VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

November 29, 2021

10 CFR 50.90

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

Serial No.:	21-138A
NRA/GDM:	R2
Docket Nos.:	50-280
	50-281
License Nos.:	DPR-32
	DPR-37

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2
PROPOSED LICENSE AMENDMENT REQUEST
REMOVAL OF REFUELING WATER CHEMICAL ADDITION TANK AND REPLACEMENT OF CONTAINMENT SUMP BUFFER
SUPPLEMENTAL INFORMATION

By letter dated September 30, 2021 (Serial No. 21-138), Virginia Electric and Power Company (Dominion Energy Virginia) submitted a license amendment request (LAR) for Surry Power Station (Surry) Units 1 and 2. The proposed LAR would revise the Surry Units 1 and 2 Technical Specifications (TS) to eliminate the Refueling Water Chemical Addition Tank (CAT) and allow the use of sodium tetraborate decahydrate (NaTB) to replace sodium hydroxide (NaOH) as a chemical additive (buffer) for containment sump pH control following a loss-of-coolant accident (LOCA). By letter dated November 10, 2021, the U. S. Nuclear Regulatory Commission (NRC) informed Dominion Energy Virginia that additional information was required before the NRC would accept the LAR for review. The NRC provided Dominion Energy Virginia an opportunity to supplement the proposed LAR by submitting the requested supplemental information within thirteen working days, i.e., by November 30, 2021.

Dominion Energy Virginia's response to the NRC request for supplemental information is provided in the enclosure. The supplemental information does not affect the conclusions of the significant hazards consideration determination or the environmental assessment included in the September 30, 2021 LAR.

As a noted in the LAR, Dominion Energy Virginia respectfully requests approval of the proposed TS change by September 30, 2022, with implementation of the proposed TS change to coincide with the completion of the fall 2022 refueling outage for Surry Unit 1 and the spring 2023 refueling outage for Surry Unit 2.

Should you have any questions or require additional information, please contact Mr. Gary D. Miller at (804) 273-2771.

Respectfully,

Mark D. Sartain
Vice President – Nuclear Engineering and Fleet Support

Commitments contained in this letter: None

Enclosure: Response to NRC Request for Supplemental Information

Attachments:
1. Proposed Surry Unit 1 UFSAR Update (Interim)
2. Proposed Surry Units 1 and 2 UFSAR Update (Final)

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Mr. Mark D. Sartain, who is Vice President – Nuclear Engineering and Fleet Support, of Virginia Electric and Power Company. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 29th day of November, 2021.

My Commission Expires: August 31, 2023.

GARY DON MILLER
Notary Public
Commonwealth of Virginia
Reg. # 7629412
My Commission Expires August 31, 2023

Notary Public

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Enclosure

RESPONSE TO NRC REQUEST FOR SUPPLEMENTAL INFORMATION

PROPOSED LICENSE AMENDMENT REQUEST

REMOVAL OF REFUELING WATER CHEMICAL ADDITION TANK AND REPLACEMENT OF CONTAINMENT SUMP BUFFER

**Virginia Electric and Power Company
(Dominion Energy Virginia)
Surry Power Station Units 1 and 2**

RESPONSE TO NRC REQUEST FOR SUPPLEMENTAL INFORMATION

License Amendment Request - Removal of Refueling Water Chemical Addition Tank and Replacement of Containment Sump Buffer

Surry Power Station Units 1 and 2

BACKGROUND

By letter dated September 30, 2021 (Serial No. 21-138), Virginia Electric and Power Company (Dominion Energy Virginia) submitted a license amendment request (LAR) for Surry Power Station (Surry) Units 1 and 2. The proposed LAR would revise the Surry Units 1 and 2 Technical Specifications (TS) to eliminate the Refueling Water Chemical Addition Tank (CAT) and allow the use of sodium tetraborate decahydrate (NaTB) to replace sodium hydroxide (NaOH) as a chemical additive (buffer) for containment sump pH control following a loss-of-coolant accident (LOCA). By letter dated November 10, 2021, the Nuclear Regulatory Commission (NRC) informed Dominion Energy Virginia that additional information was required before the NRC would accept the LAR for review and provided an opportunity to supplement the proposed LAR by providing additional information to address the items detailed in their letter.

Dominion Energy Virginia's response to the NRC request for supplemental information is provided below.

NRC Request No. 1

A description of how the NaTB (sodium tetraborate decahydrate) will be stored, such as the number of baskets, size, detailed x-y-z location, and how they are designed to contain the NaTB while allowing access for the water to dissolve it.

Dominion Energy Virginia Response

Seven (7) baskets will be installed in each of the Surry Unit 1 and Unit 2 Containments and will contain the required amount of NaTB chemical. Each basket will have nominal dimensions of 6' x 5' x 1.5'. The baskets will be installed on the (-)27'-7" elevation of the Surry Unit 1 and Unit 2 Containments near the annulus, as well as near the Incore Instrumentation Room. The baskets use a fine mesh supported by a perforated plate to contain the NaTB chemical that allows the containment sump water to passively dissolve the NaTB. The perforated plate and fine mesh system encompass the four basket side walls and the basket bottom. The planned installation locations of the baskets in the Surry Units 1 and 2 Containments are shown in Figures 1 and 2, respectively, and are provided for information. It should be noted that the locations could be adjusted during the design change implementation process due to unforeseen installation issues.

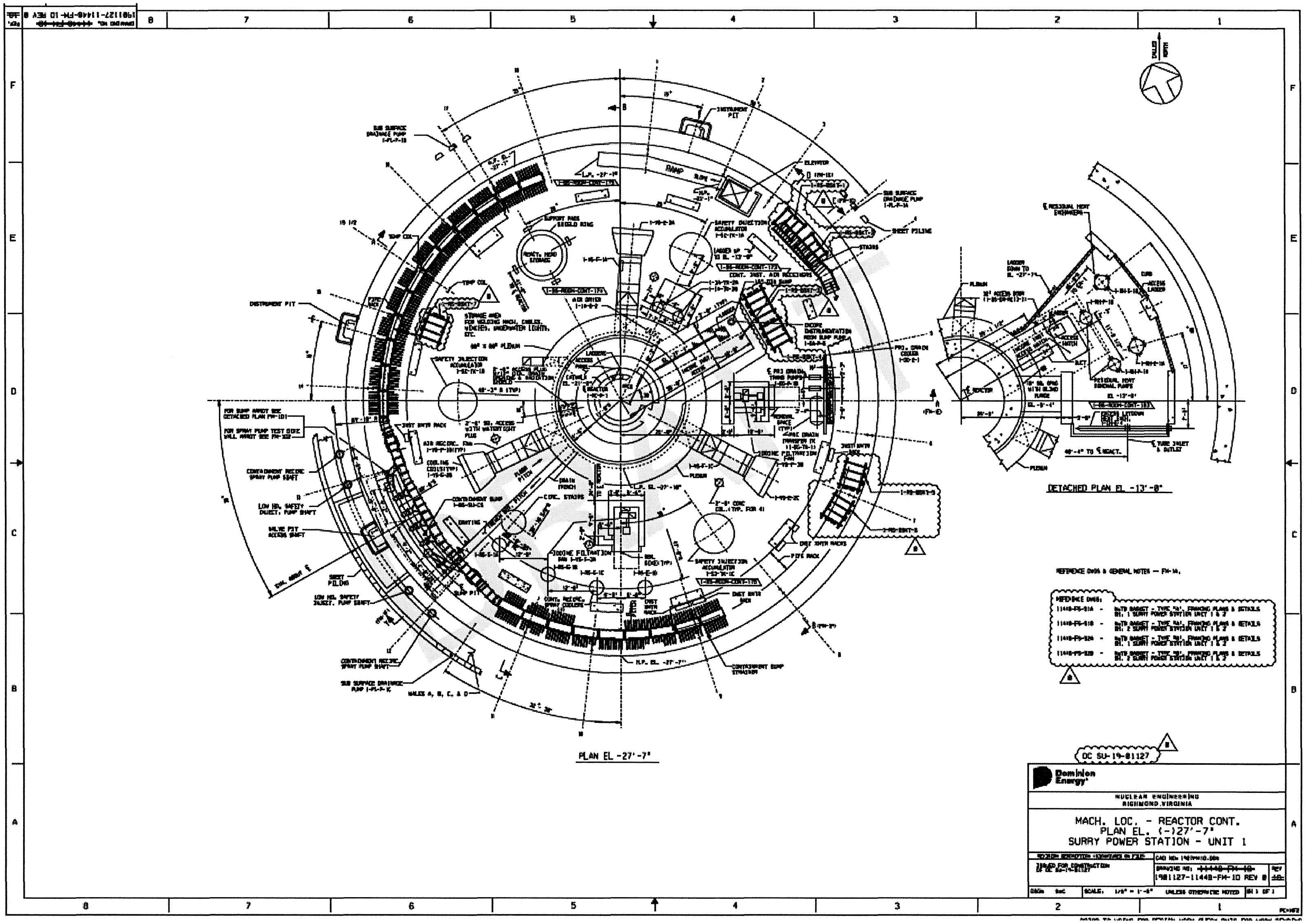

Figure 1 – Currently Planned NaTB Basket Locations in Unit 1 Containment

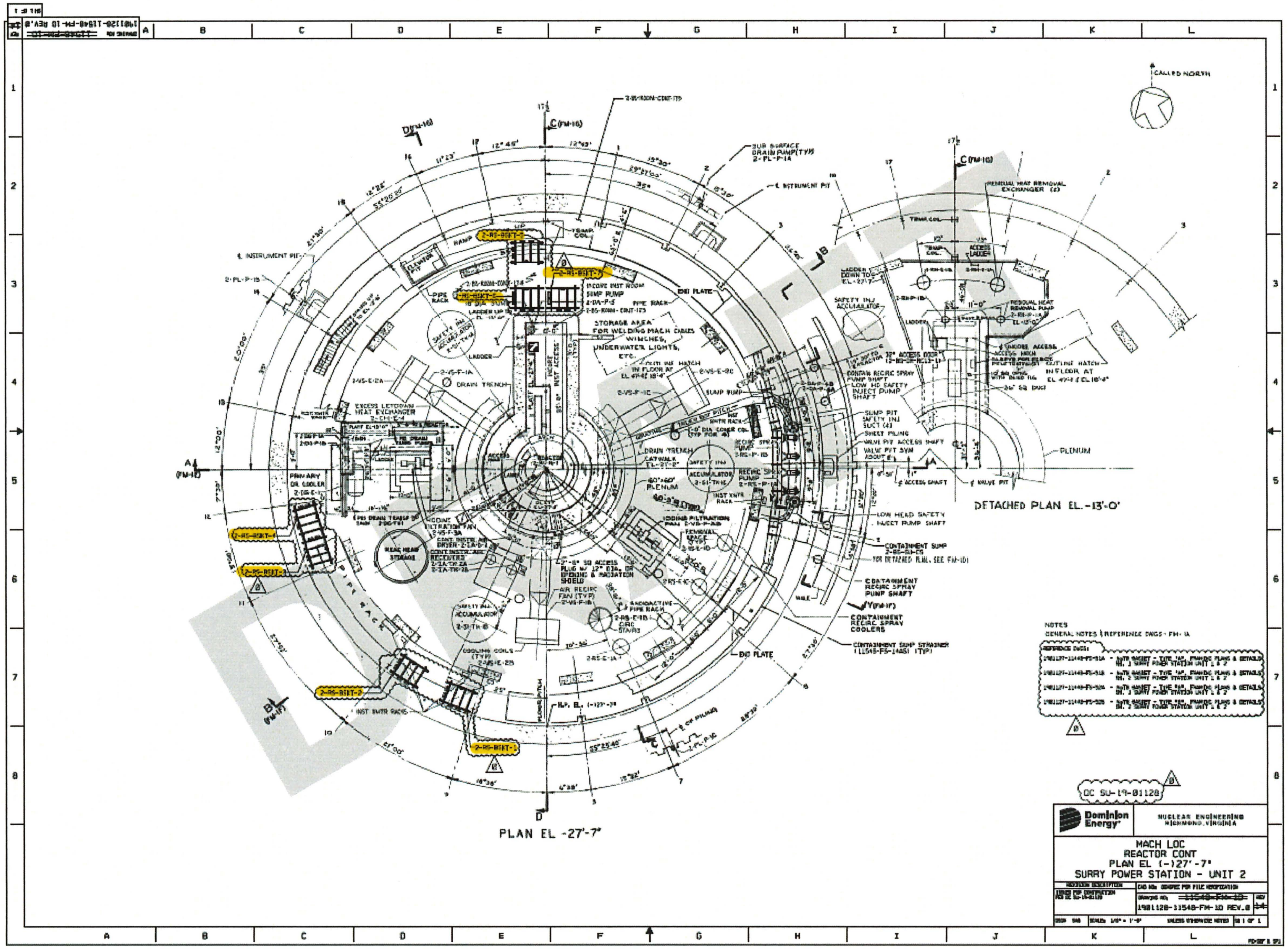

Figure 2 – Currently Planned NaTB Basket Locations in Unit 2 Containment

NRC Request No. 2

A summary of the post-Loss of Coolant Accident (LOCA) borated water sources, with a description of the boron concentrations considered.

Dominion Energy Virginia Response

The borated water sources considered as part of the buffer replacement project are provided in Table 1.

