operability of the diesel generator starting air system is tested and inspected during scheduled testing of the diesel generator.

Testing of the diesel generator systems is discussed generally in Subsection 8.3.1.1.

The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.5.6.5 Instrument Applications

Each air receiver tank is provided with a pressure switch, a pressure indicator, and a low pressure alarm. For Diesel Generator 'E', a pressure switch, pressure indicator and low pressure alarm is provided for each bank of air receivers (2). The pressure switch starts the air compressors when the air pressure in the tanks is 240 psi and falling and stops them when the pressure reaches 250 psi rising.

9.5.7 DIESEL GENERATOR LUBRICATION SYSTEM

9.5.7.1 Design Bases

The Diesel Generator Lubrication System has safety-related functions and is designed to the following design bases:

a) The DGLS is designed to supply lube oil to the engine bearings surfaces and other internal moving parts at controlled pressure, temperature and cleanliness conditions to permit continuous diesel generator operation at its continuous rated load.

b) To remain functional during and after a Safe Shutdown Earthquake (SSE).

c) To meet single failure criterion, in that if a failure in the lubrication system prevents satisfactory operation of the associated diesel generator, the other three diesel generators will provide adequate power to safely shut down the plant or mitigate the consequences of any postulated accidents.

d) Designed to permit inspection and testing during plant operation.

The DGLS cooler is designed in accordance with ASME Section III, Class 3. Piping and valves are in accordance with manufacturers standards for Diesel Generators A, B, C and D as shown in Table 3.2-1. Piping and valves for Diesel Generator E are designed in accordance with ASME Section III, Class 3 requirements for auxiliary skid components and in accordance with manufacturers standards for the diesel engine skid components.

9.5.7.2 System Description

The DGLS consists of an oil sump in the engine frame, an engine driven positive displacement pump, and an oil cooler and filter. The lube oil pump takes oil from the sump through a strainer and delivers it to a three-way thermostatically controlled valve that directs the oil through or around the oil cooler, through a full flow multiple element cartridge type filter, through a basket strainer, to the engine bearings and other internal moving engine parts and back to the sump. The E Diesel Generator full flow filter has an internal automatic bypass that will open if the element becomes clogged. Indication of high differential pressure across the filter shows up as a trouble alarm. The DGLS provides sufficient, reliable, sump storage of lube oil for operating the standby diesel generators for at least seven days at their maximum rated loads without makeup.

Instrumentation is provided to monitor the lube oil temperature, pressure and sump level. All system alarms are annunciated on the diesel generator control panels and retransmitted to the control room via a trouble alarm. The DGLS operates automatically, excluding the lube oil makeup and storage portions. Adequate alarms are provided to detect and annunciate the need for lube oil makeup. Lube oil can be added manually to the engine during operation if necessary.

The system also includes a standby prelubrication system and preheating system to keep the engine ready for quick start standby operation. It consists of a motor-driven positive displacement pump that takes oil from the sump and directs it through an electric heater, through the main oil filter, through the oil strainer, through the engine bearings and pistons and back to the sump. In order to prevent flooding of the turbocharger bearings and associated housing for Diesel Generators A, B, C and D, the prelubrication intervals and timing are controlled. For all engines, warm lube oil is circulated through the engines by the AC powered, motor-driven circulating and prelube pump whenever engine speed is below 280 RPM. Automatic signals start the pump on decreasing speed, maintaining flow during diesel generator shutdown, and stop the pump on increasing speed. For Diesel Generators A, B, C and D, the lube oil supply to the turbocharger bearings is cutoff until the engine is either starting or running. Therefore, continuous prelubrication of the engine bearing circuit does not affect nor will if flood the turbocharger bearings. The turbocharger bearings for Diesel Generator E are designed to allow for continuous lubrication. Therefore, it is not necessary to cutoff flow to turbocharger bearings after a diesel generator shutdown.

The DGLS is schematically illustrated in Dwg. M-134, Sh. 1 for Diesel Generators A, B, C and D and in Dwg. FF61604, Sh. 3 for Diesel Generator E. Dust protection is discussed in Section 9.4.7.2.

9.5.7.3 Safety Evaluation

The DGLS is an integral part of the diesel generator. The system meets the single failure criterion in that, if a failure in this system prevents the satisfactory operation of the associated diesel generator, the other three aligned diesel generators will provide adequate power to safely shut down the plant or to mitigate the consequences of any of the postulated accidents.

Each diesel generator lube oil sump contains an adequate reservoir of lube oil to maintain a sufficient quantity of lube oil for the diesel generator operating for seven days at its maximum-rated load.

Bearing temperature detectors are provided to indicate hot spots. Ten (twelve for Diesel Generator E) explosion relief valve-doors have been provided on each engine to relieve excessive pressures resulting from a crankcase explosion. The relief valve-doors are spring loaded to close following pressure decay, preventing air from entering the crankcase and causing a secondary explosion.

The DGLS is designed to satisfy Seismic Category I requirements and is located within structures designed to withstand effects from design weather conditions.

To prevent possible damage or shutdown of a diesel engine from low lube oil, sump low level instrumentation is provided. Setpoints for alarms are sufficient to allow plant personnel adequate time for corrective action.

All system alarms are annunciated on the diesel generator control panels and retransmitted to the control room via a trouble alarm.

Tornado, flood, and missile protection are discussed in Sections 3.3, 3.4, and 3.5 respectively. Protection against the dynamic effects associated with a postulated rupture of piping is discussed in Section 3.6. Environmental design is discussed in Section 3.11.

9.5.7.4 Tests and Inspection

The operability of the diesel lubrication system is tested and inspected along with the overall engine during scheduled testing of the engine.

