9.5.8 Diesel Generator Air Intake and Exhaust System

The diesel generator air intake and exhaust system (DGAIES) provides the diesel engine with combustion air from the outside. The combustion air passes through a filter, silencer, and heater before being compressed by a turbocharger and cooled by the coolant system before entering the individual cylinders for combustion.

The exhaust gas system collects the exhaust gas from the individual cylinders and conveys them via the engine-mounted turbocharger, emissions equipment, and an exhaust gas silencer to the outside.

9.5.8.1 Design Basis

The design of the system and EPGB establishes that the arrangement and location of the combustion air intake and exhaust gas discharge are such that dilution and contamination of the intake air will not prevent operation of the EDG at rated power output or cause engine shutdown as a consequence of any metrological or accident condition.

Each EDG set has a separate, independent diesel engine combustion air and exhaust gas system, as shown in Figure 9.5.8-1—Emergency Diesel Generator Air Intake and Exhaust System.

- The safety-related portions of the DGAIES are designed in accordance with Seismic Category I. Safety-related systems are required to function following a DBA, and are required to achieve and maintain a safe shutdown condition.

- Safety functions can be performed, assuming a single active component failure coincident with the LOOP (GDC 17).

- None of the safety-related components of the DGAIES are shared with any other division or unit (GDC 5).

- Each DGAIES is protected from the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, and external missiles GDC 2). Each system remains functional after an SSE and performs its intended functions following a postulated hazard, such as fire, internal missiles, or pipe break. Failure of one division DGAIES will not affect the function of more than one DGAIES (GDC 3 and 4).

- Safety functions can be performed, assuming a single active component failure coincident with the LOOP due to the four100 percent design structure of the EDGs (GDC 44).

- Active components of each of the DGAIES sub-systems of the EDGs can be tested during plant operation. The DGAIES uses design and fabrication codes consistent with the quality group classification assigned by RG 1.26 and seismic category

assigned by RG 1.29. Power and control functions are designed in accordance with RG 1.32.

- The DGAIES is designed to provide combustion air under all operating conditions.

The DGAIES is only operational when providing combustion air to the diesel engine and removing the exhaust gasses from the engine. The emission control function of the DGAIES is a non-safety function.

9.5.8.2 System Description

The diesel engine combustion air system provides the necessary combustion air for the diesel engine, and the exhaust gas system provides a path for exhaust products of combustion from the EDGs to the environment under all operating conditions.

9.5.8.2.1 General Description

The combustion air for the diesel engine is taken directly from outside the EPGB via an air duct located on the upper floor level (i.e., elevation +51 ft, 6 in) of the building inside the missile protection area. The air passes through a filter, inlet damper, silencer and heater before entering the diesel engine turbocharger.

The turbocharger is operated by the kinetic energy of the exhaust gas and compresses the combustion air, which then passes through an intercooler before entering the individual cylinders. Compressed combustion air is supplied to the ejector of the crankcase ventilation system. The air flow through the ejector creates a vacuum that removes combustible vapors from the engine crankcase. The crankcase vacuum function is described in Section 9.5.7.2.1 and shown on Figure 9.5.7-1.

The intercooler is a heat exchanger, supplied with DGCWS to cool the intake air that has been heated by compression.

The cooled compressed air forces more air into each cylinder during the intake portion of the combustion cycle, increasing the horsepower of the engine. The compressed air is required for the EDG to meet its rated output.

The exhaust gas system, which consists of pipes, emission control equipment, and an exhaust gas silencer, is insulated to reduce radiated heat in the EPGB to an acceptable level.

The layout of the main components (i.e., piping, filters, and valves) provides the space required to permit inspection, cleaning, maintenance, and repair of the system.

9.5.8.2.2 Component Description

Table 3.2.2-1 provides the seismic design and other design classifications for components in the DGAIES.

The system contains the following components:

- Intake and exhaust silencers to attenuate the sound levels both in the EPGB and outside the building to meet site requirements.
- Filter(s) to separate dirt from the injection stream remove dust and small particles from the combustion air supply to the turbochargers.
- Pipes and ducting to route the air into the engine to minimize pressure drop, and piping to route exhaust from the engine to meet backpressure specifications of the engine manufacturer.
- Exhaust emission equipment to control exhaust emissions to meet federal, state, and local emissions requirements.
- Sensor(s) to monitor exhaust gas temperature, and filter differential pressure to alert the operators of abnormal conditions which may warrant operator action.

9.5.8.3 System Operation

The DGAIES supports the EDG and as such normal operation of the system is required any time the EDG is running. During normal diesel engine operation, air flows from outside the EPGB into the air duct and then through the air intake filter for particulate removal and a silencer for noise reductions. The power of the diesel engine is raised by compression of the combustion air in the engine-mounted turbocharger before the air enters the cylinders. The exhaust gas heat is used to operate the turbocharger. The exhaust gas flow is directed through the exhaust gas emissions equipment and silencer for noise attenuation and then discharged to the outside.