TABLE 1 - BORATED WATER SOURCES				
#	**Parameter**	**Units**	**Minimum**	**Maximum**
Refueling Water Storage Tank (RWST)				
1.a	Volume	gal	361,916	388,917
1.b	Boron Concentration	ppm	2,277	2,525
Reactor Coolant System (RCS)				
2.a	Volume	gal	63,018	67,380
2.b	Boron Concentration	ppm	0	2,525
Safety Injection Accumulators and Associated Piping (SIAs)				
3.a	Volume – SIAs	gal	21,682	23,201
3.b	Volume – SIA Piping	gal	1,104	1,104
3.c	Boron Concentration	ppm	2,228	2,525
SI Piping (sum of all 3 loops)				
4.a	Volume	gal	369	369
4.b	Boron Concentration	ppm	0	2,525

NRC Request No. 3

A summary of the sources of other acids and bases included in the post-LOCA pH calculation, and at least a reference to how they were calculated.

Dominion Energy Virginia Response

Other (non-boric acid) acids and bases considered in the post-LOCA pH calculation are summarized in Tables 2 and 3, respectively.

TABLE 2 – NON-BORIC ACIDS INCLUDED IN POST-LOCA PH CALCULATION			
#	**Acid**	**Source**	**Reference(s)**
1	Nitric Acid	Irradiation of water	§2.2.4 of NUREG/CR-5950
2	Hydrochloric Acid	Irradiation of chloride bearing cables	§2.2.5.2 of NUREG/CR-5950
3	Hydriodic Acid	Released core inventory	• ORIGAMI in SCALE 6.2.3 • §3.2 of Reg Guide 1.183 • §2.2.2 of NUREG/CR-5950

TABLE 3 – BASES INCLUDED IN POST-LOCA PH CALCULATION			
#	**Base**	**Source**	**Reference(s)**
1	Cesium Hydroxide	Released core inventory	• ORIGAMI in SCALE 6.2.3 • §3.2 of Reg Guide 1.183 • §2.3.1 of NUREG/CR-5950
2	Lithium Hydroxide	RCS water	Plant chemistry procedure

NRC Request No. 4

A description of the methodology and results for calculating pH and the required NaTB quantity, or the analysis.

Dominion Energy Virginia Response

The pH / buffer quantity analysis considers all species in the containment sump solution to be in equilibrium, i.e., it is based on steady state conditions. The sump pH is computed using guidance from NUREG/CR-5950.

The concentration of negatively charged species (anions) must equal the concentration of positively charged species (cations) for electroneutrality in the sump. The sum of negative charges for the charge balance is determined from the molal concentrations of anions $B(OH)_4^-$, $B_2(OH)_7^-$, $B_3(OH)_{10}^-$, $B_4(OH)_{14}^{2-}$ or $B_5(OH)_{18}^{3-}$, OH^-, NO_3^-, Cl^-, and I^-. The sum of positive charges for the charge balance is determined from the concentrations of H^+, Na^+, Cs^+, and Li^+. The ionic activity product constant of water is modeled using the Marshall-Frank correlation[1].

Boric acid speciation is based on the temperature dependent molal-equilibrium quotients reported by Palmer[2]. The concentration of boron in solution based on the total mass of boric acid and NaTB must be equal to the concentration based on the contribution of all boric acid species.

Equilibrium sump conditions are determined using an analytical model which was benchmarked to site-specific buffer testing using the same buffer as will be installed. Different inputs are utilized based on whether the calculation is determining: 1) solution pH based on buffer quantity, or 2) buffer quantity based on desired solution pH. The model iterates boric acid speciation, and either NaTB mass or pH until convergence is achieved for the boron mass balance and charge balance equations.

The amount of NaTB required for long-term post-LOCA containment sump pH control (i.e., to ensure the sump pH remains at or above 7) is approximately 10,760 lbm. This quantity is determined using the methodology described above, as well as the inputs described in the response to NRC Request No. 5.

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[1] Marshall, W. L., and E. U. Franck, "Ion Product of Water Substance, 0-1000°C, 1-10,000 Bars New International Formulation and Its Background," Journal of Physical and Chemical Reference Data, Vol. 10, No. 2, pp. 295-304, 1981.

[2] Palmer, D. A., Bénézeth, P., and D. J. Wesolowski, "Boric Acid Hydrolysis: A New Look at the Available Data," PowerPlant Chemistry, v. 2(5), pp. 261-264, 2000.

NRC Request No. 5

For each case considered, a description of how input values and ranges were selected for the water and chemicals used in the calculations (e.g., water, boron, NaTB, and other acids and bases).

Dominion Energy Virginia Response

- Determination of NaTB Required

The following inputs were used to determine the NaTB required to ensure the minimum required sump pH at the time when Recirculation Spray is credited for iodine removal and at 30 days for 1-train of Engineered Safety Features (ESF) and full ESF. These inputs conservatively bias high the quantities of acids and bias low the quantities of bases.

- Sump pH = 7.0
- Maximum mass of boron/boric acid in the containment sump at time of interest for the ESF scenario being investigated
- Minimum lithium concentration in RCS
- Hydrochloric acid generation due to cable irradiation at time of interest (biased high)
- Nitric acid generation due to water irradiation at time of interest (biased high)
- Maximum core iodine release at time of interest
- Minimum core cesium release at time of interest
- Minimum NaTB chemical equivalence

- Determination of Maximum Sump pH Values

The following inputs were used to determine the maximum sump pH at select times for 1-train ESF and full ESF cases. These inputs conservatively bias high the quantities of bases and bias low the quantities of acids.

- Maximum NaTB mass at time of interest
- Minimum mass of boron/boric acid in the containment sump at time of interest for the scenario being investigated
- Maximum lithium concentration in RCS
- No hydrochloric acid generation due to cable irradiation
- No nitric acid generation due to water irradiation
- No core iodine release
- Maximum core cesium release at time of interest
- Maximum NaTB chemical equivalence

NRC Request No. 6

An explanation for how the mass of NaTB would be measured in order to meet the proposed requirement in Technical Specification 3.4.A.4.

Dominion Energy Virginia Response

Each basket has indication marks to assist in visually identifying the minimum acceptable level of NaTB to be added in the field. The basket mark indicating the minimum level is higher than the minimum required level associated with the specified TS minimum buffer mass, based on the minimum buffer density, which ensures sufficient buffer will be installed in containment.

NRC Request No. 7

A description of the test that will be performed to verify that the NaTB in the baskets provides adequate pH adjustment, according to the proposed sampling test #4 in the license amendment submission, Table 4.1-2B, "Minimum Frequencies for Sampling Tests."

Dominion Energy Virginia Response

A NaTB buffer sample will be taken from each of the seven baskets during each refueling outage (RFO). Using the sample, a known quantity of buffer will be added to a known quantity/concentration of borated water. The test will be satisfactory provided the resultant solution pH is 7.0 or greater. The mass of the NaTB added to the test is based on the initial prototypical pH adjustment / buffer testing that was previously performed in support of the buffer replacement.

NRC Request No. 8

Revisions to Final Safety Analysis Report Sections such as 6.1 (General Description), 6.2.3.3 (Chemical Additives), and 6.3.1 (Spray System), which describe the use and characteristics of sodium hydroxide as the chemical additive.

Dominion Energy Virginia Response

The proposed updates to the Surry Unit 1 and Unit 2 Updated Final Safety Analysis Report (UFSAR) to reflect the proposed changes described in the LAR are provided in Attachments 1 and 2, respectively. The UFSAR updates will be implemented in accordance with the design change update process associated with the design change packages implementing the removal of the CATs and the replacement of the containment sump buffer. The proposed Unit 1 UFSAR revision is an interim revision

that reflects the differences between Unit 1 and Unit 2 following the implementation of the Unit 1 modifications during the fall 2022 refueling outage (RFO). The Unit 2 UFSAR revision reflects the final plant configuration after the modifications have been completed for both units following the Unit 2 spring 2023 RFO. The Surry Unit 1 and 2 site Plot Plans in the UFSAR will also be revised to reflect the removal of the CAT at each unit.

NRC Request No. 9

A reference to the current GL 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors" chemical effects assessment of record for Surry Units 1 and 2 that supports the license amendment's statement of reducing chemical precipitate, and a discussion, as appropriate, describing how this change may effect post-LOCA sump volumes.

Dominion Energy Virginia Response

Generic Letter (GL) 2004-02

The Surry GL 2004-02 chemical effects analysis is summarized in Dominion Energy Virginia's letter to the NRC dated February 27, 2009 [ADAMS Accession No. 090641018]. A new calculation was developed in support of the CAT removal / buffer replacement design change to assess the impact on Surry's resolution of Generic Safety Issue (GSI)-191 / GL 2004-02 as a result of changing the buffer from sodium hydroxide to NaTB. The assessment was based on both industry literature and utilizing the existing chemical effects models to predict aluminum dissolution following buffer replacement. The design sump pH limits do not change with buffer replacement; however, the pH of the initial spray from the RWST is greatly reduced without adding NaOH. The reduction in the initial spray pH results in less aluminum dissolution and therefore less subsequent precipitation. The overall conclusion of the assessment is that the design basis strainer head loss testing that was performed using chemical precipitate quantities based on a sodium hydroxide buffer remains bounding for the use of the NaTB buffer.

Post-LOCA Sump Volume Discussion

The CAT volume ranges from approximately 3,700 to 4,650 gallons but was not included in the minimum flood level used for the Emergency Core Cooling System (ECCS) net positive suction head (NPSH) analysis. Therefore, removal of the CAT does not impact the flood level used for the NPSH analysis. The maximum flood level analysis includes the volume of water from the CAT. The impact on maximum flood level of the total basket volume including solid NaTB (45 ft^3 metal + chemical volume per basket) was evaluated. This evaluation accounts for the removal of the credited volume from the CAT, as well as the volume of water displaced by the addition of the

NaTB baskets. The addition of the total basket volume including solid NaTB is less than the volume from the CAT; therefore, it was determined the maximum flood level remains below the design basis value after buffer replacement.

NRC Request No. 10

General structural arrangement drawing(s) of the new containment chemical baskets documenting the basket support structure, including basket weight and basket design details.

Dominion Energy Virginia Response

The NaTB baskets are designed of stainless steel (Type 304 SS) and have a frame with a fine mesh and perforated metal plate enclosure. The baskets are designed with four caster wheels (type 304 SS and 2205 Duplex SS) to facilitate the movement of the baskets during outages, if required. The baskets are designed with a raised bottom to provide additional surface area to dissolve the NaTB in sump water and to avoid loss of NaTB due to any inadvertent water spillage or leakage on the containment floor. The baskets include internal level indication used for inventory verification and ease of adding NaTB, as well as a removable cover which is provided with a drip edge to ensure that accumulated leaks/condensate above the baskets are directed away from the NaTB inside the basket.

The weight of one filled NaTB basket is approximately 3,975 lbs., and the weight of one fully assembled empty NaTB basket is approximately 1,425 lbs.

A picture of baskets similar to the planned baskets is provided in Figure 3.

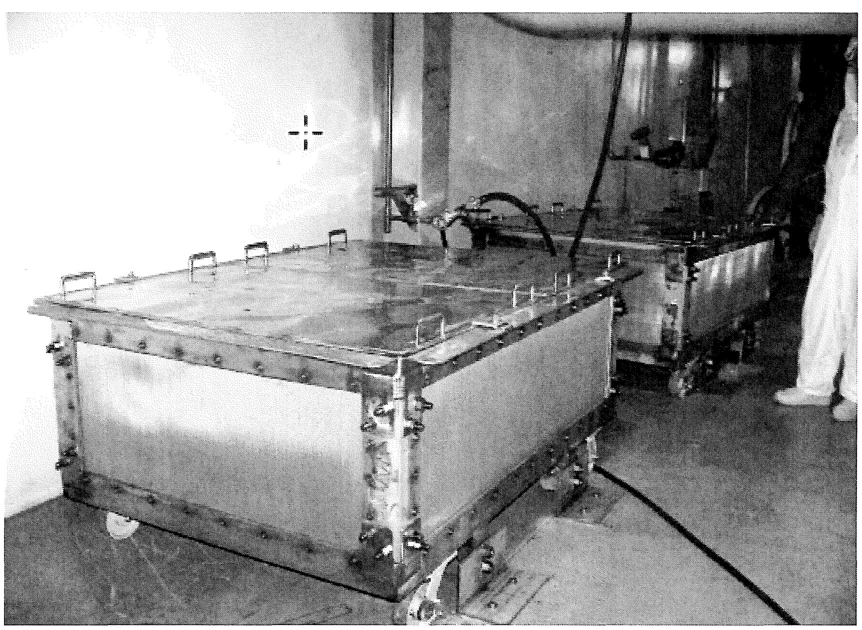


Figure 3 – NaTB Basket (Example)

NRC Request No. 11

Objective evidence (data, calculations) to support the statement in the license amendment that "The design loads for the baskets are generated by combining the unfactored load effects of dead loading, chemical pressure loading, and seismic loading...[the] baskets were evaluated to maintain their structural integrity during a Design Basis Earthquake event concurrent with post LOCA elevated temperature conditions." This information should also state the applicable design code applied, applicable design loads, load combinations used for the design, a summary of computed stresses, and margins showing the structural integrity of the baskets.

Dominion Energy Virginia Response

The basket members and connections are analyzed to meet applicable licensing and design basis requirements in the UFSAR and Dominion Energy Nuclear Engineering Standard (DNES) DNES-STD-CE-0046, AISC 9th Edition, "Manual of Steel Construction". In accordance with the AISC 9th Edition and UFSAR Section 15.2.4, *Seismic Design*, allowable stresses for members may be increased by 1/3 for earthquake loading using the applicable load combinations. When considering the 1/3 increase for earthquake loading, the maximum member interaction for members, connections, welds, wheels, bolts, and anchor bolts is less than the required 1.0. While not required, additional checks were conservatively performed on the members and connections using ASCE 8-90, ASCE 7-88, and Design Guide 24. In all cases, the additional checks satisfy the code requirements.