During standby periods, the keep-warm feature of the system is checked at scheduled intervals to ensure that the oil is warm enough to assist quick starting of the engine.

The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.5.7.5 Instrument Application

The pressure, temperature and level instrumentation and control devices for the DGLS are shown schematically in Dwg. M-134, Sh. 1 for Diesel Generators A, B, C and D and Dwg. FF61604, Sh. 3 for Diesel Generator 'E'. Their location is also shown on these figures. Low lube oil pressure trips the diesel generator during any mode of operation.

9.5.8 DIESEL GENERATOR COMBUSTION AIR INTAKE AND EXHAUST SYSTEM

This subsection discusses the mechanical features of the diesel generator combustion air intake and exhaust system. The diesel generator buildings ventilation systems are discussed in Subsection 9.4.7.

9.5.8.1 Design Bases

The diesel generator combustion air intake and exhaust system has safety-related functions and is designed to the following design bases:

a) The diesel generator combustion air intake and exhaust systems are capable of supplying adequate combustion air and disposing of resultant exhaust products to permit continuous diesel generator operation at its continuous rated load.

b) To remain functional during and after a Safe Shutdown Earthquake (SSE).

c) To meet single failure criterion, in that if a failure in the combustion air intake and exhaust system prevents satisfactory operation of the associated diesel generator, the other three diesel generators will provide adequate power to safely shut down the plant or mitigate the consequences of any postulated accidents.

d) The diesel generator combustion air intake and exhaust systems are capable of being tested during plant operation.

Codes and standards applicable to the diesel generator combustion air intake and exhaust system are listed in Table 3.2-1.

9.5.8.2 System Description

The diesel generator combustion air intake and exhaust system is shown schematically on Dwg. M-134, Sh. 1 for Diesel Generators A, B, C and D and Dwg. M-134, Sh. 7 for Diesel Generator 'E'. Each diesel generator has a separate exhaust and intake system.

9.5.8.2.1 Component Description and System Operation

Each air intake system includes an air intake filter and an intake silencer with the necessary interconnecting piping and flexible joint for connection to the engine turbocharger. A butterfly valve is located in the turbocharger air inlet to shut off combustion air flow when engine overspeeding occurs.

An exhaust gas driven turbocharger draws in a volume of air that is equally divided between the two banks of combustion cylinders by the intake manifolds.

Compressing the air with the turbocharger generally raises the temperature to a point where cooling water must be continually circulated to cool it. Occasionally the air being compressed enters the turbocharger at a temperature too low for adequate combustion. In this case heated water from the jacket water inlet header is circulated through the intercoolers. The heater/intercoolers are fin-tube type and are mounted directly in the engine air inlet headers downstream of the turbocharger.

Following combustion the hot exhaust gases leave the cylinders through the exhaust manifold and are then used to drive the turbocharger. The gas leaves the turbocharger through a flexible joint and enters the exhaust piping, which includes a silencer. The exhaust piping terminates at the diesel generator building roof and is completely missile protected for Diesel Generators A, B, C and D. For Diesel Generator 'E', the exhaust piping terminates into an insulated exhaust chamber located in the southeast corner of the Diesel Generator 'E' Building at plant elevation 726 feet. This exhaust piping is also missile protected.

9.5.8.3 Safety Evaluation

The diesel generator combustion air intake and exhaust system is an integral part of the diesel generator. The system meets the single failure criterion in that, if a failure in this system prevents satisfactory operation of the associated diesel generator, the other three divisions of the emergency power system will provide adequate power to safely shut down the plant or mitigate the consequences of any of the postulated accidents. The diesel generator combustion air intake and exhaust system is located within the confines of the diesel generator building. The intake and exhaust ducts are located outside the buildings and are missile protected. All equipment and supports for this system are designed to Seismic Category I requirements.

Diesel engines A, B, C and D are Cooper-Bessemer Model KSV-16-T, and are located in four separate rooms at plant elevation 677 feet. Each engine is supplied with combustion air from intakes also at plant elevation 677 feet. Each engine, at full load, exhausts approximately 48,000 cubic feet per minute at a temperature of approximately 950 degrees Fahrenheit. Exhaust gases from the engines are carried by piping through silencers to roof level at plant elevation 723 feet. Each of the four exhaust pipes runs horizontally across the roof to a common discharge point. The exhaust pipes are fully enclosed in a concrete structure for missile protection, except for the very end of the pipe, which is exposed to the outside. The end of the pipe is protected from missiles by vertical concrete walls which are open above and at the lower front for exhaust gas discharge. Each of the four exhaust pipes discharge against the vertical concrete missile shield located some four feet beyond the end of the pipe. These discharge pipes are installed in pairs in two bays, separated by additional missile shielding. These arrangements are shown on Figures 9.5-26 and 9.5-27.

Diesel engine 'E' is a Cooper-Bessemer Model KSV-20-T, and is located in its own Seismic Category I building at plant elevation 676 feet. This engine is supplied with combustion air from the air intake chamber located on the north side of the building at plant elevation 708 feet. This engine, at full load, exhausts approximately 51,000 cubic feet per minute at a temperature of approximately 950°F. The exhaust gases from this engine are carried by piping through expansion joints and a silencer to an insulated exhaust chamber located in the southeast corner of the building at plant elevation 726 feet. The exhaust chamber and piping is protected against the effects of tornadoes and missiles. This arrangement is shown in Figure 9.5-26A.

None of the components of the diesel generator air intake and exhausts systems are exposed to inclement weather conditions except about 4 feet of the exit end of the exhaust pipe on Diesel Generators A, B, C and D. This section of the pipe is open to the atmosphere from above. The bottom of the pipe is 5 ft.-6 in. above the roof of the building. Since the pipe is closely shielded on all sides, except directly above, exposure is minimized. In addition, the exhaust pipe end is cut at an angle which would prohibit accumulation of sleet and snow in the pipe. See Figure 9.5-27.

