9.5.6 DIESEL GENERATOR STARTING SYSTEM

This subsection discusses the mechanical features of the diesel generator starting system. Control and instrumentation for starting the diesel generator system are discussed in section 7.3. The standby power supply is discussed in detail in section 8.3.

9.5.6.1 Design Bases

Protection of the diesel generator starting system from wind and tornado effects 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 postulated rupture of piping is discussed in section 3.6. Environmental design is discussed in section 3.11.

9.5.6.1.1 Safety Design Bases

A. The diesel generator starting system initiates an engine start such that within 9.5 s after receipt of the start signal, the diesel generator is operating at load speed and is ready to begin load sequencing. This time frame is less than that assumed in the accident analyses presented in chapter 15.

B. The diesel generator starting system is designed so that no single active failure, assuming a loss of off-site power, can result in a complete loss of the standby power source function.

C. Portions of the diesel generator starting system which are required to start the diesel upon receipt of an engineered safety features actuation signal are designed to remain functional after a safe shutdown earthquake.

D. Active components of the system can be tested during plant operation in accordance with 10 CFR 50, General Design Criterion 18.

9.5.6.1.2 Power Generation Design Bases

The diesel generator starting system has no power generation design basis.

9.5.6.1.3 Codes and Standards

Codes and standards applicable to the diesel generator starting system are listed in table 3.2.2-1.

NUCLEAR REGULATORY COMMISSION

Docket No. 50-424/425-OLA-3 EXHIBIT NO. GA II-98B

In the matter of Georgia Power Co. et al., Vogtle Units 1 & 2

☐ Staff ☒ Applicant ☐ Intervenor ☐ Other

☒ Identified ☐ Received ☐ Rejected Reporter CR

Date 7-7-95 Witness Mosbaugh

9.5.6.2 System Description

The diesel generator starting system is shown schematically in figure 9.5.4-1. Each diesel generator is equipped with two independent and redundant starting air systems. Each starting air system consists of one air compressor, aftercooler, air dryer, air receiver, compressor air intake filter, scale trap, piping, valves, and associated instrumentation. Design parameters for the major system components are summarized in table 9.5.6-1.

9.5.6.2.1 Component Description

9.5.6.2.1.1 Air Compressors. One motor-driven compressor is provided for each starting air system (two starting air systems per diesel generator set). Each starting air system is sized to be capable of completely recharging its air receivers from minimum automatic cranking pressure to 250 psig within 30 min.

9.5.6.2.1.2 Air Dryers. Each starting air system is equipped with an air dryer to ensure that dry air is available for all starts.

9.5.6.2.1.3 Air Receivers. Each starting air system is equipped with one air receiver. Each air receiver is capable of providing starting air for five consecutive engine starts without compressor assistance. Provisions are made for blowdown of air receivers to eliminate any moisture that might accumulate.

9.5.6.2.1.4 Aftercoolers. Each starting air system is equipped with an aftercooler to cool the air after compression and to condense any moisture in the air to aid the air dryers in removing moisture. The aftercooler is installed between the compressor and the dryer.

9.5.6.2.1.5 Air Start Distributors. Each engine is equipped with two air start distributors, one per air start system. The air distributors time, or distribute, the starting air to each cylinder in relation to the power stroke of each piston.

9.5.6.2.1.6 Air Start Solenoid Valves. Each starting air system is equipped with two air start solenoid valves, connected in parallel, so that failure of one solenoid valve does not compromise the operability of the system.

The piping downstream of the receiver is provided with a drainline to remove any moisture which may accumulate. A Y-strainer is installed upstream of the parallel air start valves to prevent oil and particulate from fouling these valves. Periodic testing of the diesel confirms operability of these valves.

9.5.6.2.2 System Operation

The air receivers for each diesel engine are maintained at operating pressure by compressors. The compressors start when air receiver pressure drops to 225 psig and stop when pressure is increased to 250 psig. Two compressors are provided. Each compressor keeps one receiver pressurized. A check valve in the air receiver charging line ensures that a broken line from the compressor will not affect the receiver. The air dryers and aftercoolers ensure that the starting air is dry.

When the diesel generator set receives a start signal, all four solenoid valves are energized simultaneously, allowing starting air to flow to each cylinder, using air from both air start systems independently. Thus, if one air start system fails to operate, the second will start the diesel generator set without waiting for a second start attempt and without switching from the first air start system to the second. When a start signal is initiated, either manual or automatic, the starting air valves (HV-9068A and B and HV-9070A and B) will all open, admitting air to both banks of cylinders on the engine. The starting air valves will open for 5 seconds and automatically close after the 5 seconds have elapsed. However, the 5-second time limit is bypassed on an emergency start signal. The air distributor for each bank will properly time the opening of the air valve in each cylinder head to admit air to the cylinder whose piston is in proper position for the starting effort. As soon as the engine has fired and is running on its own power, a speed switch cuts the electrical circuit to the starting air valves and causes the valves to close. The speed switch is set to cut off the electrical circuit to the starting air valves at an engine speed of approximately 300 rpm. Also, the air valve

in each cylinder head cannot admit starting air to the cylinder if the cylinder has fired. This is due to the differential pressure between the starting air pressure and the pressure of combustion inside the cylinder. Normally, after two to three engine revolutions the engine will fire and no starting air will be used to rotate the engine, even though the engine has not reached a speed of 300 rpm. When receiver pressure drops to 150 psig, the automatic starting sequence is stopped, but manual start attempts may be made as long as both receivers are connected to their respective cylinder banks and until pressure drops to approximately 90 psig. Starting air pressure below 90 psig is not sufficient to turn the engine, and the receivers must be recharged at this point.