Justification for Non-safety – Quality (NSQ) Basket Design:

As a result of this modification, baskets are designed to hold the NaTB buffering agent and are to be placed in the Containment basement. The NaTB buffering agent, which is procured as Safety Related due to its function of providing pH control for the containment sump and to retain radioactive iodine in solution, can perform its design function without the presence of the baskets. Therefore, the purpose of the baskets is to contain the NaTB buffering agent. A failure modes and effects analysis was performed to demonstrate credible failure of the basket does not impede the NaTB buffering agent from performing its design function. Any buffering agent that was to escape from the basket would improve the dissolution rate.

DNES-AA-MEL-4001, "Determining the Safety Classification of Structures, Systems, and Components," has been reviewed to determine the safety classification of the baskets. Per DNES-AA-MEL-4001, Attachment 2, Code 5.2.6 and 5.2.26a, the baskets are classified as Non-safety Quality (NSQ) (i.e., components that are not safety related but have special quality/regulatory requirements). Code 5.2.6 is defined as, "Components that are NOT functionally safety related, but that are required to be seismically restrained, supported or anchored to prevent damage to nearby safety

related equipment." NSQ Code 5.2.26a is defined as, "Those components, systems, and structures that are NOT safety-related, but which are designed and installed as seismically qualified to ensure the required level of functionality during and/or after a DBE [Design Basis Event]. This definition includes components that are required to remain functional (i.e., some or all of their active and/or passive functions must remain intact) during and/or after a DBE. This requirement may be the result of a SAR/licensing commitment or just the desire to achieve enhanced reliability. This includes "active" components that must remain fully operational, as well as "active" and "passive" components that only have to maintain system pressure boundary." Per DNES-AA-MEL-4001, a Design Basis Event (DBE) includes the following: normal operation, anticipated operational occurrences/transients, design basis accidents, external events, and natural phenomena. Therefore, the baskets are designed to meet Seismic II/I requirements. Additionally, the baskets are designed to maintain their structural integrity during a DBE.

NRC Request No. 12

A discussion on the high energy lines in the vicinity of the baskets, and how the baskets are protected from HELB effects (jet impingement and pipe whip) is not included.

Dominion Energy Virginia Response

To ensure the NaTB baskets are not adversely affected or adversely affect the containment sump strainers, the planned installation locations for the NaTB baskets have been chosen to avoid placement in areas that could be affected by HELB effects in the containment basement. Protection against the effects of blowdown jet forces and pipe whip resulting from a postulated pipe rupture of the Reactor Coolant, Pressurizer, Main Steam, and Feedwater System piping is provided by a combination of distance, restraints, and barriers. Specifically, high energy piping is protected / isolated by missile barriers and restrained to limit pipe whip. The baskets located in the containment annulus area are protected by the crane wall. Baskets that are not protected by the crane wall are located so that the impingement pressure from an HELB would not affect the baskets such that the ability of the NaTB buffer to perform its design function would be impeded based on the zone of influence (ZOI) radius. Therefore, the baskets are sufficiently protected from the effects of HELBs through the use of barriers, restraints, and distance.

Attachment 1

PROPOSED SURRY UNIT 1 UFSAR UPDATE (INTERIM)

Virginia Electric and Power Company
(Dominion Energy Virginia)
Surry Power Station Unit 1

installing the closed side of a spectacle flange. The maximum purge rate through this path is limited to 20,000 cfm as the filter also serves the Auxiliary Building General Exhaust.

5.3.1.4 **Design Evaluation**

Whenever the three main recirculation fan and coil units, the three CRDM fan and coil units, and the main coolant pump cooling systems are operating, the containment bulk air temperature will be maintained below 125°F. Two of the three fans in the recirculation system will continue to operate under limited main coolant leakage conditions that result in containment pressures up to but not exceeding the Consequence Limiting Safeguards (CLS) high-high containment pressure actuation setpoint (Section 7.5.1.2). The third fan will continue to operate, if normal station power is available, until stopped either manually or by actuation of an electrical fault protection device. This may provide sufficient heat removal to permit reactor shutdown under limited leakage conditions without resorting to caustic spray injection.

REMOVE

The inside containment filter units will remove the airborne iodine and particulate radioactivity that could result from nominal operational leakage during subatmospheric operations.

The purge system provides the capability to change the containment air and remove radioactivity, if required, before entry for refueling and maintenance. The purge system is designed for one air change per hour and to maintain a minimum of 60°F inside the containment.

5.3.1.4.1 Incident Control

During normal operation of the plant, the containment purge system is not in use.

After unit shutdown and cooldown, purging of the containment can take place. The purge exhaust air may be directed to either the non-safety-related or safety-related ventilation filters in the auxiliary building if fuel is being handled inside containment, but no filtration is credited in the analysis. The analysis of the fuel handling accident in containment does not require that containment integrity be established prior to fuel movement. The purge design flow through the non-safety-related filter is 20,000 cfm with a limit of 30,000 cfm through the safety-related filters when containment integrity is established. If containment integrity is not established, the maximum purge exhaust rate equals the maximum safety-related fan flow limit of 39,600 cfm. The physical design and installation of the duct systems preclude exceeding these limits. The discharge of the safety-related filters and non-safety-related filter are monitored by the same system for radioactivity prior to release. Should a LOCA signal from the other unit be received, the air-operated isolation dampers will fail closed and allow the safety-related filters to treat the air exhausted from the ECCS areas. As described in Section 9.13.4.1, if a safety injection actuation occurs and auto alignment of the ventilation system is defeated, manual action is required to realign the system to the ECCS filtration mode. An alarm is received in the main control room if the purge is not realigned following a safety injection signal. This condition is not expected however, since defeating the automatic realignment is no longer credited in the fuel

REPLACE

Chapter 6: Engineered Safeguards

List of Figures

INSERT

CHAPTER 6 ENGINEERED SAFEGUARDS

6.1 GENERAL DESCRIPTION

Note: As required by the Renewed Operating Licenses for Surry Units 1 and 2, issued March 20, 2003, various systems, structures, and components discussed within this chapter are subject to aging management. The programs and activities necessary to manage the aging of these systems, structures, and components are discussed in Chapter 18.

The engineered safeguards, together with the containment (Chapter 5), protect the public and the station in the event of the design-basis accident, as defined in Sections 14.5.1.2 and 14.5.5. The engineered safeguards are designed to minimize the accident by performing the following three functions:

1. Supply borated water to the reactor coolant system to cool the core, decrease reactivity, limit fuel rod cladding temperatures, limit the metal-water reaction, and ensure that the core remains intact.
2. Limit the driving potential, including differential pressure and time duration, for leakage out of the containment structure.
3. Reduce the concentration of airborne fission products available for leakage.

The first function is satisfied by the timely, continuous, and adequate supply of borated water to the reactor coolant system and the reactor core. The second function is satisfied by the provision of heat sinks for the condensation of steam released inside the containment, the inherent depressurization of the containment below atmospheric pressure following the design-basis accident, and means for maintaining the containment at subatmospheric conditions for an extended period of time. The third function is satisfied by providing chemical additives (NaOH) to the containment spray to enhance the spray removal of radioactive iodine from the containment atmosphere.

(Unit 2)

INSERT

(NaTB) to the sump water which is recirculated by the ECCS and recirculation spray systems (Unit 1) or

The engineered safeguards system

1. A safety injection system (Section 6.2) that injects borated water into the cold legs of all three reactor coolant loops.
2. Two separate low-head safety injection subsystems, either of which provides long-term removal of decay heat from the reactor core.
3. Two separate subsystems of the spray system (containment spray and recirculation spray) that operate together to reduce the containment temperature, return the containment pressure to subatmospheric, and remove heat from the containment. The recirculation spray subsystem maintains the containment subatmospheric and transfers heat from the containment to the service water system (Section 9.9).

A composite schematic diagram of the engineered safeguards systems is shown in Figures 6.1-1 and 6.1-2 for Units 1 and 2, respectively.

The safety injection system provides for the charging of borated water to the reactor coolant system from the accumulators following a LOCA. The three accumulators are self-contained and are designed to supply water as soon as the reactor coolant system pressure drops below 600 psig. Additional makeup to the reactor coolant system is provided by the charging pumps, operating in the safety injection mode, and the low-head safety injection pumps. Both the charging and low-head safety injection pumps are located outside the containment, are driven by an electric motor, are capable of being rapidly energized or operated, and are powered from the emergency power buses. The pumps also ensure an adequate supply of borated water for an extended period of time by recirculating water from the containment sump to the reactor core through two separate flow paths.

The containment spray subsystem supplies chilled borated water to the containment immediately following the receipt of the safeguards initiation signal. This subsystem includes two full-capacity, electric-motor-driven containment spray pumps that are located outside the containment and are supplied with power from the emergency buses. The containment spray pumps supply chilled water from the refueling water storage tank to the containment. Either pump is capable of furnishing sufficient spray water to prevent overpressurizing the containment structure. A chemical addition tank is balanced hydraulically with the refueling water storage tank and provides a flow of sodium hydroxide solution to increase the alkalinity of the containment spray and recirculated spray to ensure effective removal of radioactive iodine. (Unit 2) INSERT

The recirculation spray subsystem recirculates water from the containment sumps through service-water-cooled recirculation spray heat exchangers to the recirculation spray headers. Two of the four 50% design capacity, motor-driven recirculation spray pumps are located outside the containment. All four of the recirculation spray coolers are located inside the containment and transfer containment heat to the service water system (Section 9.9).

The containment spray and recirculation spray subsystems are capable of reducing the containment pressure to subatmospheric in less than 60 minutes, thus terminating all outleakage to the environment. This original design criterion was modified in conjunction with the analyses for implementation of the alternative source term. The modified criteria require that, following the LOCA, the containment pressure be less than 1.0 psig within 1 hour and less than 0.0 psig within 4 hours. The radiological consequences analysis demonstrates acceptable results provided the containment pressure does not exceed 1.0 psig for the interval from 1 to 4 hours following the Design Basis Accident. Beyond 4 hours, containment pressure is assumed to be less than 0.0 psig, terminating leakage from containment.

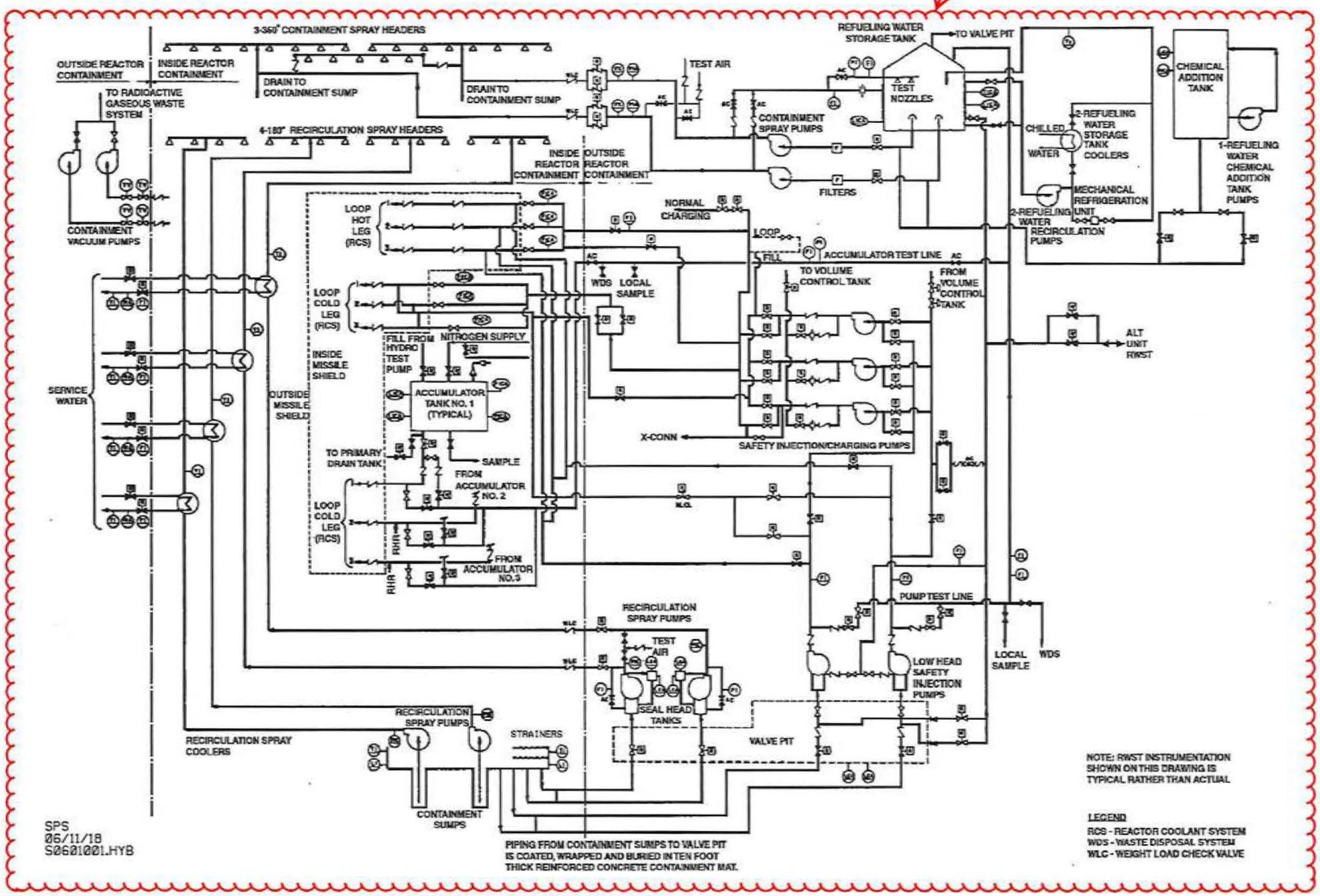
INSERT

The containment vacuum system removes any subsequent air inleakage after the containment pressure has been reduced to subatmospheric. Because of the inherent low-leakage design of the containment, the use of the vacuum pumps will probably not be required for several