The effects on combustion air quality of recirculation of engine exhaust gases has been analyzed for Diesel Generators A, B, C and D. For the analysis, it was assumed that all four diesel generators are operating at full load, and that all exhaust gases were discharged to the two open bays of the missile shield enclosure. It was also assumed that the exhaust gases travel upward out the bay and spread in the open atmosphere at an angle of ninety degrees to form approximately a conical plume. Two engines exhaust into each bay, so that the volume of gases from each of the two bays is approximately 96,000 cubic feet per minute. The assumption of plume spread at a ninety degree angle is reasonable, considering the exhaust gas horizontal velocity against the missile shield, and further considering the elevated temperatures of the gases, both factors contributing to rapid turbulent mixing.

The diesels on the Susquehanna project utilize approximately 200% required combustion air. The engines will continue to operate at full load capacity down to approximately 85 percent of normal oxygen in the combustion air (17 percent vs. 20 percent oxygen in normal ambient air). The conservative value of 130 percent combustion air is assumed for this analysis. The actual exhaust gases contain approximately 10% oxygen. The analysis assumed that the exhaust gases from the engines contain approximately 6 percent oxygen as an additional conservatism.

As the exhaust gases expand in the atmosphere in a cone-shaped vertical plume, each increment of gas contains the original volume, containing 6 percent oxygen, plus some additional volume of entrained ambient air containing 20 percent oxygen. Maintaining the cone-shaped plume expansion at 90 degrees for a number of one-foot increments, it was then calculated that entrainment of ambient air caused the oxygen-depleted exhaust gases to become enriched to 17.5 percent oxygen at eight feet above the bay, and to 18.1 percent oxygen at ten feet above the bay. Thus, even if exhaust gases are entrained by dynamic mixing in the turbulent wake of the building into the engine air intakes some 53 feet below, sufficient oxygen will be present to sustain normal engine operation.

The effects on combustion air quality of recirculation of engine exhaust gases has not been analyzed for Diesel Generator 'E'. To minimize recirculation of engine exhaust into the combustion air intake, the combustion exhaust is located at the opposite end of the building. The potential for exhaust gases mixing with intake air is extremely remote, however, should this occur, the concentration of exhaust gases in the intake air would be minimal and would not affect engine operation.

The engines are equipped with temperature indicators in the air inlet manifolds and cylinder exhaust thermocouples to monitor the intake and exhaust temperatures. There is also a gauge on the engine control panel to monitor intake and crankcase pressures. The engine is not equipped with alarm or shutdown sensors for abnormal conditions in the intake and exhaust systems, as the engines are designed to operate under all specified operating conditions.

Flood protection is discussed in Section 3.4. Protection against dynamic effects associated with postulated rupture of piping is discussed in Section 3.6. Environmental design is discussed in Section 3.11.

9.5.8.4 Tests and Inspections

Testing of the diesel generator system is discussed generally in Section 8.3. The diesel generator combustion air intake and exhaust system is operationally checked during the periodic testing of the diesel generator system.

The system was pre-operationally tested in accordance with the requirements of Chapter 14.

9.5.8.5 Instrument Application

Instrument locations are shown on Dwg. M-134, Sh. 1 for Diesel Generators A, B, C and D and Dwg. M-134, Sh. 7 for Diesel Generator 'E'.

9.5.9 HYDROGEN WATER CHEMISTRY (HWC) SYSTEM

The function of the Hydrogen Water Chemistry (HWC) System is to supply and inject hydrogen gas into the feedwater system at a flow rate necessary to mitigate the chemical conditions in the Boiling Water Reactor (BWR) that allow Intergranular Stress Corrosion Cracking (IGSCC) in the lower reactor vessel internals.

9.5.9.1 Design Basis

The HWC System has no safety-related functions.

The HWC System is designed to inject hydrogen into the reactor feedwater at the suction of the three feedwater pumps to mitigate IGSCC in the recirculation piping and reactor vessel internals. The hydrogen causes a reduction in a dissolved oxygen concentration by decreasing the radiolytic production rate of hydrogen and oxygen in the vessel core region and recirculation water. The addition of hydrogen to the feedwater results in an excess ratio of hydrogen to oxygen at the entrance to the offgas system. An oxygen flow rate of approximately equal to one half the hydrogen flow rate is injected to the offgas system upstream of the catalytic recombiner. Because oxygen concentration is reduced in the steam, condensate oxygen concentration is also reduced. To counter this effect, a small amount of oxygen may be injected into the condensate pump suction to keep oxygen concentration in the feedwater within acceptable limits.

9.5.9.2 System Description

The HWC System consists of a Tank Farm Gas Supply facility, hydrogen injection equipment, oxygen injection equipment, process piping and monitoring and control instrumentation.
The Gas Supply facility is operated and maintained by a commercial gas supply vendor. The facility is common for both units. The function of this facility is to store and supply hydrogen and oxygen at the required pressure and flow rates. The Gas Supply facility is automatic in operation and includes its own controls, alarms, and shutdowns. Excess flow check valves are provided to shut off hydrogen and oxygen gas flow in the event of a pipe break.

The HWC System is designed to inject hydrogen into the plant feedwater, inject a stoichiometric amount of oxygen into the offgas system, and monitor the results. The system also manually injects oxygen into the condensate system. The system includes gas flow control valves, automatic controls, alarms, and automatic shutdowns.

