2.8 Steam and Power Conversion Systems

2.8.1 Turbine-Generator System

1.0 Description

The turbine-generator system is a non-safety-related system that converts the energy of the steam produced in the steam generators into mechanical shaft power and then into electrical energy.

The flow of steam is directed from the steam generators to the turbine through the main steam system, turbine stop valves, and turbine control valves. After expanding through the turbine, which drives the main generator, exhaust steam is transported to the main condenser.

Turbine overspeed control is provided by two separate turbine overspeed protection systems, in addition to the normal speed control function. The primary and backup overspeed protection systems are included to minimize the possibility of turbine rotor failure and turbine missile generation.

2.0 Arrangement

2.1 The basic configuration of the turbine-generator system is shown in Figure 2.8.1-1—Turbine-Generator System Basic Configuration.

2.2 The axis of the turbine rotor shafts is positioned such that safety-related structures, except for two of the four Essential Service Water Buildings and two of the four Emergency Power Generating Buildings, are located outside the turbine low-trajectory hazard zone.

2.3 The location of the turbine-generator system equipment is listed in Table 2.8.1-1—Turbine-generator System Equipment Mechanical Design.

2.4 Turbine rotor integrity is provided through the combined use of selected materials with suitable toughness, analyses, testing, and inspections.

2.5 The probability of turbine material and overspeed-related failures resulting in external turbine missiles is less than $1x10^{-4}$ per turbine year.

3.0 Instrumentation and Controls (I&C) Design Features, Displays, and Controls

3.1 Controls exist in the main control room (MCR) to trip the turbine-generator.

3.2 The turbine generator has diverse and independent overspeed protection systems.

4.0 Electrical Power Design Features

4.1 Turbine stop valves and turbine control valves as listed in Table 2.8.1-1 fail closed on loss of power.

5.0 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.8.1-3 lists the turbine-generator system ITAAC.

Table 2.8.1-1—Turbine-Generator System Equipment Mechanical Design

Description	Tag Number(1)	Location	ASME Code Section III	Function	Seismic Category
Turbine Stop Valve 1 Turbine Stop Valve 2 Turbine Stop Valve 3 Turbine Stop Valve 4	30MAA11AA010 30MAA12AA020 30MAA13AA030 30MAA14AA040	Turbine Building	N/A	Close	N/A
Turbine Control Valve 1 Turbine Control Valve 2 Turbine Control Valve 3 Turbine Control Valve 4	30MAA11AA011 30MAA12AA012 30MAA13AA013 30MAA14AA014	Turbine Building	N/A	Close	N/A
Turbine-generator	N/A	Turbine Building	N/A	N/A	N/A

1) Equipment tag numbers are provided for information only and are not part of the certified design.

Table 2.8.1-2—Turbine-Generator System Equipment I&C and Electrical Design

Description	Tag Number(1)	Location	IEEE Class 1E	EQ –Harsh Env.	PACS
Overspeed Protection System	N/A	Turbine Building	N/A	N/A	N/A
Backup Overspeed Protection System	N/A	Turbine Building	N/A	N/A	N/A

1) Equipment tag numbers are provided for information only and are not part of the certified design.

Table 2.8.1-3—Turbine-Generator System ITAAC (3 Sheets)

	Commitment Wording	Inspections, Tests, Analyses	Acceptance Criteria
2.1	The basic configuration of the turbine-generator system is shown on Figure 2.8.1-1.	Inspections of the as-built system as shown on Figure 2.8.1-1 will be conducted.	The as-built turbine-generator system conforms with the basic configuration as shown in Figure 2.8.1-1.
2.2	The axis of the turbine rotor shafts is positioned such that safety-related structures, except for two of the four Essential Service Water Buildings and two of the four Emergency Power Generating Buildings, are located outside the turbine low-trajectory hazard zone.	An inspection of the location of the axis of the turbine rotor shafts to verify that safety-related structures, except for two of the four Essential Service Water Buildings and two of the four Emergency Power Generating Buildings, are located outside the turbine low-trajectory hazard zone will be performed.	The location of the of the axis of the turbine rotor shafts is favorable with respect to protection of safety-related structures, except for two of the four Essential Service Water Buildings and two of the four Emergency Power Generating Buildings, from turbine missiles outside the turbine low-trajectory hazard zone.
2.3	The location of the turbine-generator system equipment is listed in Table 2.8.1-1.	An inspection will be performed of the location of the equipment.	The turbine-generator system equipment is located as listed in Table 2.8.1-1.
2.4	Turbine rotor integrity is provided through the combined use of selected materials with suitable toughness, analyses, testing, and inspections.	A vendor analysis of the site-specific turbine rotor material property data, turbine rotor and blade design, and pre-service inspection and testing requirements will be conducted. This information will be available for review greater than one year before loading the fuel.	A vendor analysis exists and concludes that the turbine rotor integrity meets the requirements of the manufacturer's turbine missile probability analysis: (1) turbine material property data, rotor and blade design analyses (including loading combinations, assumptions and warm-up time) demonstrating safety margin to withstand loadings from overspeed events, and (2) the requirements for pre-service testing and inspection information.

Table 2.8.1-3—Turbine-Generator System ITAAC (3 Sheets)

Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
2.5	The probability of turbine material and overspeed related failures resulting in external turbine missiles is < $1x10^{-4}$ per turbine year.	A material and overspeed failures analysis will be performed on the as-built turbine design.	An analysis exists and concludes that the probability of turbine material and overspeed related failures resulting in external turbine missiles is < 1x10-4 per turbine year.
3.1	Controls exist in the MCR to trip the turbine-generator.	Tests will be performed for the existence of control signals from the MCR.	Controls exist in the MCR to trip the turbine-generator.

Table 2.8.1-3—Turbine-Generator System ITAAC (3 Sheets)

Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
3.2	The turbine generator has diverse and independent overspeed protection systems.	a. Inspections and analyses will be performed on the overspeed protection systems.	a. A report exists and concludes that the turbine overspeed protection systems are diverse and independent by verifying: • Each system is designed and manufactured by a different vendor. • Software used to transform the analog speed signal into a digital signal is diverse between the two systems. • Components, process inputs and process outputs are not shared between the two systems. • The two systems are installed in separate cabinets. • The two systems are powered by separate power sources.
		b. Tests will be performed for operation of the overspeed and backup overspeed protection systems listed in Table 2.8.1-2.	b. Overspeed and backup overspeed turbine trips occur within the design limits for the systems listed in Table 2.8.1-2.
4.1	Turbine stop valves and turbine control valves as listed in Table 2.8.1-1 fail closed on loss of power.	Testing will be performed for the turbine stop valves and turbine control valves as listed in Table 2.8.1-1 to fail closed on loss of power.	Following loss of power, turbine stop valves and turbine control valves as listed in Table 2.8.1-1 fail closed.

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