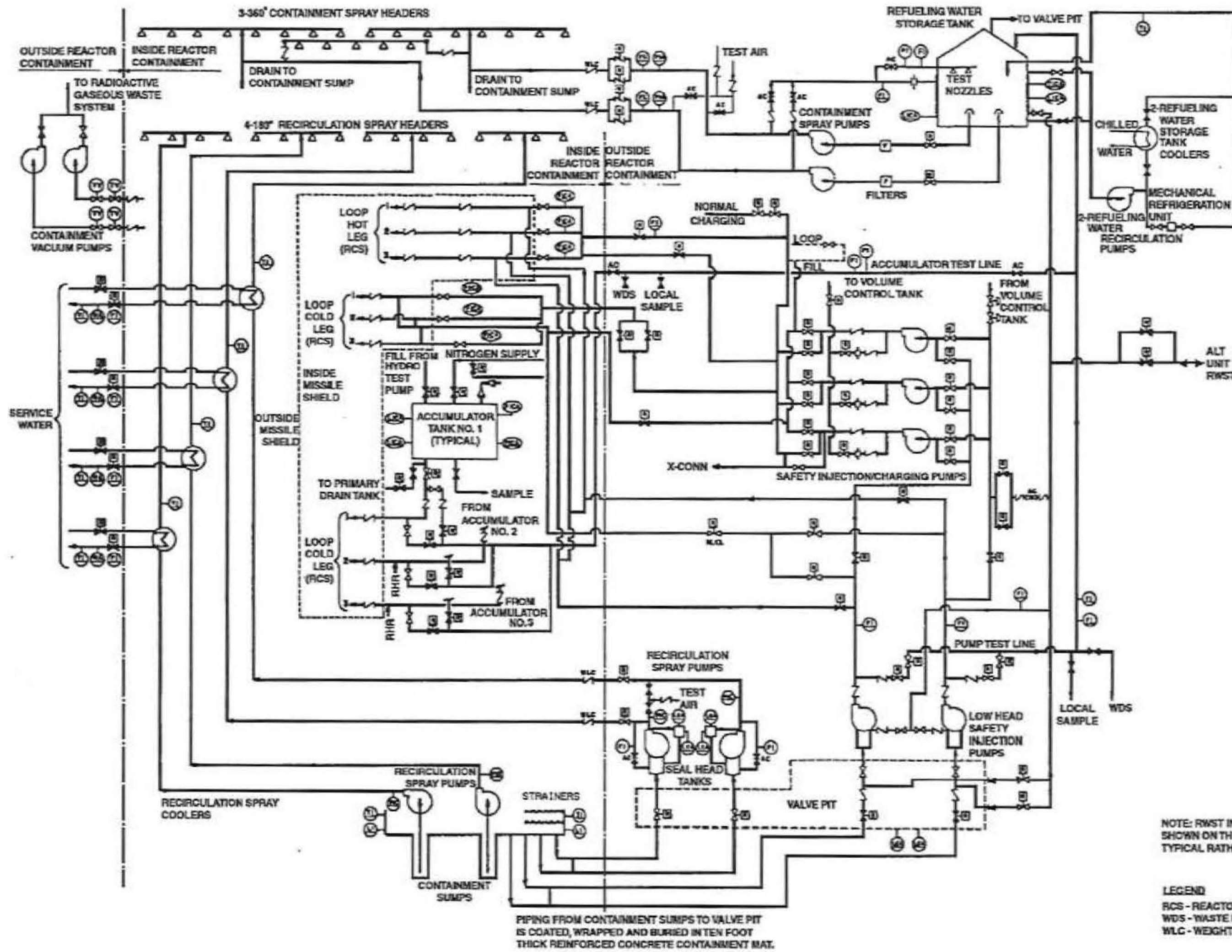
Sodium Tetraborate Decahydrate (NaTB) is stored in baskets inside containment to increase the alkalinity of the sump water produced during an event which exceeds the CLS high-high containment pressure actuation setpoint. The NaTB solution is recirculated by the recirculation spray subsystem to ensure effective removal of radioactive iodine (Unit 1).

REPLACE WITH INSERT A

Figure 6.1-1
UNIT 1 ENGINEERED SAFEGUARDS SYSTEMS



INSERT A



NOTE: RWST INSTRUMENTATION SHOWN ON THIS DRAWING IS TYPICAL RATHER THAN ACTUAL

LEGEND

RCS - REACTOR COOLANT SYSTEM
WDS - WASTE DISPOSAL SYSTEM
WLC - WEIGHT LOAD CHECK VALVE

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

1. Two production line motors were used for this test. One was exposed to a total of 1.5×10^8 rad of gamma radiation in approximately one month. The other motor was used for the final comparative analysis.
2. Both motors were tested for coil resistance by the Wheatstone bridge method, and for insulation resistance by meggering both before and after motor vibration and reversing operations.

The compatibility of construction materials with a postaccident solution of boric acid and sodium hydroxide is discussed in WCAP-7153.

REPLACE

sodium hydroxide, and boric acid and sodium tetraborate decahydrate is discussed in WCAP-7153 (Reference 12) and WCAP-16596 (Reference 13), respectively.

The recirculation spray sump in containment is maintained wet to provide a water seal to reduce the potential for pressure locking the LHSI pumps containment suction MOV's (Reference 9).

6.2.2.2.5 Manual Valves

The stainless steel manual globe, gate, and check valves are designed and built in accordance with the requirements outlined in the motor-operated valve description above (Section 6.2.2.2.4).

The carbon steel valves are built to conform with USAS B16.5. The materials of construction of the body, bonnet, and disk conform to the requirements of ASTM A105, Grade II; A181, Grade II; or A216, Grade WCB or WCC. The carbon steel valves pass only non-radioactive gases and were subjected to hydrostatic test as outlined in MSS-SP-61, except that the test pressure was maintained for at least 30 minutes.

6.2.2.2.6 Vent Valves

High point vents have been installed at critical points in the suction lines of the charging (HHSI) pumps, and the discharge lines of the LHSI pumps where gasses could collect.

6.2.2.2.7 Accumulator Check Valves

The pressure-containing parts of these valve assemblies are designed in accordance with MSS SP-66. Parts in contact with the operating fluid are of austenitic stainless steel or of equivalent corrosion-resistant materials procured to applicable ASTM or Westinghouse specifications.

The three combinations (Bars A, B, and C) represent degraded cases with operation of less than the installed emergency core cooling equipment. These cases are shown only to present the capability of individual portions of the system and to demonstrate the overall margins of the system. The operation of one safety injection charging pump together with two accumulators is probably capable of providing protection over a considerably greater range than shown. However, the analysis has only considered breaks up to the 8-inch diameter.

Bar D, which is the combination of the safety equipment in Bars B and C, and which also represents the minimum engineered safeguards available automatically, provides protection as shown over the complete range of break sizes up to and including the complete circumferential fracture of a reactor coolant pipe.

For the small range of break sizes up to 2 inches, as shown in Bar A, the action of one safety injection charging pump acting alone is sufficient to maintain enough core water inventory to ensure continued core cooling.

6.2.3.2 **Borated Water Injection Chemistry**

During the injection of emergency cooling water into the reactor coolant system following a LOCA, the concentration of boron will vary depending on the depressurization history of the reactor. If depressurization were slow, the high-head pumps would inject boric acid at a concentration greater than 2300 ppm, which would be diluted by the coolant remaining in the system. Rapid depressurization would bring about early injection of water containing boric acid at a concentration greater than 2250 ppm from the accumulators. When recirculation begins, the average concentration of boric acid is (and will remain) at a concentration that will maintain the core subcritical.

The concentrations of other materials, including chlorides, are quite low in this solution, corrosion products being generally insoluble in a basic solution. Assuming 50% of the maximum core inventory is released to containment after a LOCA, the principal fission product in the sump (assuming a gross core failure) would be iodine at a range between approximately 1.6 to 1.9 ppm for 500 days of operation and approximately 3.0 to 3.6 ppm for 1000 days of operation. The temperature of the sump water is reduced below 150°F, under normal operating conditions with a minimum of two recirculation coolers in operation, after a relatively short period of time (i.e., a few hours). Below 150°F, chloride stress corrosion does not constitute a problem.

REPLACE

4.25 and 4.75 (Unit 1) and 8.5 and 10.5 (Unit 2)

REMOVE

6.2.3.3 **Chemical Additives**

Containment transient analyses show that the chemical additive spray (containment spray), having a pH between 8.5 and 10.5, will be used for approximately 1½ hours if minimum safeguards operate and approximately 50 minutes if normal safeguards operate. During this period, the containment will be cooling from 280°F to approximately 140°F. At the end of the initial containment cooling period, lasting no longer than approximately one hour, the recirculation spray system will continue in service for an indefinite period; however, the pH of the

INSERT during the long-term postaccident period

INSERT box and italicized text

REMOVE

recirculating spray fluid should be between 7.0 and 9.0 and further addition of chemical spray additives is not contemplated.

ADD Insert B

The following information is only applicable to Unit 2.

Sodium hydroxide is normally stored for many industrial applications in atmospheric-vented tanks. Reaction of sodium hydroxide with atmospheric carbon dioxide to form a large precipitate does not occur. However, to eliminate particulate matter from any potential source, the containment spray subsystem includes a strainer on the suction side of the containment spray pumps. This strainer will have openings smaller than the smallest spray nozzles, and therefore will remove any particulate matter from the containment spray flow that might prevent the system from functioning.

To illustrate the remoteness of a CO_2 + NaOH reaction, calculations were made based on the following assumptions:

1. The tank temperature varies from 35° to 95°F each day, causing the tank to breathe.
2. All CO_2 entering the tank reacts with the caustic.

The calculations indicate that this process must continue for 90 years to react with 1% of the stored caustic. This reaction would not cause a precipitate to form.

Based on past operating experience and calculational results, a sodium carbonate precipitate cannot form; therefore, the functioning of the system will not be impaired because of precipitation.

The major construction materials that will be exposed to the containment spray solution and the corrosion or deterioration rates for each under maximum exposure conditions, are listed in Table 6.2-7.

REMOVE

REPLACE containment

The materials adversely affected by the chemical additive spray are aluminum and zinc.

containment

The time-temperature exposure conditions under which these materials will be exposed to the chemical additive spray are from approximately 50 minutes to 1½ hours, with the temperature decreasing from 280° to 140°F.

The materials will also be exposed to the recirculation sprays, which have a pH between 7.0 and 9.0 for the postaccident recirculation period with the temperature at approximately 140°F.

The consequence of corrosion and/or deterioration on materials with regard to postaccident operation of the engineered safeguards is negligible because components of the engineered safeguards are constructed of stainless steel.

REMOVE

The corrosion rate of stainless steel is low enough in the spray solution to be of no practical concern (Reference 1).

Insert B

The following information is only applicable to Unit 1

Sodium Tetraborate Decahydrate stored inside containment is a white crystalline chemical in granular form. The NaTB is stored inside baskets which contain the chemical until it is dissolved by the containment sump water. To eliminate particulate matter from any potential source, the containment spray subsystem includes a strainer on the suction side of the containment spray pumps. This strainer will have openings smaller than the smallest spray nozzles, and therefore will remove any particulate matter from the containment spray flow that might prevent the system from functioning. Additionally, using NaTB as a buffer does not result in any different precipitates than those that form with the original NaOH buffer and the amount of precipitates is reduced, resulting in lower strainer head losses. Therefore, the functioning of the system will not be impaired because of precipitation.

Table 6.2-7
CONSTRUCTION MATERIAL EXPOSURE TO CONTAINMENT SPRAY

Material	Corrosion Rate[a]
Carbon steel [b]	0.0
Stainless steel	0.0
Concrete [b]	0.0
Mineral wool	0.0
Calcium silicate and Unibestos	0.0
Aluminum	12.0 $mg/dm^2/hr$ [c]
Zinc (paint and galvanizing on steel)	0.04 $mg/dm^2/hr$ [c]
Copper	0.0
90-10 copper nickel	0.0
Polyethylene and neoprene	0.0

REPLACE

containment

The maximum total duration of use for the chemical additive spray system is approximately 60 minutes.

a. Less than 1 mil/yr considered to be zero corrosion rate.

b. Painted with Corlar Epoxy Chemical Resistant Enamel, which is a polyamide catalyzed epoxy resin paint.

c. Corrosion rate at 140°F, maximum exposure temperature after 1 hour. Aluminum has corrosion rate of less than 800 $mg/dm^2/hr$ at peak temperature.