The system includes an HWC Control Panel, a Hydrogen Flow Control Panel, an Oxygen Flow Control Panel, a HWC Hydrogen Isolation Valve and oxygen analyzers (which are part of the offgas system analyzers described in Section 11.3.2.2.8). These panels are connected by process piping and signal wiring to provide monitoring and control of the HWC process.

9.5.9.3 Safety Evaluation

The HWC System is not a safety-related system and does not have any direct interface with any safety-related structure, system, or component. The failure of the HWC system or its components will not compromise any safety-related system or prevent a safe shutdown of the plant. The HWC equipment and components are non-Seismic Category I. The plant may be operated without the HWC System in-service.

The design of the HWC System complies, with some minor exceptions, with the NRC approved EPRI Guidelines contained in the document EPRI NP-5283-SR-A "Guidelines for Permanent BWR Hydrogen Water Chemistry Installations-1987 Revision".

Exceptions to EPRI Guidelines are listed here:

- For hydrogen injection control, three flow control valves in parallel are used. Redundant flow control valves are not used. Oxygen flow control is performed by single flow control valve. This is a deviation from the EPRI guideline recommendation of redundant flow control valves. The justification is based on good GE field experience with flow control valve operation and reliability.

- The signal from high reactor recirculation water dissolved oxygen is not used. This signal was based on the original concept of hydrogen addition for protection of reactor recirculation piping. For in-vessel component protection, the hydrogen addition is sufficient to suppress the reactor recirculation water dissolved oxygen level to less than the detectable limit.

- Reactor scram is a recommended trip. The hydrogen injection system does not automatically trip on a reactor scram signal; however, the system trips at a low power setpoint based on the feedwater flow rate. Therefore, the power level trip serves the same function as a reactor scram trip. The hydrogen injection system can also be manually shutdown from the control room.

- The High Offgas % Oxygen concentration trip of the HWC system is not used. The high percent oxygen alarm was included in the EPRI Guidelines to prevent postulated influences on the charcoal delay system. The identified concerns were: auto-ignition, non-linear burning rates vs. percent oxygen, over-pressurization of the charcoal vessels, increasing burning rates as pressure increases (rocket engine effect) and any other abnormal burning effects with high oxygen percentages. These issues were evaluated experimentally at the University of Utah under contract with GE-H, and none of the above-mentioned conditions were observed over a range of 21% to 100% oxygen. On this basis, the high percent oxygen alarm can be removed. The HWC system will be operated from above a low power setpoint once steam is present in the three shells (HP, IP and LP) of the main condenser or the main turbine is a rated speed, up to 100% plant power. In order for steam to be present in the required locations during startup, two turbine bypass valves are required to be fully open and a third at least partially open.

- EPRI guidelines recommended no injection below 20% power. Hydrogen and oxygen injection occurs above the low power setpoint which is below 20% power, once steam is admitted to the three shells (HP, IP and LP) of the main condenser by way of two open Turbine Bypass Valves and a third at least partially open, or the main turbine is at rated speed. The EPRI guidelines were based on taking credit for a Main Steam Line Radiation Monitor (MSLRM) initiated main steam line isolation valve closure for the Control Rod Drop Accident (CRDA), which resulted in a reactor scram. The MSLRM initiated main steam isolation valve closure / scram signals have been removed. For the CRDA, the MSLRM trips and isolates the Mechanical Vacuum Pump at approximately 5% power. Therefore, HWC will not inject at the time while the MVP isolation will be needed for a CRDA. The MSLRM is also an isolation signal for the reactor water sample valves. This isolation signal is not credited in the plant design basis to mitigate any plant event but does provide a diverse means to initiate an isolation actuation. MSLRM also provides an alarm function. The existing MSLRM design functions are not impacted with hydrogen injection above 5% power.

Excess flow check valves are installed in the hydrogen lines to restrict flow in case of a broken line. Bellows seal valves and welded piping are used in the hydrogen flow control panel to minimize the possibility of leakage of hydrogen. Feed water hydrogen injection lines contain check valves to prevent feedwater from entering the hydrogen lines and to protect upstream hydrogen gas components. Automatic isolation valves are installed to prevent hydrogen injection into a non-operating feedwater pump. Purge connections are provided to completely purge air from the system before hydrogen is put into the line. Hydrogen area monitors are provided to detect hydrogen leakage. Hydrogen area monitors alarm if hydrogen is detected and the HWC System shuts down if hydrogen approaches flammability limit.

The separation distances from the nearest safety-related building and air intakes to the liquid hydrogen and oxygen storage tanks and gaseous hydrogen receivers meets the requirements given in the NRC approved EPRI Guidelines contained in the document EPRI NP-5283-SR-A “Guidelines for Permanent BWR Hydrogen Water Chemistry Installations-1987 Revision”.
The injection of hydrogen causes readjustments in the reactor coolant water chemistry and the

plants' design basis radiation source terms. The effects are documented in FSAR Chapters 11 and 12.

9.5.9.4 Inspection and Testing

The HWC System will be pre-operationally tested.

9.5.9.5 Instrumentation and Control

Instrumentation for recording of parameters necessary to monitor and control the Hydrogen Injection System and to indicate and/or alarm abnormal and or undesirable conditions is provided. A Programmable Logic Controller (PLC) processes the measured variable and operator commands to perform the control functions. A graphic display Operator Interface Unit (OIU) is provided for operator information, data logging and operator input of flow control setpoint and flow control valve manual mode position demands. The HWC System is designed with alarms and trips on critical parameters in order to notify operators of system upsets and to automatically shutdown the system, if necessary.

Important control functions are listed below:

- Flow control is provided to automatically follow plant power levels (as determined from feedwater flow). Alternately, the operator may enter a hydrogen flow setpoint. Oxygen flow automatically follows hydrogen flow after an appropriate time delay. Setpoint changes are delayed by a ramping function to provide smooth flow control.

