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. Samples are taken at sample points R-40 and R-44, Table 11.5-1. 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 functions:

- Maintain safety-related 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.)
- Flooding detection inside the RB (containment and annulus), SBs, and FB. (Refer to Section 9.3.3.3 and Section 9.3.3.5).
- Provide a safety-related trip of the essential service water system (ESWS) pump and close the ESWS pump discharge valve in a Safeguard Building (SB) flooding event. (Refer to Section 9.3.3.3 and Section 9.3.3.5.)
- Supports reactor coolant pressure boundary (RCPB) leakage detection.
- Maintain the component cooling water system's (CCWS) capability to perform it's safety related functions by maintaining the integrity of the CCWS' pressure boundary at the two systems' interface. This is a secondary design function.

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).
- 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.
- The spent fuel pool spray subsystem is capable of providing the spent fuel pool with makeup water during beyond design basis loss of cooling events.
- Detect and identify the location of the source of reactor coolant leakage within the RB. The leakage detection function provided by the NIDVS is a non-safety-related augmented quality function and consists of water level measurements provided by the sumps and collection tanks in the system as part of the reactor coolant leakage detection capability. Sump levels within the NIDVS are used to confirm the initial assumptions for reactor coolant leakage and leak before break analysis. Refer to Section 5.2.
- The floor drains in the NIDVS have the capacity to accommodate the maximum expected flow rate from a rupture of the largest water pipe in the NFSF area. The floor drains are gravity fed to the building sump. Because there are no drain connections on the drain header higher in elevation than the NFSF floor drains, backflow is prevented.

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.

Mobile (portable) pumps are used where no leakage is expected, such as for in-containment refueling water storage tank liner leakage. Mobile pumps may also be used during infrequent maintenance on the steam generator blowdown system. 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.

Refer to Section 12.3.6.5.5 for nuclear island drain/vent system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

9.3.3.2.2 Component Description

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

The reactor coolant drain tank (RCDT) collects effluents originating from systems containing primary coolant. The RCDT is located on the lowest floor and is continuously purged of gases by the gaseous waste processing system (GWPS). The effluents are routed to the coolant supply and storage system. The primary function is to collect RCP seal No. 213 leak-off.

The primary effluents that can not be collected by the RCDT for geometrical reasons are collected in the process drain tank. The tank is located below the RCDT and is continuously purged by the containment ventilation system. The effluents are routed to the coolant supply and storage system.

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 radiologically 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 radiologically 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-radiologically controlled area. It is further divided into two portions:

- SBs non-radiologically controlled area floor drains.
- NAB non-radiologically controlled area floor drains.

Spent Fuel Pool Spray Subsystem

The spent duel pool spray (SFPS) subsystem adds spray cooling and an alternate fill pipe to the spent fuel pool. In the event of a large spent fuel pool leak, the spent fuel can be cooled by recycling fuel pool water from the fuel building sumps by the use of the KTC sump pumps (30KTC30AP001/2). In addition to supplying water from the fuel building sumps, makeup water can also be supplied to the spent fuel pool by either the fire water distribution system or a hose connection located on the exterior of the fuel building at grade level. The hose connection will allow for a portable pump or pumper truck to supply makeup water to the spent fuel pool.

The SFPS subsystem is a dry system consisting of two separate, but redundant trains that will be physically located on opposite sides of the spent fuel pool. Both trains are sized to provide the required makeup water to the spent fuel pool. Therefore, if one train is inoperable, the other train will deliver the required makeup water to keep the spent fuel in a safe state.

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. Sump discharge lines in each of the SB and FB are routed individually to their destination in the NAB.

Boron-containing reactor coolant leakage from primary vents, drains, pump seal, 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 NIDVS 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 primary effluent heat exchanger 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-radiologically controlled area of each SB is equipped with safety-related level instrumentation to automatically trip the ESWS pump and close the associated discharge isolation valve. The level setpoint that initiates ESW isolation via the NIDVS safety-related sensors is above the floor level. The safety-related sensors are provided with Class 1E power and are classified as Seismic Category I.

- To notify the MCR operator of a flooding event and to begin operator action to isolate the flooding source, the RB sumps and the FB sumps are equipped with safety-related Seismic Category I instrumentation to alarm in the MCR.

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.

- Sumps inside the RB, SBs, and FB are equipped with safety-related Seismic Category I level instrumentation to mitigate the effects of internal flooding and maintain safe shutdown capability. This instrumentation provides alarms in the MCR to initiate operator action to isolate the flooding source or provides signals to automatically isolate the source.

- The NIDVS contains instrumentation that monitors 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 NIDVS, including floor drains and sump pumps, is assumed to be unavailable to mitigate the effects of internal flooding.

The design 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. NIDVS effluents are only transferred to a radiologically controlled area for recycle or treatment.

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.
- Flooding detection inside the RB (containment and annulus), SBs, and FB.
- Automatic isolation of ESWS train in the event of a large flooding event in a SB.

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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