6.3 CONSEQUENCE-LIMITING SAFEGUARDS

6.3.1 Spray System

6.3.1.1 **Design Bases**

The spray system consists of the containment spray subsystem and the recirculation spray subsystem, which are designed to provide the necessary cooling and depressurization of the containment after any LOCA. Spray system component data are given in Table 6.3-1.

Safety related components, piping, valves, and supports in the spray system are Seismic Category I.

The subsystems, operating together, cool and depressurize the containment to subatmospheric pressure following the design-basis accident.

The recirculation subsystem is, in addition, capable of maintaining the subatmospheric pressure in the containment for an extended period following the design-basis accident.

INSERT (Unit 2)

The removal of radioactive iodine from the containment atmosphere after a design-basis accident is accomplished through the addition of sodium hydroxide solution to the containment spray (Section 14.5.4).

INSERT dissolution of sodium tetraborate decahydrate into the containment sump water which is used by the recirculation spray subsystem (Unit 1) and the

The spray system is designed to depressurize the containment to subatmospheric pressure with any one of the two containment spray pumps operating and only two of the four recirculation spray pumps operating.

6.3.1.2 **Spray System Components**

The spray system is designed, fabricated, inspected, and installed to meet the requirements of the General Design Criteria, as discussed in Section 1.4. The spray subsystems and their components are considered to be essential to accident prevention and/or the mitigation of accident consequences that could affect the public health and safety.

6.3.1.2.1 Pumps and Valves

The spray pumps and valves are fabricated, welded, and inspected according to the requirements of the applicable portions of the ASME Code, Sections III, VIII and IX. Materials of construction are stainless steel or equivalent corrosion-resistant materials.

Valve packing and pump seals are selected to minimize or eliminate leakage where necessary. Motor-operated valve operators are selected because their proven superior reliability in past applications ensures reliable valve operation under incident conditions.

The Teflon sleeve and packing of the outside recirculation spray system suction valves have been changed to XOMOX 7. This change reflects the review performed in accordance with NUREG-0578, Section 2.1.6.b. In this review it was found that the valves would be located in a

high-radiation area as a result of a LOCA. The Teflon material is satisfactory to only 1×10^4 rads, whereas the XOMOX 7 material is satisfactory to 8×10^6 rads. The expected 60-year normal plus postaccident integrated radiation dose in this area is conservatively estimated not to exceed 8×10^6 rads.

REPLACE

The containment spray system piping and equipment are fabricated of ASTM A358, Type 304 stainless steel, or equivalent, which has a corrosion rate of less than 0.0001 in/yr at the ~~system operating conditions of 45°F temperature~~ and 8.7 to 10.4 pH.

4.25 to 4.75 pH (Unit 1) and 8.7 to 10.4 pH (Unit 2)

REPLACE

The recirculation spray system piping and equipment are also fabricated of Type 304 or Type 316L stainless steel, or equivalent, except for the Recirculation Spray Heat Exchanger (RSHX) tubing which is titanium, and the spray nozzles which are brass. System operating conditions are 200° to 130°F temperature and 7.7 to 8.5 pH during the long-term postaccident period.

REPLACE

Per NUREG-0800 (Reference 11), stress

7.0 to 9.0 pH (Unit 1) and 7.7 to 8.5 pH Unit 2)

Stress corrosion cracking of austenitic stainless steel is inhibited in boric acid, sodium hydroxide solutions in the hypothetical environment after the design-basis accident, when the pH is 8.0 or greater.

7.0 REPLACE borated

REMOVE

The systems operate at a relatively low pressure of approximately 100 psi gauge and are not highly stressed during operation, so that the inducement toward cracking is reduced.

Because the pH of the containment spray solution is above 8.0 and the recirculation spray solution pH is essentially 8.0, the potential for caustic stress corrosion cracking in the containment spray system and recirculation spray system is virtually nonexistent.

6.3.1.2.2 M

The potential for caustic stress corrosion cracking in the containment spray system and recirculation spray system is virtually nonexistent because of the following:

1. The short duration of containment spray system operation (Unit 1)
2. The pH of the containment spray solution is above 7.0 (Unit 2)
3. The recirculation spray solution pH is above 7.0 during the long-term postaccident period (Unit 1 and Unit 2)

Electri

IEEE, and N

is such that n

Windin

calculated to occur under design-basis accident conditions. This type of insulation is used in motors located inside containment.

REPLACE

The containment motors have been selected to ensure operation during LOCA conditions. Motor electrical insulation is in accordance with ANSI, IEEE, and NEMA standards. The motors are tested as required by these standards. Bearings are antifriction type. Bearing loading and high-temperature tests have been performed, and the expected bearing life equals, or exceeds, that specified by the Anti Friction Bearing Manufacturers Association (AFBMA).

6.3.1.2.3 Piping

Piping fabrication, installation, and testing are in accordance with the Specification for Power Plant Piping, ANSI B31.1, with supplemental requirements and inspections as necessary

The suction lines between the containment sump and the ORS pumps are cross connected. This design feature was originally provided to ensure a supply of water to each pump in the event that the suction of either pump become clogged. The current common header strainers that protect the pump suction lines are designed to withstand the full debris load that could be generated by a LOCA.

The design data of the spray system components are given in Table 6.3-1.

6.3.1.3 **Description**

6.3.1.3.1 Containment Spray System

The containment spray system consists of two completely separate trains of spray rings located in the containment dome and one common spray ring located outside the crane wall. Each train is rated at 100% capacity. The recirculation spray system is composed of two trains, each consisting of an inside recirculation spray subsystem and an outside recirculation spray subsystem. Each subsystem is approximately 50% capacity, and consists of one recirculation spray pump, one recirculation spray heat exchanger (RSHX), and one 180° coverage spray header with nozzles.

REPLACE

An additional ring header common to both containment spray trains is installed at Elevation 95 ft. 6 in. outside the crane wall. Check valves are installed in each branch connection from the riser to the common header to limit fill time, should one containment spray pump train fail to start.

Figure 6.3-1a (Unit 1) and Figure 6.3-1b (Unit 2)

The containment spray subsystem is shown in Figure 6.3-1 and the recirculation spray subsystem is shown in Figure 6.3-2. Elevations of all piping and components of these subsystems are shown in Figure 6.3-4.

(Unit 2 only) INSERT (Unit 2 only)

Each of the containment spray headers draws water independently from the refueling water storage tank. The sodium hydroxide solution used for iodine removal from the containment atmosphere is added to the containment spray water by a balanced gravity feed from the chemical addition tank. The refueling water storage tank is a vertical cylinder with a flat bottom and a dome top, and is secured to a reinforced-concrete foundation. The refueling water storage tank is fabricated of ASTM A240, Type 304L stainless steel, in accordance with API STD-650. The requirements for welding, welding procedures, welder qualification, weld point efficiency, and weld inspection are in accordance with Section IX of the ASME Code and the Specification for Field Fabricated Storage Tanks (Reference 4). The chemical addition tank is a vertical cylindrical vessel with flanged and dished heads mounted on a skirt and secured to the reinforced concrete foundation. The chemical addition tank is fabricated of ASTM A240, Type 304 stainless steel in accordance with Section VIII of the ASME Code.

Both tanks are designed as Class I components, as described in Section 2.5, to withstand design seismic loading in accordance with the design stress criteria of ASME Code Section III, Figure N-414, *Nuclear Vessels*. The connecting piping is designed to withstand seismic loading to

ensure the functioning of the system. The refueling water storage tank is provided with a manhole for inspection access.

Prior to unit operation, the water in the refueling water storage tank is cooled to a temperature of slightly below 45°F by either circulating the water through a heat exchanger that uses chilled water from the chilled water subsystem of the component cooling system (Section 9.4) or by using mechanical refrigeration units. Mechanical refrigeration units then maintain the tank water below 45°F. The tank is insulated. The refueling water storage tank also has a nozzle connection that supplies water to the safety injection system (Section 6.2).

The refueling water storage tank (RWST) is a passive component and is required only during a short period following an accident. It is provided with four channels of level indication, which provide signals to level indicators. The level indication range for the RWST is approximately 14,000 gallons at 0% level to approximately 399,000 gallons at 100% level. The RWST is maintained at greater than 387,100 gallons of borated water at or below a temperature of 45°F during normal plant power operations. Level transmitters provide input to a low level alarm and an empty alarm when RWST level drops below these respective setpoints. When two of four channels have sensed a low RWST level condition, an interlock signal is generated to allow for the start of the IRS and ORS pumps on a CLS Hi-Hi Actuation. Additionally, when two of four channels have sensed a low-low RWST level condition, a signal is generated to realign safety injection to the recirculation mode automatically. It takes approximately three minutes to realign the valves from injection to recirculation mode. The key values for the RWST assumed in the safety analysis are presented in Table 5.4-17. The safety analysis values are conservative with respect to plant operation.

(Unit 2 only) INSERT

The chemical addition tank is located close to the refueling water storage tank. The normal operating capacity of the CAT, including instrument uncertainties, is greater than the minimum CAT volume of 3800 gallons assumed in the safety analysis. Flow of the sodium hydroxide solution is from the chemical addition tank directly to the containment spray pump suction via a caustic addition line. This flow path provides for a reduced caustic transit time and introduces the caustic at an essentially constant rate. The constant addition rate provides for a more constant spray pH during the various modes of safeguards system operation. (Unit 2 only) INSERT

A line from the chemical addition tank circulating pump is installed to permit periodic circulation of caustic solution in the piping and maintain the capability of recirculating the chemical addition tank.

(Unit 2 only) INSERT

The chemical addition tank is insulated and the recirculation line is electrically heat traced to keep the tank and recirculation line contents at a temperature well above the freezing point of the chemical spray solution. The chemical addition tank has a low-temperature alarm set at 35°F.

The containment spray pumps are capable of supplying approximately 3200 gpm of borated water to two separate circular containment spray ring headers located approximately 96 feet above the operating floor in the dome of the containment structure and the common crane wall

maintained post-LOCA considering the presence of debris in the Reactor Coolant System and core. The change in buffer from sodium hydroxide to sodium tetraborate decahydrate has been evaluated and determined to not adversely affect the conclusions of the above evaluations and tests. Based on the above evaluations and tests, the area of perforations in the strainer was determined to be sufficient such that under full debris loading conditions there would be adequate NPSH available to the RS and LHSI pumps during accident conditions.

INSERT

6.3.1.4.2 Recirculation Spray Nozzles

The spray system consists of two separate but parallel containment spray rings located in the containment dome and one common containment spray ring located outside the crane wall, plus four separate but parallel recirculation spray headers, each of approximately 50% capacity. The use of a separate spray header connected to the discharge of each pump results in a fixed flow rate, and allows for optimized selection of spray nozzle sizes. This arrangement gives the optimum combination of small spray particles for maximum heat transfer and larger particles for better coverage toward the center and sides of the containment. In addition, this arrangement also ensures that a failure of a component in any one subsystem does not affect the operational capability of the other subsystems.

The methods of preventing the plugging of spray nozzles in the two systems vary. For each containment spray train, the materials of construction, as well as the pump suction filter, prevent nozzle plugging. A method of nozzle testing is provided in the refueling water storage tank to ensure that no particulates that could plug the containment spray nozzles collect in the tank. Despite this precaution and regardless of strainer perforation size, some types of particles could conceivably pass lengthwise through the strainer and cause clogging of a spray nozzle. However, since the strainer perforations are smaller than the smallest spray nozzle opening, such an occurrence is considered to be highly improbable.

The containment sump strainer assembly is designed such that a single assembly provides filtered borated water to all four RS System pumps, as discussed in Section 6.3.1.3. The design feature of the strainer prevents complete failure of all suction points of the RS System. The strainers are raised off of the floor, which prevents large debris (non-buoyant) from reaching the fins and blocking them. It provides significantly large area of fin perforations that reduces the approach velocity and possibility of the strainer becoming completely blocked.

Since the redundant capacity of the recirculation spray subsystems increases from 100% after a loss-of-coolant incident to 400% to 1000% 1 day after an incident, plugging that could only occur on a long-term basis would have no significant effect on the capability of the subsystems.

6.3.1.4.3 Recirculation Spray Heat Exchangers

Initially, the heat exchangers of the recirculation spray trains are clean and dry, with maximum heat transfer capability. For long-term operation, on the order of weeks or months, there may be some fouling of the tubes on the service water side, with resultant loss in heat

The recirculation spray subsystem nozzles will be subject to an inspection or smoke or air test following maintenance or an activity which could cause blockage to provide indication that plugging of the nozzles has not occurred. The testing of system controls is discussed in Section 7.5.

Electrical insulation resistance tests are performed during the lifetime of the RS motors to verify the integrity of the insulation. Periodic tests are also performed to ensure the motors remain in a reliable operating condition.

The Recirculation Spray System is subject to the applicable inservice inspection and inservice testing requirements of the ASME Code, as required by 10 CFR 50 (Code of Federal Regulations, Title 10, Part 50).