- Flow balancing between the three feedwater pumps is done by using three flow control valves in parallel. Each valve receives the same control air signal, thus the valves operate together. Each flow control valve is followed by an isolation valve. The isolation valve can open only when a "pump in service" signal is received by the HWC control system.

- Shutdown on selected signals is implemented by immediately closing the hydrogen flow control and isolation valves, but allowing the oxygen flow to ramp down after the preset time delay.

- Manual switches are provided for each of the automatic isolation valves. These switches allow closure of their respective valves regardless of the PLC logic.

- A manual shutdown switch on the HWC control panel and a switch in the control room provide for immediate system shutdown.

- Analog signals representing major process variables are transmitted to the plant computer.

9.5.10 PASSIVE ZINC INJECTION SYSTEM

The function of the Passive Zinc Injection System is to supply and inject depleted zinc into the feedwater system at a flow rate necessary to aid in reducing shutdown dose rates by reducing

Co-60 deposition by controlling contamination buildup or plate out on the primary system pipe internal surfaces.

9.5.10.1 Design Bases

The Passive Zinc Injection System has no safety-related functions.

The system is designed to inject zinc into the reactor feedwater at the suction of the REACTOR FEED PUMP 'A' or 'B' to mitigate radiation buildup, primarily from Co-60, on the recirculation piping. The zinc in the reactor water causes the newly forming pipe film, after a chemical decontamination of the recirculation piping, to incorporate zinc and exclude the Co-60. (Reference: EPRI BWR Water Chemistry Guidelines 2000 Revision, TR-103515-R2)

9.5.10.2 System Description

The Passive Zinc Injection System will inject a zinc solution into feedwater by passing a small stream of feedwater from the REACTOR FEED PUMP 'A' or 'B' discharge pipe through the system containing pelletized zinc oxide. The zinc solution will be returned to the REACTOR FEED PUMP 'A' or 'B' suction pipe.

The system consists of a dissolution vessel, a strainer on the discharge of the vessel, a manual flow control valve, and manual isolation valves at the inlet and outlet of the skid. The skid will have local instruments to monitor the flow rate (nominally 20 to 100 gpm), the differential pressure across the vessel and the strainer, and the temperature of the vessel.

9.5.10.3 Safety Evaluation

The Passive Zinc Injection System is not a safety-related system and does not have any direct interface with any safety-related structure, system, or component. The failure of the system or its components will not compromise any safety-related system or prevent a safe shutdown of the plant. The Passive Zinc Injection equipment and components are non-Seismic Category I. The plant may be operated without the Passive Zinc Injection System in-service.

9.5.10.4 Inspection and Testing

The Passive Zinc Injection System will be pre-operationally tested.

9.5.10.5 Instrumentation and Control

Local instruments are used to monitor and control the Passive Zinc Injection System. Important control functions are listed in this section:

- A manual flow control valve is provided to control flow.
- A flow instrument is used to monitor the flow.
- A differential pressure instrument is used to monitor the pressure drop across the dissolution vessel and the outlet strainer.
- A temperature instrument is used to monitor the temperature of the dissolution vessel.

9.5.11 REFERENCES

9.5-1 Fire Protection Review Report

9.5-2 NEDO-10466, G. C. Minor, H. R. Clay, "Power Generation Control Complex Design Criteria and Safety Evaluation, "Licensing Topical Report, Class I, Revision 2, March, 1978.

9.5-3 EPRI NP-5283-SR-A “Guidelines for Permanent BWR Hydrogen Water Chemistry Installations-1987 Revision.”

9.5-4 EPRI TR-103515-R12 “BWR Water Chemistry Guidelines-2000 Revision.”

TABLE 9.5-3

EMERGENCY LIGHTING SYSTEM IN SUSQUEHANNA SES

EMERGENCY LIGHTING SYSTEM					
	EMERGENCY LIGHT SYSTEM				
	125V DC EMERG. LIGHTING POWER SYSTEM	SELF-CONTAINED BATTERY LIGHTING			
AREA		EXIT LIGHT RATE 2½ HRS	STAIR LIGHT RATED 1½ HRS	EMERG. LIGHT UNIT RATED 8 HRS	EMERG. LIGHT CENTER RATE 8 HRS
TURBINE BUILDING					
EL 656'	YES				
EL 676'	YES			YES(3)	
EL 699'	YES			YES(3)	
EL 714'	YES				
EL 729'	YES			YES(3)	
STAIRWAYS			YES	YES(3)	
REMOTE SHUTDOWN PASS.				YES(3)	
RADWASTE BUILDING					
EL 646'	YES	YES			
EL 660'	YES	YES			
EL 676'	YES	YES			
EL 691'	YES	YES			
STAIRWAYS			YES		
REACTOR BUILDING					
EL 645'	YES			YES(3)	
EL 670'	YES			YES(3)	
EL 683'	YES				
EL 719'	YES			YES(3)	
EL 749'	YES			YES(3)	
EL 779'	YES				
EL 799'	YES				
EL 818'	YES				
STAIRWAYS			YES	YES(3)	
REMOTE SHUTDOWN PASS.				YES(3)	
NORTH & SOUTH					
GATE HOUSE		YES			
SCC	YES				