9.5.8.3.1 Normal Operation

When the plant is operating under normal conditions, the EDGs are maintained in standby. The air intake and exhaust system is maintained ready to support diesel operation.

9.5.8.3.2 Abnormal Operation

The combustion air and exhaust air systems are monitored and an alarm is sounded in the MCR to alert the operator when a degraded condition exists.

The intake filters are monitored for differential pressure and an alarm sounds when a condition exists that could affect the operability of the engine it supplies. The filter elements are replaceable and in extreme conditions they could be replaced online.

The temperature of the engine exhaust gas is monitored to verify that the engine is operating as designed. An alarm is sounded if the exhaust temperature exceeds established parameters which could damage internal components of the engine or prevent the engine from meeting its design power requirements. Heat generated by the engine combustion is maintained in a defined range to allow the engine, turbocharger, and emissions equipment to function as designed.

The exhaust system is equipped with a bypass valve and a bypass stack which provides a safety-related exhaust path in the event that a system failure downstream restricts the exhaust flow.

9.5.8.4 Safety Evaluation

- The safety-related portion of the combustion air system is located inside the EPGB and meets the same safety objectives as the diesel engine itself. This building is designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles, and other natural phenomena. Sections 3.3, 3.4, 3.5, 3.7(B), and 3.8 provide the bases for the adequacy of the structural design of these buildings.

- The safety-related portion of the DGAIES is designed to remain functional after an SSE. Sections 3.7(B).2 and 3.9(B provide the design loading conditions that were considered. There are no high- or moderate-pressure lines in the EPGB whose failure can affect the function of more than one DGAIES. Sections 3.5, 3.6 and 9.5.1 provide the hazards analyses to establish that a safe shutdown, as outlined in Section 7.4, can be achieved and maintained.

- The DGAIES for each diesel engine is independent of any other diesel engine's DGAIES. This precludes the sharing of any safety-related systems and components that could prevent those systems or components from performing required safety functions.

- The four-division design of the EDG air system provides complete redundancy; therefore no single failure compromises the EDG system safety functions. Vital power can be supplied from either onsite or offsite power systems, as described in Chapter 8. This meets the recommendation of NUREG/CR-0660 (Reference 1).

- All the power supplies and control functions necessary for safe function of the air handling system are Class IE, as described in Chapters 7 and 8.

9.5.8.5 Inspection and Testing Requirements

The DGAIES is initially tested using the program detailed in Chapter 14 and Section 14.2, tests #104, 105, and 106.

The operability of the system is checked by periodic testing and inspection of the EDG system.

Maintenance is executed in accordance with the supplier requirements.

9.5.8.6 Instrument Requirements

The EDG control system monitors the diesel generator support system. Alarms essential for the availability of the system are transmitted to the MCR. The air filters are monitored for differential pressure and the temperature of the exhaust gas is monitored. Indicators and alarms are listed in Table 9.5.8-1.

The instrumentation and control for the DGAIES is designed to provide the following non-safety-related functions:

- Monitoring of diesel engine combustion air system – The air filters are monitored for fouling by differential pressure measurement.
- Intake air shutoff dampers – The intake air supply is equipped with shutoff dampers that are actuated in the event of an emergency shutdown or overspeed trip. The dampers are actuated by the automated safety actuation system. The dampers have no safety-related function.
- Monitoring of diesel engine exhaust gas system – The temperature and backpressure of the exhaust gas is monitored.

9.5.8.7 References

1. NUREG/CR-0660, "Enhancement of Onsite Emergency Diesel Generator Reliability," University of Dayton Research Institute for the U.S. NRC; UDR-TR-79-07; February 1979.

Table 9.5.8-1—DGAIES Indicators and Alarms

Component	Indication/Alarm
Intake air Temperature	Monitoring w/alarm
Intake air filter A differential pressure	Monitoring w/alarm
Intake air filter B differential pressure	Monitoring w/alarm
Intake silencer A differential pressure	Monitoring w/alarm
Intake silencer B differential pressure	Monitoring w/alarm
Intercooler A differential pressure	Monitoring w/alarm
Intercooler B differential pressure	Monitoring w/alarm
Manifold pressure A	Monitoring w/alarm
Manifold pressure B	Monitoring w/alarm
Cyl. Bank A exhaust gas temperature	Monitoring w/alarm
Cyl. Bank B exhaust gas temperature	Monitoring w/alarm
Turbo A inlet gas temperature	Monitoring w/alarm
Turbo B inlet gas temperature	Monitoring w/alarm
Turbo A outlet gas temperature	Monitoring w/alarm
Turbo B outlet gas temperature	Monitoring w/alarm
Turbo A inlet gas pressure	Monitoring w/alarm
Turbo B inlet gas pressure	Monitoring w/alarm
Turbo A outlet gas pressure	Monitoring w/alarm
Turbo B outlet gas pressure	Monitoring w/alarm
Exhaust System back pressure	Monitoring w/alarm
Temperature downstream of diesel engine	Monitoring w/alarm

Next File