6.3 REFERENCES

1. NRC Bulletin No. 93-02: *Debris Plugging of Emergency Core Cooling Suction Strainers*, dated May 11, 1993.
2. Letter from Virginia Electric and Power Company to the NRC, dated June 10, 1993, Serial No. 93-307, *Response to NRC Bulletin 93-02.*
3. Letter from Virginia Electric and Power Company to USNRC dated February 7, 1996 (Serial No. 95-566A), *Generic Letter 95-07 Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves, Surry and North Anna Power Station.*
4. Stone & Webster Specification NUS-258, *Specification for Field Fabricated Storage Tanks*, Revision 2.
5. NRC Generic Letter GL 2004-02, *Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors*, dated September 13, 2004.
6. Nuclear Energy Institute (NEI) Document NEI 04-07, *Pressurized Water Reactor Sump Performance Evaluation Methodology*, dated December 2004.
7. Safety Evaluation by the Office of Nuclear Reactor Regulation Related to NRC Generic Letter 2004-02, *Nuclear Energy Institute Guidance Report Pressurized Water Reactor Sump Performance Evaluation Methodology.*
8. Letter from Dominion Resources Inc. to the NRC, dated September 1, 2005, Serial No. 05-212, *Response to NRC Generic Letter 2004-02.*
9. Westinghouse Document WCAP-16406-P, Revision 1, *Downstream Wear Evaluation Methodology for Containment Sump Screens in Pressurized Water Reactors.*
10. Westinghouse Document WCAP-16793-NP, Revision 0, *Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid.*

ADD
Insert C

Insert C

11. U.S. Nuclear Regulatory Commission Standard Review Plan NUREG-0800, Chapter 6, Section 6.1.1, Rev 2, *Engineered Safety Features Materials.*

12. WCAP-7153, *Investigation of Chemical Additives for Reactor Containment Sprays*, dated March 1968.

13. WCAP-16596-NP, Revision 0, *Evaluation of Alternative Emergency Core Cooling System Buffering Agents*, dated July 2006.

Table 6.3-1 (CONTINUED)
SPRAY SYSTEM COMPONENT DATA

Chemical Addition Tank (Unit 2 only) INSERT	
Number	2 (1 per unit) 1 REPLACE
Type	Vertical cylindrical
Capacity	4311 gal
Design pressure	25 psig
Design temperature	150°F
Material	SS 304
Design code	ASME Section VIII
Operating pressure	Atmospheric
Operating temperature	Ambient
NaOH concentration	17-18%
Chemical Addition Tank Pump (Unit 2 only) INSERT	
Number	2 (1 per unit) 1 REPLACE
Type	Vertical centrifugal
Rated flow	50 gpm
Rated head	7 ft
Theoretical horsepower	0.1 hp
Seal	Mechanical
Design pressure	225 psig
Material	
Pump casing	SS 316
Shaft	SAE 4140
Impeller	SS 316
Recirculation Spray System Strainer Assembly	
Number	1 (for both ORS and IRS Systems)
Material	SS 304
Design Code	ASME Section III, Subsection NF, Class 3
Structural DP	9.0 psid
Perforations	0.0625 in. diameter
Operating Pressure	9.0-59.7 psia
Operating Temperature	75-280°F
Fluid Flowing	Borated water

ADD Insert D

Piping

Piping is designed to the Code for Pressure Piping, ANSI B31.1.

Valves

Recirculation Spray system valves are designed in accordance with ANSI B16.5, Steel Piping Flanges and Flanged Fittings, or ANSI B16.34, Steel Butt-Welded End Valves.

Insert D

Sodium Tetraborate Decahydrate Baskets (Unit 1 only)

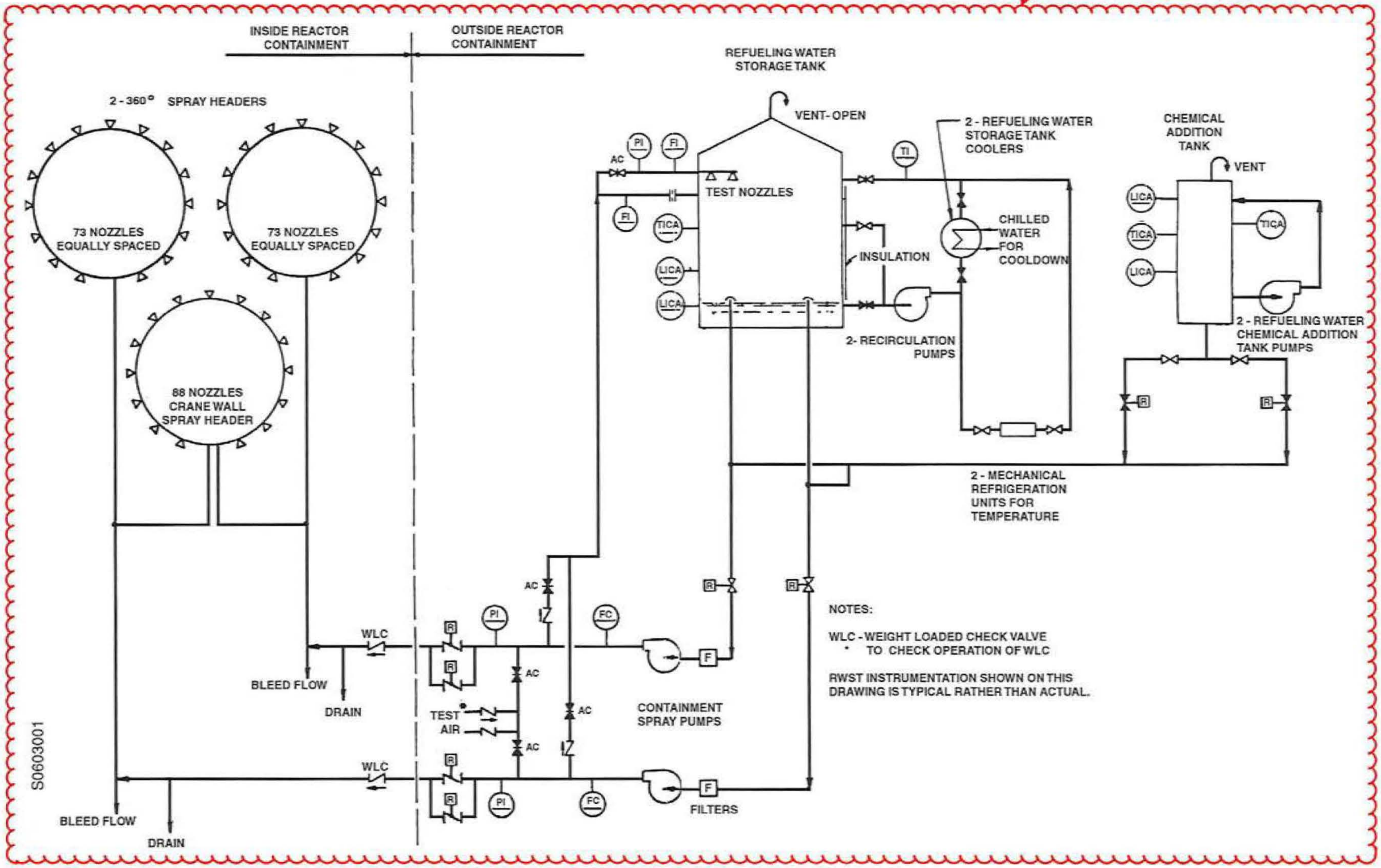
Number	7
Material	
Basket	SS 304
Wheels	Duplex SS 2205
Nominal size (internal dimensions)	6 ft x 5 ft x 1.5 ft
Operating Pressure	9.0-59.7 psia
Operating Temperature	75-280°F
Technical Specification minimum	10760 lbm
Chemical Grade	SQ Granular
Chemical Specification	
B_2O_3	36.5-38.3%
Equivalent $Na_2B_4O_7 \cdot 10H_2O$	99.9-105.0%
Na_2O	16.2-17.1%
SO_4	$\leq$ 3.0 ppm
Cl	$\leq$ 0.4 ppm
Fe	$\leq$ 2.0 ppm
Chemical Sieve Specification	
Standard No.	8
Retained	$\leq$ 0.1%

INSERT Unit 1

REPLACE 6.3-1a

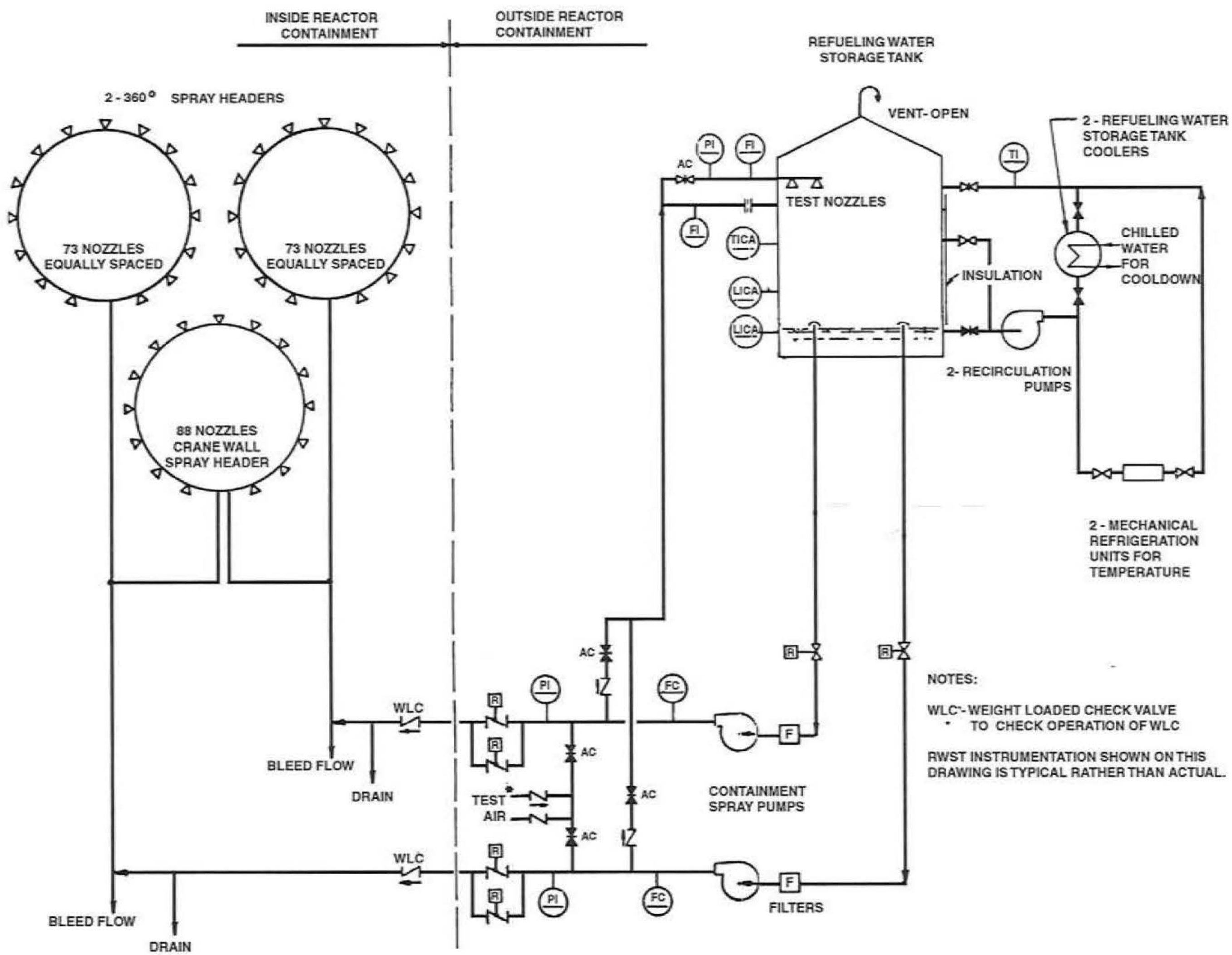
REPLACE WITH INSERT E

Figure 6.3-1
CONTAINMENT SPRAY SUBSYSTEM



REPLACE 6.3-26a

INSERT E



INSIDE REACTOR CONTAINMENT
OUTSIDE REACTOR CONTAINMENT
2 - 360° SPRAY HEADERS
73 NOZZLES EQUALLY SPACED
73 NOZZLES EQUALLY SPACED
88 NOZZLES CRANE WALL SPRAY HEADER
REFUELING WATER STORAGE TANK
VENT- OPEN
TEST NOZZLES
INSULATION
2 - REFUELING WATER STORAGE TANK COOLERS
CHILLED WATER FOR COOLDOWN
2- RECIRCULATION PUMPS
2 - MECHANICAL REFRIGERATION UNITS FOR TEMPERATURE
PI
FI
TICA
LICA
TI
AC
WLC
BLEED FLOW
DRAIN
TEST AIR
FC
CONTAINMENT SPRAY PUMPS
FILTERS
NOTES:
WLC - WEIGHT LOADED CHECK VALVE
* TO CHECK OPERATION OF WLC
RWST INSTRUMENTATION SHOWN ON THIS DRAWING IS TYPICAL RATHER THAN ACTUAL.