TABLE 9.5-3

EMERGENCY LIGHTING SYSTEM IN SUSQUEHANNA SES

EMERGENCY LIGHTING SYSTEM					
	EMERGENCY LIGHT SYSTEM				
		SELF-CONTAINED BATTERY LIGHTING			
AREA	125V DC EMERG. LIGHTING POWER SYSTEM	EXIT LIGHT RATE 2½ HRS	STAIR LIGHT RATED 1½ HRS	EMERG. LIGHT UNIT RATED 8 HRS	EMERG. LIGHT CENTER RATE 8 HRS
CONTAINMENT					
EL 704’	YES				
EL 719’	YES				
EL 739’	YES				
EL 779’	YES				
CONTROL STRUCTURE					
EL 676’	YES				
EL 698’	YES			YES(3)	
EL 714’	YES				
EL 729’ CONTROL RM					YES
EL 741’1” TSC				YES	
EL 754’	YES				
EL 771’	YES				
EL 783’	YES			YES(3)	
EL 806’	YES				
STAIRWAYS			YES	YES(3)	
REMOTE SHUTDOWN PASS.				YES(3)	YES
ESSW PUMPHOUSE		YES			
INTAKE STRUCTURE	YES				
CW PUMPHOUSE		YES	YES		
CHLORINE & SULFURIC BUILDING		YES			
DIESEL GENERATOR BLDG STAIRWAYS		YES		YES	
ADMINISTRATION BLDG		YES	YES		
DIESEL GENERATOR & FACILITY		YES(1)	YES(2)	YES	

(1) 90 minute battery rating
(2) 8 hour battery rating
(3) 8 hour emergency light units provided in these areas for the purpose of safe shutdown in accordance with 10CFR50 Appendix R.

TABLE 9.5-4

COMMUNICATION SYSTEMS

VITAL AREA	PAGE-TALK INTERCOM (5 CH.)	TELEPHONE PUBLIC SWITCHED	INTRAPLANT MAINT/TEST JACK PHONE	EMERGENCY ALARM SYSTEM	SECURITY COMMUNICATION	RADIO COMMUNICATION	APPENDIX R COMMUNICATION	SATELLITE TELEPHONE
U1 & U2 Reactor Building					**			
EL 818'	Yes	Yes	Yes	Yes				
EL 799'	Yes		Yes	Yes				
EL 779'	Yes		Yes	Yes				
EL 749'	Yes		Yes	Yes			Yes	
EL 719'	Yes	Yes	Yes	Yes			Yes	
EL 683'	Yes		Yes	Yes				
EL 670'	Yes	Yes	Yes	Yes			Yes	
EL 645'	Yes	Yes	Yes	Yes				
U1 & U2 Control Structure					**			
EL 806'	Yes		Yes	Yes			Yes	
EL 783'	Yes		Yes	Yes				
EL 771'	Yes	Yes	Yes	Yes				
EL 754'	Yes		Yes	Yes				
EL 741'	Yes	Yes		Yes				Yes
EL 729'	Yes	Yes	Yes	Yes			Yes	Yes
EL 698'	Yes	Yes	Yes	Yes			Yes	
U1 & U2 Turbine Building					**			
EL 676'	Yes	Yes	Yes	Yes				
EL 699'							Yes	
U1 & U2 Emergency Service Water Area					**			
EL 685'	Yes	Yes	Yes	Yes				
Diesel Generator Rooms 'A-D'					**			
EL 710'								
EL 676'	Yes		Yes	Yes			Yes	
EL 660'								
Diesel Generator 'E' Building					**			
EL 708'	Yes		Yes	Yes			Yes	
EL 675'-6"	Yes		Yes	Yes				
EL 656'-6"	Yes		Yes	Yes				

** See Security System Section.

FIGURE 9.5-13 REPLACED BY DWG. E-408, SH. 1

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FIGURE 9.5-13 REPLACED BY DWG. E-408, SH. 1

FIGURE 9.5-13, Rev. 55

AutoCAD Figure 9_5_13.doc

FIGURE 9.5-14 REPLACED BY DWG. E-408, SH. 2

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FIGURE 9.5-14 REPLACED BY DWG. E-408, SH. 2

FIGURE 9.5-14, Rev. 55

AutoCAD Figure 9_5_14.doc

FIGURE 9.5-15 REPLACED BY DWG. E-409, SH. 1

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FIGURE 9.5-15 REPLACED BY DWG. E-409, SH. 1

FIGURE 9.5-15, Rev. 49

AutoCAD Figure 9_5_15.doc

FIGURE 9.5-16 REPLACED BY DWG. E-409, SH. 2

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FIGURE 9.5-16 REPLACED BY DWG. E-409, SH. 2

FIGURE 9.5-16, Rev. 50

AutoCAD Figure 9_5_16.doc

FIGURE 9.5-16A REPLACED BY DWG. E-409, SH. 3

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FIGURE 9.5-16A REPLACED BY DWG. E-409, SH. 3

FIGURE 9.5-16A, Rev. 55

AutoCAD Figure 9_5_16A.doc

FIGURE 9.5-16B REPLACED BY DWG. E-409, SH. 4

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FIGURE 9.5-16B REPLACED BY DWG. E-409, SH. 4

FIGURE 9.5-16B, Rev. 50

AutoCAD Figure 9_5_16B.doc

FIGURE 9.5-16C REPLACED BY DWG. E-409, SH. 5

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FIGURE 9.5-16C REPLACED BY DWG. E-409, SH. 5

FIGURE 9.5-16C, Rev. 51

AutoCAD Figure 9_5_16C.doc

FIGURE 9.5-16D REPLACED BY DWG. E-409, SH. 6

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FIGURE 9.5-16D REPLACED BY DWG. E-409, SH. 6

FIGURE 9.5-16D, Rev. 49

AutoCAD Figure 9_5_16D.doc

FIGURE 9.5-16E REPLACED BY DWG. E-409, SH. 7

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FIGURE 9.5-16E REPLACED BY DWG. E-409, SH. 7

FIGURE 9.5-16E, Rev. 51

AutoCAD Figure 9_5_16E.doc

FIGURE 9.5-17 REPLACED BY DWG. E-411, SH. 1

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.5-17 REPLACED BY DWG. E-411, SH. 1