An air-cooled refrigerated type dryer is provided upstream of the starting air receiver tank to remove water vapor from the compressed air before it reaches the receiver tank. The dryer is designed for an ambient temperature range of 35°F (minimum) and 120°F (maximum). The air dryer is designed to run continuously; i.e., it does not cycle on and off with the air compressor. Compressed air, saturated with water vapor and entering the dryer, is precooled by the outgoing refrigerated air in the air-to-air heat exchanger. The precooled air then enters the air-to-refrigerant heat exchanger (refrigeration evaporator) where it is cooled by giving up heat to the refrigeration system. As the air cools, water vapor condenses into liquid droplets which are separated out of the air stream by a separator and automatically discharged by a draintrap. The cold air then exits after it has passed through the other side of the air-to-air heat exchanger, where it is warmed by the incoming hot air. This reheating increases the air's effective volume and prevents pipe sweating downstream. A constant temperature at all load conditions is maintained in the air-to-refrigerant heat exchanger by means of a hot gas bypass valve in the refrigeration system. This means of refrigeration control also allows for efficient noncycling operation of the refrigeration compressor.

Rating conditions for compressed air capacities of the air dryer are in accordance with Class H of the NFPA-recommended standard NFPA T3.27.2(1975) -- 100 psig and 100°F saturated inlet compressed air conditions, 100°F ambient temperature, and a 33°F to 39°F pressure dew point. The evaporator control circuit is factory set at 35°F. Based on the above conditions, the rated capacity for the air dryer is 170 sf³/min, which is approximately twice the capacity of the starting air compressor. Therefore, the pressure dew point set for the air dryer is more than 10°F below the minimum ambient temperature of 50°F.

9.5.6.3 Safety Evaluation

A. Compressed air for each diesel is stored in an individual storage and starting system. Each system holds sufficient air to start the diesel five times under a no-load condition without compressor assistance. The continuous availability of the air starting system keeps the diesel engine in constant readiness.

B. The solenoid air start valves are installed in parallel in each system. If one valve fails to operate, the parallel valve will supply starting air. A failure of a compressor is indicated by an air receiver low-pressure alarm; this alarm prompts the operator to take corrective action. Each air receiver contains sufficient air when the low-pressure alarm occurs to start its associated diesel engine at least five times. The duration of each start is about 3 s or two to three engine revolutions. A single active failure in either air starting system does not compromise the ability of the standby power system to accomplish its function. Table 9.5.6-2 summarizes the failure modes and effects analysis for the starting air system.

C. The diesel engine starting system, except for the air compressors, aftercoolers, and air dryers, is designed in accordance with Seismic Category 1 requirements as specified in section 3.2.

D. The design of the system allows all active components of the system to be separately tested during plant power generation operation, as discussed in paragraph 9.5.6.4 below.

9.5.6.4 Tests and Inspections

The starting air compressors for each diesel engine are tested periodically to ensure continued operability. Compressor suction air filters are periodically checked for cleanliness. During the preoperational testing of the diesel generator, the entire compressed starting air system is operated to ensure 100-percent capability. Due to the redundancy of the starting air system, all testing can be performed without affecting normal plant operations or safety systems.

9.5.6.5 Instrumentation Applications

Each compressor and air receiver is furnished with instrumentation consisting of locally mounted pressure switches, pressure indicators, and overpressure protection devices. The pressure switches support the automatic control modes of compressor and receiver operation. Low starting air pressure of 210 psig and diesel start failure are annunciated locally and in the control room. Diesel generator instrumentation is further described in subsection 8.3.1.

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TABLE 9.5.6-1 (SHEET 1 OF 2)

STANDBY DIESEL GENERATOR STARTING SYSTEM
COMPONENT DATA

Compressors

Quantity (per engine)	2
Type	Reciprocating, air cooled
Capacity (sf³/min)	76
Discharge pressure (psig)	250
Air temperature leaving cooler (°F)	120-135
Number of stages/cylinders	2/3 (2 low pressure, 1 high pressure)
Revolutions per minute	790
Regulation	Dual control
Design code	Manufacturer's standard
Driver	
Type	Electric motor TEFC
Horsepower	30
Revolutions per minute	1800
Power supply	460-V, 60-Hz, 3-phase
Source of power	MCC 1NBI/2NBI, 1NBO/2NBO
Seismic design	Category 2

Dryers

Quantity (per engine)	2
Type	Mechanical, refrigeration
Flow capacity (sf³/min)	200
Design pressure (psig)	275
Air inlet temperature (°F)	120-135
Dew point of air leaving dryer (°F)	50
Design code	Manufacturer's standard
Maximum working pressure (psig)	275
Refrigeration compressor (hp)	1
Refrigerant type	R12
Power supply	230-V, 60-Hz, 1-phase
Source of power	MCC 1NBI/2NBI, 1NBO/2NBO
Maximum Δp at rated flow (psi)	5
Seismic design	Category 2

TABLE 9.5.6-1 (SHEET 2 OF 2)

Air start receivers	
Quantity (per engine)	2
Type	Vertical, cylindrical
Capacity (ft^3)	305
Design pressure/temperature (psig/°F)	275/400
Operating pressure/temperature (psig/°F)	250/110
Material	Carbon steel SA 516-70
Code	ASME Section III, Class 3
Seismic design	Category 1
Piping, fittings, and valves (safety related)	
Material	Carbon steel and stainless steel
Design code	ASME Section III, Class 3
Seismic design	Category 1
Piping, fittings, and valves (nonsafety related)	
Material	Carbon steel and stainless steel
Design code	Manufacturer's standard or ANSI B31.1