ADD NEW FIGURE 6.3-1b
ON NEW PAGE 6.3-26b
AFTER FIGURE 6.3-1a

Figure 6.3-1b
UNIT 2 CONTAINMENT SPRAY SUBSYSTEM

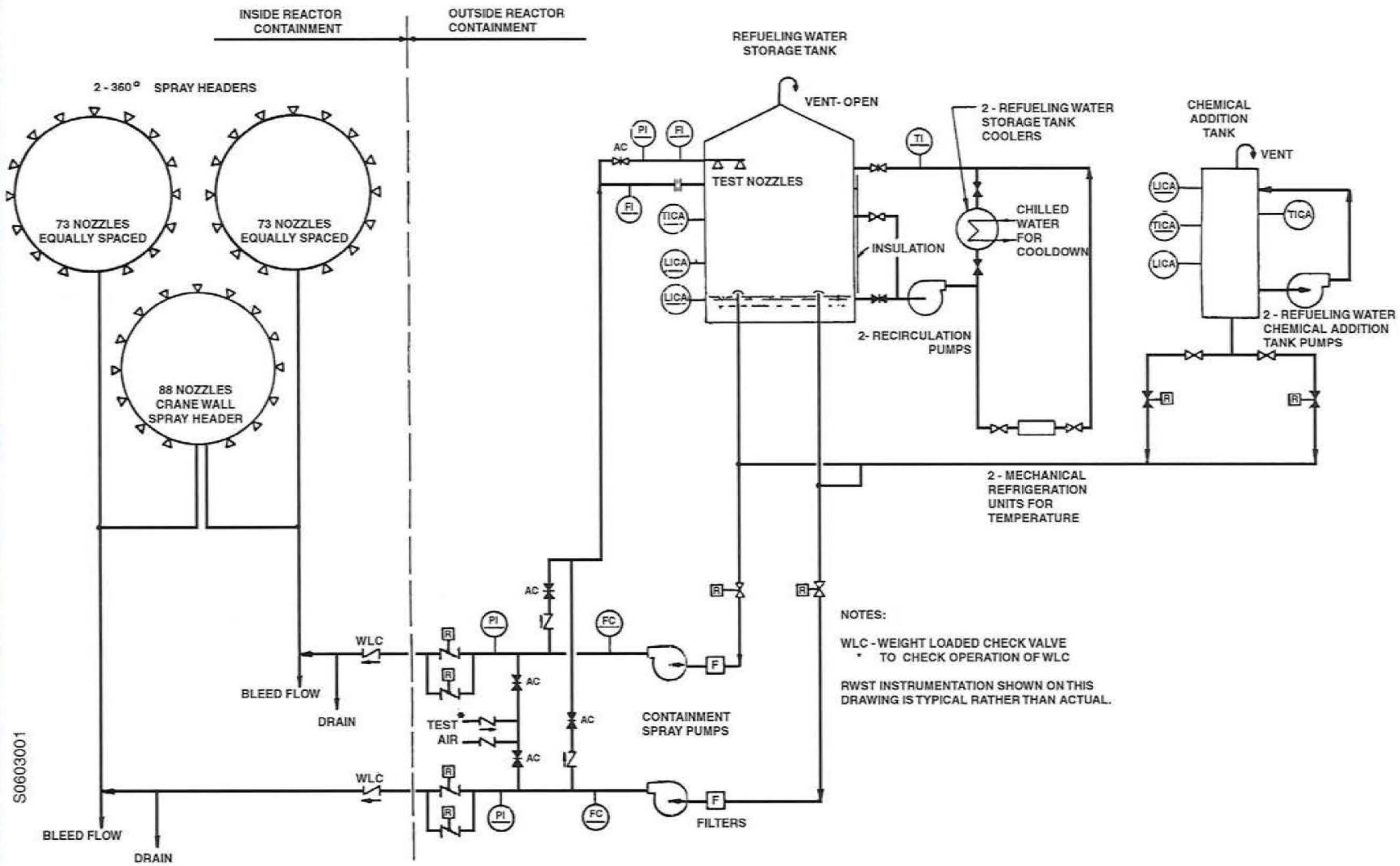


Table 7.5-2 (CONTINUED)
VALVES/DAMPERS ACTUATED BY ENGINEERED SAFEGUARDS SIGNALS

2-CS-MOV-202A[d]
2-CS-MOV-202B[d]
REPLACE

Designation (Valve or Damper Tag No.) (Similar for Unit 2)	Service (Actuated Valve or Damper Description)	Function (Actuated Valve or Damper Position)	Signal (Actuation Signal)	Override/Bypass (Override or bypass condition following actuation)
1-CS-MOV-101A [a]	Cont spray pump A discharge isolation valve	Open	CLS-HiHi	None
1-CS-MOV-101B [a]	Cont spray pump A discharge isolation valve	Open	CLS-HiHi	None
1-CS-MOV-101C [a]	Cont spray pump B discharge isolation valve	Open	CLS-HiHi	None
1-CS-MOV-101D [a]	Cont spray pump B discharge isolation valve	Open	CLS-HiHi	None
1-CS-MOV-102A [a]	Cont spray chem add tank isolation valve	Open	CLS-HiHi	None
1-CS-MOV-102B [a]	Cont spray chem add tank isolation valve	Open	CLS-HiHi	None
1-CV-TV-150A	Cont vacuum pump B outside cont isolation valve	Closed	SI	None
1-CV-TV-150B	Cont vacuum pump B outside cont isolation valve	Closed	SI	None
1-CV-TV-150C	Cont vacuum pump A outside cont isolation valve	Closed	SI	None
1-CV-TV-150D	Cont vacuum pump A outside cont isolation valve	Closed	SI	None
1-CW-MOV-100A [a]	Circ water condenser outlet isolation valve	Closed	CLS-HiHi *	None
1-CW-MOV-100B [a]	Circ water condenser outlet isolation valve	Closed	CLS-HiHi *	None
1-CW-MOV-100C [a]	Circ water condenser outlet isolation valve	Closed	CLS-HiHi *	None
1-CW-MOV-100D [a]	Circ water condenser outlet isolation valve	Closed	CLS-HiHi *	None
1-CW-MOV-106A [a]	Circ water condenser inlet isolation valve	Closed	CLS-HiHi *	None

a. These circuits have features that could prevent immediate operation of the component when the engineered safeguards signal is actuated. Such features are a necessary part of the circuit (such as a limit switch), or they require conscious effort by an operator to prevent operation (such as manipulation of a pushbutton or a selector switch). A valve limit switch could act to delay safeguards-initiated operation if the valve was in mid-travel and had to complete the travel sequence before operating in response to the safeguards signal. A pushbutton or selector switch held in the actuated position gives the operators an option, in some cases, of delaying component response to an emergency safeguards signals.

b. A key-operated switch is under administrative control to prevent inadvertent component operation and to satisfy the requirements of IEEE Standard 279-1971.

c. A mode switch is under administrative control to prevent inadvertent alignment of this damper during refueling (Section 9.13.4.1).

d. The valve tag number listed is for Unit 2 because there is no equivalent valve tag number for Unit 1.

INSERT

Table 15.2-1 (CONTINUED)

STRUCTURES, SYSTEMS, AND COMPONENTS DESIGNED FOR SEISMIC AND TORNADO CRITERIA

(Refer to the equipment classification list (Q-list) for a more comprehensive list of components. See Note 1.)

c. Pressurizer surge line was reanalyzed per NRC Bulletin 88-11, dated December 20, 1988.

Item	Earthquake Criterion	Tornado Criterion	Sponsor[a]	Note
Systems (continued)				
Reactor coolant system (continued)				
Pressurizer safety and relief valves	I	P	W	
Safety injection system				
Accumulators and supports	I	NA	W	
Low-head safety injection pumps and piping	I	P	W	P for containment integrity
Boric acid injection tanks and piping	I	P	W	
Piping, valves, and supports	I	NA	SW	Except drain/sample lines
Containment spray system				
Refueling water storage tank	I	NA	SW	
Containment spray pumps	I	NA	SW	
Piping, valves, and supports	I	NA	SW	Except recirculation lines
Refueling water chemical addition tank	I	NA	SW	
Recirculation spray systems				
Recirculation spray pumps and piping	I	P	SW	P for containment integrity
Recirculation spray heat exchangers	I	NA	SW	
Reactor containment sump and screens	I	NA	SW	
Piping, valves, and supports	I	NA	SW	

(Unit 2) INSERT

- Diesel-driven fire pump fuel oil storage tanks
- Refueling water storage tanks
- Chemical addition tanks

Chemical addition tank (Unit 2 only) REPLACE

- Emergency condensate storage tanks
- Fire Protection/Domestic water storage tanks (re-inspection required during the Period of Extended Operation)
- Emergency service water pump diesel fuel oil storage tank

An engineering evaluation may determine that the observed condition is acceptable or requires repair; or, in the case of degraded coatings, may direct removal of the coating, non-destructive examination of the substrate material, and replacement of the coating. Re-inspections are dependent upon the observed surface condition, and the results of this engineering evaluation. For the one-time inspections, tank conditions were confirmed to be acceptable, but the fire protection/domestic water storage tanks require re-inspection during the Period of Extended Operation. Corrective actions for conditions that are adverse to quality are performed in accordance with the Corrective Action System. Corrective action provides reasonable assurance that conditions adverse to quality are promptly corrected.

In addition to the one-time inspections of specified tanks, a second aspect of Item 10, Table 18-1 is to evaluate the need for ongoing inspections. The one-time inspection results for all tanks, except the fire protection/domestic water storage tanks, indicated acceptability during the complete Period of Extended Operation (PEO). The fire protection/domestic water storage tank will require re-inspection during the PEO based on an engineering evaluation of the one-time inspection results.

The combination of acceptable results from the one-time inspections, and the development of plans for future inspection of the fire protection/domestic water storage tanks, completes the tasks required for Item 10, Table 18-1.

18.1.4 Non-Environmental Qualification (EQ) Cable Monitoring

The purpose of the Non-EQ Cable Monitoring activities is to perform inspections on a limited, but representative, number or accessible cable jackets and connector coverings that are utilized in non-EQ applications (Item 19, Table 18-1). In order to confirm that ambient conditions are not changing sufficiently to lead to age-related degradation of the in-scope cable jackets and connector coverings, initial visual inspections for the non-EQ application insulated power cables, instrumentation cables, and control cables (including low-voltage instrumentation and control cables that are sensitive to a reduction in insulation resistance) are performed in accordance with a station procedure. Visual inspection of the representative samples of non-EQ power, instrumentation, and control cable jackets and connector coverings detect the presence of

Serial No. 21-138A
Docket Nos. 50-280/281
Enclosure

Attachment 2

PROPOSED SURRY UNITS 1 AND 2 UFSAR UPDATE (FINAL)

Virginia Electric and Power Company
(Dominion Energy Virginia)
Surry Power Station Units 1 and 2

Note to As-Builder:
RED changes are associated with SPS-UCR-2020-009
BLUE changes are associated with this UCR

REPLACE

REMOVE

Chapter 6: Engin

List of F

Figure 6.3-1a Unit 1 Containment Spray Subsystem 6.3-26a

REMOVE

Figure 6.3-1b Unit 2 Containment Spray Subsystem 6.3-26b

REMOVE

INSERT

CHAPTER 6 ENGINEERED SAFEGUARDS

6.1 GENERAL DESCRIPTION

Note: As required by the Renewed Operating Licenses for Surry Units 1 and 2, issued March 20, 2003, various systems, structures, and components discussed within this chapter are subject to aging management. The programs and activities necessary to manage the aging of these systems, structures, and components are discussed in Chapter 18.

The engineered safeguards, together with the containment (Chapter 5), protect the public and the station in the event of the design-basis accident, as defined in Sections 14.5.1.2 and 14.5.5. The engineered safeguards are designed to minimize the accident by performing the following three functions:

1. Supply borated water to the reactor coolant system to cool the core, decrease reactivity, limit fuel rod cladding temperatures, limit the metal-water reaction, and ensure that the core remains intact.

2. Limit the driving potential, including differential pressure and time duration, for leakage out of the containment structure.

3. Reduce the concentration of airborne fission products available for leakage.

The first function is satisfied by the timely, continuous, and adequate supply of borated water to the reactor coolant system and the reactor core. The second function is satisfied by the provision of heat sinks for the condensation of steam released inside the containment, the inherent depressurization of the containment below atmospheric pressure following the design-basis accident, and means for maintaining the containment at subatmospheric conditions for an extended period of time. The third function is satisfied by providing chemical additives (NaOH) to the containment spray to enhance the spray removal of radioactive iodine from the containment atmosphere.

REMOVE

(Unit 2)

INSERT

(NaTB) to the sump water which is recirculated by the ECCS and recirculation spray systems (Unit 1) or

REMOVE

The engineered safeguards system

1. A safety injection system (Section 6.2) that injects borated water into the cold legs of all three reactor coolant loops.

2. Two separate low-head safety injection subsystems, either of which provides long-term removal of decay heat from the reactor core.

3. Two separate subsystems of the spray system (containment spray and recirculation spray) that operate together to reduce the containment temperature, return the containment pressure to subatmospheric, and remove heat from the containment. The recirculation spray subsystem maintains the containment subatmospheric and transfers heat from the containment to the service water system (Section 9.9).

A composite schematic diagram of the engineered safeguards systems is shown in Figures 6.1-1 and 6.1-2 for Units 1 and 2, respectively.

The safety injection system provides for the charging of borated water to the reactor coolant system from the accumulators following a LOCA. The three accumulators are self-contained and are designed to supply water as soon as the reactor coolant system pressure drops below 600 psig. Additional makeup to the reactor coolant system is provided by the charging pumps, operating in the safety injection mode, and the low-head safety injection pumps. Both the charging and low-head safety injection pumps are located outside the containment, are driven by an electric motor, are capable of being rapidly energized or operated, and are powered from the emergency power buses. The pumps also ensure an adequate supply of borated water for an extended period of time by recirculating water from the containment sump to the reactor core through two separate flow paths.