FIGURE 9.5-17, Rev. 55

AutoCAD Figure 9_5_17.doc

FIGURE 9.5-18 REPLACED BY DWG. E-411, SH. 2

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SUSQUEHANNA STEAM ELECTRIC STATION
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FINAL SAFETY ANALYSIS REPORT

FIGURE 9.5-18 REPLACED BY DWG. E-411, SH. 2

FIGURE 9.5-18, Rev. 55

AutoCAD Figure 9_5_18.doc

FIGURE 9.5-19 REPLACED BY DWG. M-120, SH. 1

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.5-19 REPLACED BY DWG. M-120, SH. 1

FIGURE 9.5-19, Rev. 57

AutoCAD Figure 9_5_19.doc

FIGURE 9.5-19A REPLACED BY DWG. M-120, SH. 2

FSAR REV. 65

SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 & 2
FINAL SAFETY ANALYSIS REPORT

FIGURE 9.5-19A REPLACED BY DWG. M-120, SH. 2

FIGURE 9.5-19A, Rev. 57

AutoCAD Figure 9_5_19A.doc

FIGURE 9.5-19B REPLACED BY DWG. M-120, SH. 3

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.5-19B REPLACED BY DWG. M-120, SH. 3

FIGURE 9.5-19B, Rev. 2

AutoCAD Figure 9_5_19B.doc

FIGURE 9.5-20 REPLACED BY DWG. M-134, SH. 1

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SUSQUEHANNA STEAM ELECTRIC STATION
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FIGURE 9.5-20 REPLACED BY DWG. M-134, SH. 1

FIGURE 9.5-20, Rev. 56

AutoCAD Figure 9_5_20.doc

FIGURE 9.5-20A REPLACED BY DWG. M-134, SH. 5

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SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
FIGURE 9.5-20A REPLACED BY DWG. M-134, SH. 5 FIGURE 9.5-20A, Rev. 55

AutoCAD Figure 9_5_20A.doc

FIGURE 9.5-20B REPLACED BY DWG. M-134, SH. 6

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FIGURE 9.5-20B REPLACED BY DWG. M-134, SH. 6

FIGURE 9.5-20B, Rev. 49

AutoCAD Figure 9_5_20B.doc

FIGURE 9.5-20C REPLACED BY DWG. M-134, SH. 7

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FIGURE 9.5-20C REPLACED BY DWG. M-134, SH. 7

FIGURE 9.5-20C, Rev. 56

AutoCAD Figure 9_5_20C.doc

FIGURE 9.5-21 REPLACED BY DWG. M30-69, SH. 1

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FIGURE 9.5-21 REPLACED BY DWG. M30-69, SH. 1

FIGURE 9.5-21, Rev. 55

AutoCAD Figure 9_5_21.doc

FIGURE 9.5-22 REPLACED BY DWG. M30-71, SH. 1

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FIGURE 9.5-22 REPLACED BY DWG. M30-71, SH. 1

FIGURE 9.5-22, Rev. 55

AutoCAD Figure 9_5_22.doc

FIGURE 9.5-22A REPLACED BY DWG. FF61604, SH. 7

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FIGURE 9.5-22A REPLACED BY DWG. FF61604, SH. 7

FIGURE 9.5-22A, Rev. 55

AutoCAD Figure 9_5_22A.doc

FIGURE 9.5-23 REPLACED BY DWG. M-738, SH. 1

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FIGURE 9.5-23 REPLACED BY DWG. M-738, SH. 1

FIGURE 9.5-23, Rev. 55

AutoCAD Figure 9_5_23.doc

FIGURE 9.5-24 REPLACED BY DWG. FF61604, SH. 3

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FIGURE 9.5-24 REPLACED BY DWG. FF61604, SH. 3

FIGURE 9.5-24, Rev. 56

AutoCAD Figure 9_5_24.doc

Security-Related Information
Figure Withheld Under 10 CFR 2.390

SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
DIESEL GENERATOR AREA 44 PLAN ON EL. 677'-0" INTAKE & EXHAUST FIGURE 9.5-26

Security-Related Information
Figure Withheld Under 10 CFR 2.390

SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
DIESEL GENERATOR 'E' BUILDING INTAKE & EXHAUST PIPING FIGURE 9.5-26A

Security-Related Information
Figure Withheld Under 10 CFR 2.390

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DIESEL GENERATOR 'E' BUILDING
COMPOSITE PIPING
BASEMENT FLOOR EL. 656'-8"
PLAN, SECTIONS AND DETAILS

FIGURE 9.5-26B

Security-Related Information
Figure Withheld Under 10 CFR 2.390

SUSQUEHANNA STEAM ELECTRIC STATION UNITS 1 & 2 FINAL SAFETY ANALYSIS REPORT
DIESEL GENERATOR BUILDING
FIGURE 9.5-27

FIGURE 9.5-28 REPLACED BY DWG. C-1006, SH. 1

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FIGURE 9.5-28 REPLACED BY DWG. C-1006, SH. 1

FIGURE 9.5-28, Rev. 56

AutoCAD Figure 9_5_28.doc

FIGURE 9.5-29 REPLACED BY DWG. C-1007, SH. 1

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FIGURE 9.5-29 REPLACED BY DWG. C-1007, SH. 1

FIGURE 9.5-29, Rev. 56

AutoCAD Figure 9_5_29.doc

FIGURE 9.5-29-1 REPLACED BY DWG. C-1007, SH. 2

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FIGURE 9.5-29-1 REPLACED BY DWG. C-1007, SH. 2

