9.3.3 Equipment and Floor Drainage System

The nuclear island drain/vent system (NIDVS) collects, temporarily stores and discharges radioactive fluids from the nuclear island (NI) area to other plant systems in a controlled manner. Portions of the NIDVS are classified safety-related. The NIDVS operates during normal power, start-up and shutdown conditions.

9.3.3.1 Design Bases

The NIDVS performs the following safety-related function:

- Maintain containment isolation. NIDVS lines penetrating containment are capable of isolation upon receipt of a containment isolation signal (CIS) from the reactor protection system. (Refer to Section 6.2.4 and Section 7.3.)

The NIDVS has the following design basis requirements:

- Safety-related portions of the NIDVS are designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami and seiches without loss of capability to perform their safety functions (GDC 2).

- Safety-related portions of the NIDVS are designed to accommodate the effects of and be compatible with the environmental conditions associated with normal operation, maintenance, surveillance testing and postulated accidents. These portions of the NIDVS are protected against dynamic effects, including the effects of missiles, pipe whipping and discharging fluids that may result from equipment failures and from events and conditions outside the nuclear power unit (GDC 4).

- Safety-related portions of the NIDVS design includes means to suitably control the release of radioactive materials in gaseous and liquid effluents produced during normal reactor operation, including anticipated operational occurrences (AOO) (GDC 60).

The NIDVS is designed to meet the following functional criteria:

- Facilitate optimized treatment of liquid and gaseous radioactive effluents.

- Evacuate potentially radioactive gases in the reactor coolant system (RCS).

- Cool primary system effluent to a temperature safe for the demineralizer resins contained in the coolant purification system (CPS).

- For certain beyond design basis events (DBE), store highly contaminated liquid samples collected in the Nuclear Auxiliary Building (NAB) within the Reactor Building (RB) to delay their treatment.

- Detect and identify (to a practical extent) the location of the source of reactor coolant leakage within the RB.

9.3.3.2 System Description

9.3.3.2.1 General Description

The NIDVS is connected to a variety of systems by means of temporary and permanent connections. Permanent connections to systems of high design pressures are protected by means of flow restrictors and safety valves to maintain the pressure below the allowable design pressure of the drain system. Piping is principally arranged for gravitational flow from the drain collectors to the drain tanks. Wherever gravity drainage is impractical, mobile (portable) pumps are used. Mobile pumps are connected to the permanent piping using temporary flexible hoses. The general arrangement of the NIDVS is provided in Figure 9.3.3-1—Nuclear Island Drain and Vent System.

Effluents are classified in different groups according to their processing requirements and by whether or not they are recycled. They are collected according to their state (liquid or gaseous) and origin (primary drains, process drains, floor drains and decontamination effluents). Leakage to reactor containment from identified sources is collected so that flow rates are monitored separately from unidentified leakage and the total flow rate of each type is established and monitored. Leakage to reactor containment from unidentified sources is collected and the flow rate monitored with an accuracy of one gallon per minute or better. NIDVS pumps, tanks and sumps are sized to process the maximum expected rate of influx and total volume of expected leakage.

9.3.3.2.2 Component Description

Table 3.2.2-1 provides the quality group and seismic design classification of components and equipment in the NIDVS. Components are designed to the codes and standards applicable to their equipment class. The NIDVS is divided into five subsystems:

Drains/Vents and Safety Valve Discharges Subsystem

This subsystem collects from primary (i.e., potentially radioactive) drains and vents, safety valve discharges and other effluents containing boron-10 to be recycled. It is further divided into six portions:

- Primary effluents inside RB.
- RCS sweeping and pulling.
- Primary effluents inside Safeguard Buildings (SB).
- Primary effluents inside Fuel Building (FB).

- Primary effluents inside NAB.
- Safety valve discharge of primary effluents.

Vent and Collection of Rinse Water Subsystem

This subsystem serves as a vent system and a system that collects rinse water. In general, it is connected to the system to be vented or rinsed with flexible hoses and screwed plugs. It is further divided into three portions:

- Vent and rinse collection inside SBs.
- Vent and rinse collection inside FB.
- Vent and rinse collection inside NAB.

Type 1 Floor Drains Subsystem

This subsystem includes Type 1 floor drains, which are located in the controlled area and contain low boron-10 concentrations. It is further divided into five portions:

- RB floor drains.
- SBs floor drains.
- FB floor drains.
- NAB floor drains.
- Radioactive Waste Processing Building floor drains.

Type 2 Floor Drains Subsystem

This subsystem includes Type 2 floor drains, which are located in the controlled area and contain no boron-10 but may have some chemical contamination. It is further divided into three portions:

- Low contamination RB drains.
- Low contamination NAB drains.
- Low contamination Access Building drains.

Type 3 Floor Drains Subsystem

This subsystem includes Type 3 floor drains, which are located in the non-controlled area. It is further divided into two portions:

- SBs non-controlled area floor drains.

- NAB non-controlled area floor drains.

9.3.3.2.3 System Operation

During normal plant operation, the NIDVS collects different categories of liquid and gaseous effluents. Liquid leakages or discharges drain by gravity to sumps. Sump pumps automatically or manually transfer their contents to storage tanks.