FIGURE 9.5-29-1, Rev. 2

AutoCAD Figure 9_5_29_1.doc

FIGURE 9.5-30 REPLACED BY DWG. C-1032, SH. 1

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FIGURE 9.5-30 REPLACED BY DWG. C-1032, SH. 1

FIGURE 9.5-30, Rev. 55

AutoCAD Figure 9_5_30.doc

FIGURE 9.5-30A REPLACED BY DWG. C-5028, SH. 1

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FIGURE 9.5-30A REPLACED BY DWG. C-5028, SH. 1

FIGURE 9.5-30A, Rev. 56

AutoCAD Figure 9_5_30A.doc

FIGURE 9.5-31 REPLACED BY DWG. EC-1, SH. 1

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FIGURE 9.5-31 REPLACED BY DWG. EC-1, SH. 1

FIGURE 9.5-31, Rev. 57

AutoCAD Figure 9_5_31.doc

FIGURE 9.5-32 REPLACED BY DWG. EC-2, SH. 1

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FIGURE 9.5-32 REPLACED BY DWG. EC-2, SH. 1

FIGURE 9.5-32, Rev. 55

AutoCAD Figure 9_5_32.doc

FIGURE 9.5-33 REPLACED BY DWG. EC-3, SH. 1

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FIGURE 9.5-33 REPLACED BY DWG. EC-3, SH. 1

FIGURE 9.5-33, Rev. 55

AutoCAD Figure 9_5_33.doc

FIGURE 9.5-34 REPLACED BY DWG. EC-4, SH. 1

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FIGURE 9.5-34 REPLACED BY DWG. EC-4, SH. 1

FIGURE 9.5-34, Rev. 54

AutoCAD Figure 9_5_34.doc

FIGURE 9.5-35 REPLACED BY DWG. EC-5, SH. 1

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FIGURE 9.5-35 REPLACED BY DWG. EC-5, SH. 1

FIGURE 9.5-35, Rev. 49

AutoCAD Figure 9_5_35.doc

FIGURE 9.5-36 REPLACED BY DWG. EC-6, SH. 1

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FIGURE 9.5-36 REPLACED BY DWG. EC-6, SH. 1

FIGURE 9.5-36, Rev. 49

AutoCAD Figure 9_5_36.doc

FIGURE 9.5-37 REPLACED BY DWG. EC-7, SH. 1

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FIGURE 9.5-37 REPLACED BY DWG. EC-7, SH. 1

FIGURE 9.5-37, Rev. 48

AutoCAD Figure 9_5_37.doc

FIGURE 9.5-38 REPLACED BY DWG. EC-8, SH. 1

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FIGURE 9.5-38 REPLACED BY DWG. EC-8, SH. 1

FIGURE 9.5-38, Rev. 48

AutoCAD Figure 9_5_38.doc

FIGURE 9.5-39 REPLACED BY DWG. C-46, SH. 1

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FIGURE 9.5-39 REPLACED BY DWG. C-46, SH. 1

FIGURE 9.5-39, Rev. 56

AutoCAD Figure 9_5_39.doc

FIGURE 9.5-40 REPLACED BY DWG. C-901, SH. 1

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FIGURE 9.5-40 REPLACED BY DWG. C-901, SH. 1

FIGURE 9.5-40, Rev. 49

AutoCAD Figure 9_5_40.doc

FIGURE 9.5-40A REPLACED BY DWG. C-5012, SH. 1

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FIGURE 9.5-40A REPLACED BY DWG. C-5012, SH. 1

FIGURE 9.5-40A, Rev. 50

AutoCAD Figure 9_5_40A.doc

FIGURE 9.5-41 REPLACED BY DWG. C-904, SH. 1

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FIGURE 9.5-41 REPLACED BY DWG. C-904, SH. 1

FIGURE 9.5-41, Rev. 49

AutoCAD Figure 9_5_41.doc

FIGURE 9.5-41A REPLACED BY DWG. C-5013, SH. 1

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FIGURE 9.5-41A REPLACED BY DWG. C-5013, SH. 1

FIGURE 9.5-41A, Rev. 55

AutoCAD Figure 9_5_41A.doc

FIGURE 9.5-42 REPLACED BY DWG. C-905, SH. 1

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FIGURE 9.5-42 REPLACED BY DWG. C-905, SH. 1

FIGURE 9.5-42, Rev. 55

AutoCAD Figure 9_5_42.doc

FIGURE 9.5-42A REPLACED BY DWG. C-5014, SH. 1

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FIGURE 9.5-42A REPLACED BY DWG. C-5014, SH. 1

FIGURE 9.5-42A, Rev. 55

AutoCAD Figure 9_5_42A.doc

FIGURE 9.5-42B REPLACED BY DWG. C-5015, SH. 1

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FIGURE 9.5-42B REPLACED BY DWG. C-5015, SH. 1

FIGURE 9.5-42B, Rev. 55

AutoCAD Figure 9_5_42B.doc

FIGURE 9.5-43-1 REPLACED BY DWG. C-1029, SH. 1

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FIGURE 9.5-43-1 REPLACED BY DWG. C-1029, SH. 1

FIGURE 9.5-43-1, Rev. 57

AutoCAD Figure 9_5_43_1.doc

FIGURE 9.5-43-2 REPLACED BY DWG. C-1029, SH. 2

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FIGURE 9.5-43-2 REPLACED BY DWG. C-1029, SH. 2

FIGURE 9.5-43-2, Rev. 49

AutoCAD Figure 9_5_43_2.doc

FIGURE 9.5-47 REPLACED BY DWG. E-412, SH. 1

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FIGURE 9.5-47 REPLACED BY DWG. E-412, SH. 1

FIGURE 9.5-47, Rev. 55

AutoCAD Figure 9_5_47.doc