Boron-containing reactor coolant leakage from primary vents, drains, pump seal and valve stem leakage, and safety valve discharges, is collected and stored for further processing to recover the boron by the coolant supply and storage system, coolant purification system and coolant treatment system. Liquid effluents produced by the decontamination facilities are collected and stored by the NIVDS for routing to the liquid waste storage system and then for processing in the liquid waste processing system. Recovered gaseous wastes are routed to the gaseous waste processing system or appropriate ventilation system for treatment.

9.3.3.3 Safety Evaluation

Safety-related components and equipment in the NIDVS include containment isolation valves (CIV), connecting piping and penetrations. CIVs are located in portions of the following subsystems:

- Drains/vents and safety valve discharges system - primary effluents inside RB.
- Type 1 floor drains system - RB floor drains.
- Type 2 floor drains system - low contamination RB drains.

The design of safety-related portions of the NIDVS satisfies GDC 2 regarding the effects of natural phenomena.

- Safety-related portions of the NIDVS are located in the RB and FB. These buildings are designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, tsunami and seiches. Section 3.3, Section 3.4, Section 3.5, Section 3.7 and Section 3.8 provide the bases for the adequacy of the structural design of the buildings.
- Safety-related portions of the NIDVS are designated Seismic Category I and are designed to remain functional during and following a safe shutdown earthquake (SSE). Section 3.7 provides the design loading conditions that are considered.
- Safety-related portions of the NIDVS are protected against the effects of flooding by consideration of the following design features: redundancy, location and physical separation.
- To cope with a large flooding event, the NIDVS sump located in the lowest level of the non-controlled areas of each SB is equipped with redundant safety-related

level instrumentation to automatically trip the ESWS pump and close the associated discharge isolation valve. This instrumentation is located above floor level, provided with Class 1E power, and is classified as Seismic Category I.

The design of safety-related portions of the NIDVS satisfies GDC 4 regarding the capability to withstand the effects of and to be compatible with the environmental conditions (e.g., flooding) associated with normal operation, maintenance, testing and postulated accidents (e.g., pipe breaks, tank ruptures).

- Safety-related portions of the NIDVS inside the RB are located at sufficient elevation to be protected from flooding events inside this building.

- Sump pumps inside the SBs and FB are equipped with a double level measurement. The corresponding set point level in each sump is above floor level. In case of flooding inside these buildings, the dedicated level measurement systems are capable of detecting flooding at the lowest level.

- The NIDVS contains instrumentation that detects water accumulation that can adversely affect the operation of safety-related equipment. This includes monitoring the RCS leak tightness and reactor coolant inventory using leak detection and measurement means in the RB.

- The NIDVS is designed to prevent backflow of water through the drain systems into areas of the plant containing safety-related equipment by the use of check valves.

- Safety-related portions of the NIDVS are protected against the effects of internal missiles by consideration of the following design features: redundancy, location and physical separation.

- The NIDVS design considers: (1) actuation of installed fire suppression systems (e.g., gas and water), (2) accumulation of fire fighting water, and (3) prevention of backflow of combustible liquids into safety-related areas.

- Redundancy and physical separation of CIVs provide assurance that the containment isolation function is protected against fire-related events. The inner and outer CIVs are located in separate fire zones.

The design of the safety-related portions of the NIDVS satisfies GDC 60 concerning the suitable control of the release of radioactive materials in gaseous and liquid effluents, including AOOs.

- The NIDVS is designed to prevent the inadvertent transfer of contaminated fluids to non-contaminated drainage systems.

- Portions of the NIDVS that are located in areas that may contain radioactive effluents are physically separated from the plant areas that do not contain radioactive effluents. System design and operational controls monitor the transfer of effluents to the appropriate treatment systems.

9.3.3.4 Inspection and Testing Requirements

Safety-related portions of the NIDVS are inspected and tested as part of the initial test program. Refer to Section 14.2 (test abstract #098) for initial plant startup test program. The performance and structural integrity of system components is demonstrated by continuous operation.

CIV valve function and performance is tested in accordance with Technical Specifications in Chapter 16 of the FSAR and 10 CFR 50, Appendix J, programmatic requirements (refer to Section 6.2.6). Periodic inservice functional operation is monitored by instrumentation that readily identifies equipment degradation. Section 6.6 provides the ASME Boiler and Pressure Vessel Code, Section XI (Reference 1) requirements that are appropriate for the NIDVS.

9.3.3.5 Instrumentation Requirements

The CIS is originated by the reactor protection system. Containment isolation and containment valve position indication are available in the main control room. Control room alarms and indications are provided as required for:

- Water detection in the spreading area.
- RCS leakage.
- Floor drain sump leak collection to detect flooding inside the RB.
- Floor drain sump leak collection to detect flooding inside the Annulus Building.

9.3.3.6 References

1. ASME Boiler and Pressure Vessel Code, Section XI: “Rules for Inservice Inspection of Nuclear Power Plant Components,” The American Society of Mechanical Engineers, 2004.

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