The containment spray subsystem supplies chilled borated water to the containment immediately following the receipt of the safeguards initiation signal. This subsystem includes two full-capacity, electric-motor-driven containment spray pumps that are located outside the containment and are supplied with power from the emergency buses. The containment spray pumps supply chilled water from the refueling water storage tank to the containment. Either pump is capable of furnishing sufficient spray water to prevent overpressurizing the containment structure. A chemical addition tank is balanced hydraulically with the refueling water storage tank and provides a flow of sodium hydroxide solution to increase the alkalinity of the containment spray and recirculated spray to ensure effective removal of radioactive iodine. (Unit 2)

REMOVE INSERT REMOVE

The recirculation spray subsystem recirculates water from the containment sumps through service-water-cooled recirculation spray heat exchangers to the recirculation spray headers. Two of the four 50% design capacity, motor-driven recirculation spray pumps are located outside the containment. All four of the recirculation spray coolers are located inside the containment and transfer containment heat to the service water system (Section 9.9).

The containment spray and recirculation spray subsystems are capable of reducing the containment pressure to subatmospheric in less than 60 minutes, thus terminating all outleakage to the environment. This original design criterion was modified in conjunction with the analyses for implementation of the alternative source term. The modified criteria require that, following the LOCA, the containment pressure be less than 1.0 psig within 1 hour and less than 0.0 psig within 4 hours. The radiological consequences analysis demonstrates acceptable results provided the containment pressure does not exceed 1.0 psig for the interval from 1 to 4 hours following the Design Basis Accident. Beyond 4 hours, containment pressure is assumed to be less than 0.0 psig, terminating leakage from containment.

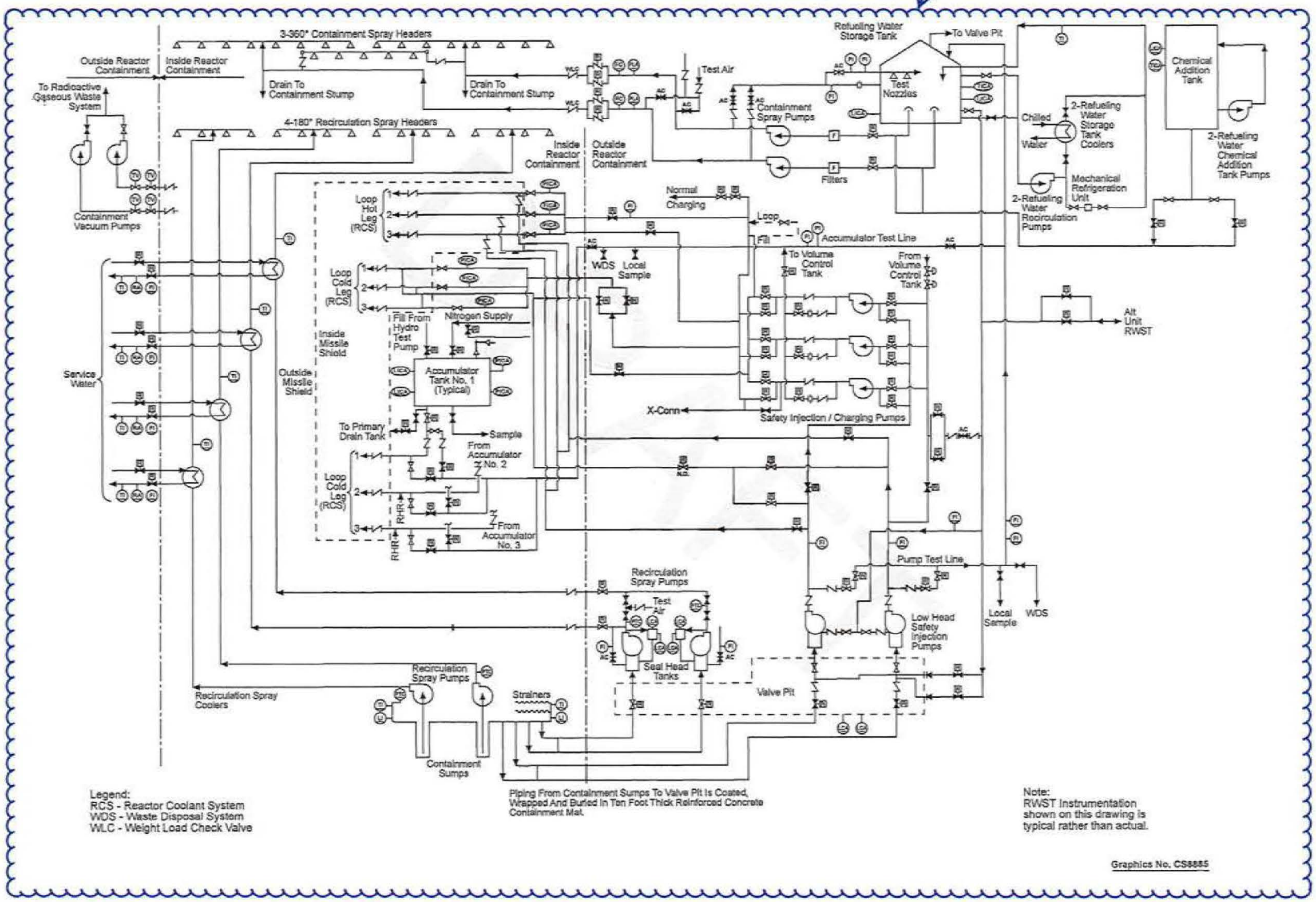
REMOVE INSERT

The containment vacuum system removes any subsequent air inleakage after the containment pressure has been reduced to subatmospheric. Because of the inherent low-leakage design of the containment, the use of the vacuum pumps will probably not be required for several

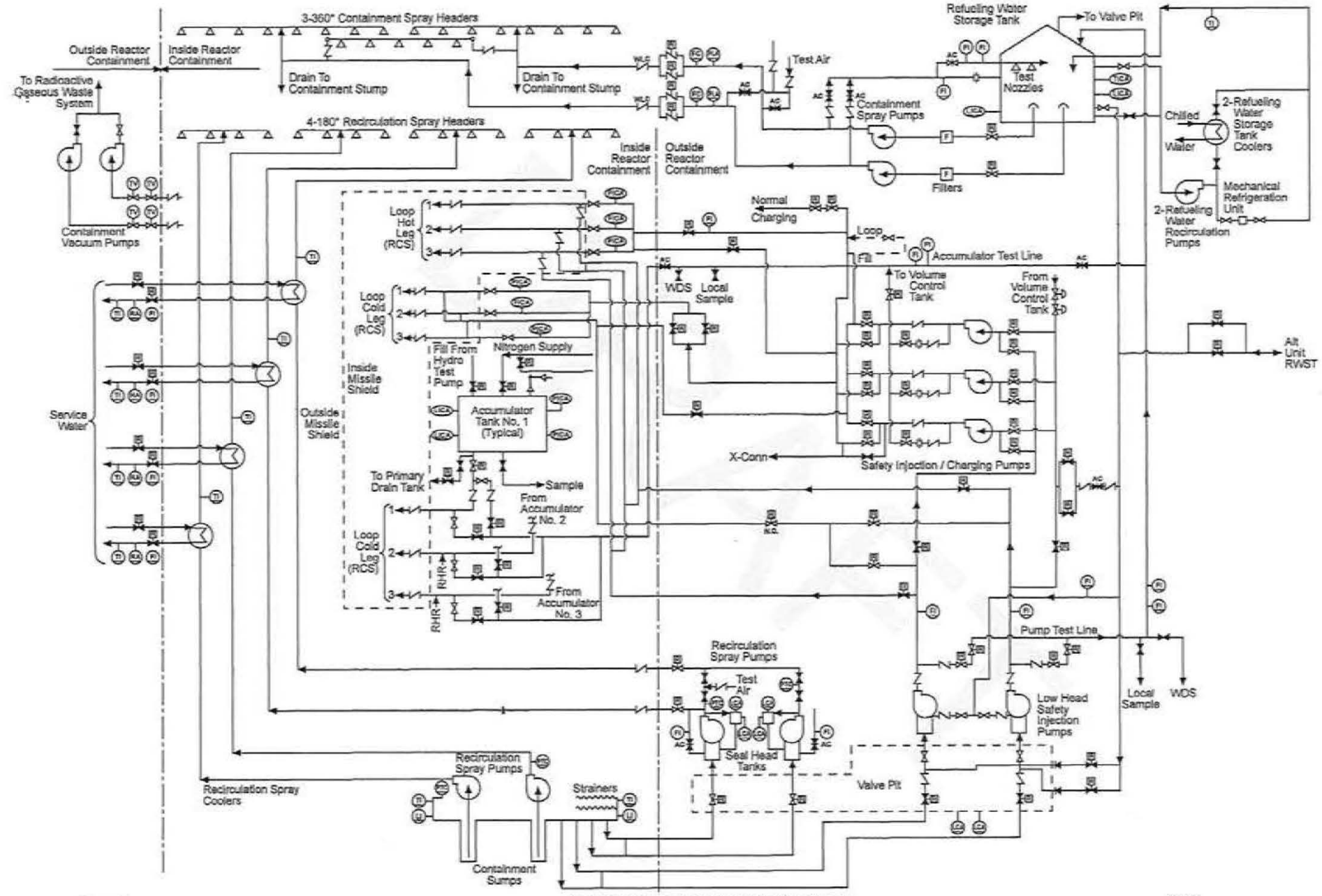
Sodium Tetraborate Decahydrate (NaTB) is stored in baskets inside containment to increase the alkalinity of the sump water produced during an event which exceeds the CLS high-high containment pressure actuation setpoint, which is recirculated by the recirculation spray subsystem to ensure effective removal of radioactive iodine (Unit 1).

REPLACE WITH INSERT A

Figure 6.1-2
UNIT 2 ENGINEERED SAFEGUARDS SYSTEMS



INSERT A



Legend:
RCS - Reactor Coolant System
WDS - Waste Disposal System
WLC - Weight Load Check Valve

Note:
RWST Instrumentation shown on this drawing is typical rather than actual.

Graphics No. CS8885

The following information is HISTORICAL and is not intended or expected to be updated for the life of the plant.

1. Two production line motors were used for this test. One was exposed to a total of 1.5×10^8 rad of gamma radiation in approximately one month. The other motor was used for the final comparative analysis.
2. Both motors were tested for coil resistance by the Wheatstone bridge method, and for insulation resistance by meggering both before and after motor vibration and reversing operations.

The compatibility of construction materials with a postaccident solution of boric acid and sodium hydroxide is discussed in WCAP-7153.

REPLACE 12 REPLACE

sodium hydroxide, and boric acid and sodium tetraborate decahydrate is discussed in WCAP-7153 (Reference 12) and WCAP-16596 (Reference 13), respectively.

The recirculation spray sump in containment is maintained wet to provide a water seal to reduce the potential for pressure locking the LHSI pumps containment suction MOV's (Reference 9).

6.2.2.2.5 Manual Valves

The stainless steel manual globe, gate, and check valves are designed and built in accordance with the requirements outlined in the motor-operated valve description above (Section 6.2.2.2.4).

REMOVE

The carbon steel valves are built to conform with USAS B16.5. The materials of construction of the body, bonnet, and disk conform to the requirements of ASTM A105, Grade II; A181, Grade II; or A216, Grade WCB or WCC. The carbon steel valves pass only non-radioactive gases and were subjected to hydrostatic test as outlined in MSS-SP-61, except that the test pressure was maintained for at least 30 minutes.

6.2.2.2.6 Vent Valves

High point vents have been installed at critical points in the suction lines of the charging (HHSI) pumps, and the discharge lines of the LHSI pumps where gasses could collect.

6.2.2.2.7 Accumulator Check Valves

The pressure-containing parts of these valve assemblies are designed in accordance with MSS SP-66. Parts in contact with the operating fluid are of austenitic stainless steel or of equivalent corrosion-resistant materials procured to applicable ASTM or Westinghouse specifications.

The three combinations (Bars A, B, and C) represent degraded cases with operation of less than the installed emergency core cooling equipment. These cases are shown only to present the capability of individual portions of the system and to demonstrate the overall margins of the system. The operation of one safety injection charging pump together with two accumulators is probably capable of providing protection over a considerably greater range than shown. However, the analysis has only considered breaks up to the 8-inch diameter.

Bar D, which is the combination of the safety equipment in Bars B and C, and which also represents the minimum engineered safeguards available automatically, provides protection as shown over the complete range of break sizes up to and including the complete circumferential fracture of a reactor coolant pipe.

For the small range of break sizes up to 2 inches, as shown in Bar A, the action of one safety injection charging pump acting alone is sufficient to maintain enough core water inventory to ensure continued core cooling.

6.2.3.2 Borated Water Injection Chemistry

During the injection of emergency cooling water into the reactor coolant system following a LOCA, the concentration of boron will vary depending on the depressurization history of the reactor. If depressurization were slow, the high-head pumps would inject boric acid at a concentration greater than 2300 ppm, which would be diluted by the coolant remaining in the system. Rapid depressurization would bring about early injection of water containing boric acid at a concentration greater than 2250 ppm from the accumulators. When recirculation begins, the average concentration of boric acid is (and will remain) at a concentration that will maintain the core subcritical.

The concentrations of other materials, including chlorides, are quite low in this solution, corrosion products being generally insoluble in a basic solution. Assuming 50% of the maximum core inventory is released to containment after a LOCA, the principal fission product in the sump (assuming a gross core failure) would be iodine at a range between approximately 1.6 to 1.9 ppm for 500 days of operation and approximately 3.0 to 3.6 ppm for 1000 days of operation. The temperature of the sump water is reduced below 150°F, under normal operating conditions with a minimum of two recirculation coolers in operation, after a relatively short period of time (i.e., a few hours). Below 150°F, chloride stress corrosion does not constitute a problem.

REMOVE

REPLACE

4.25 and 4.75 (Unit 1) and 8.5 and 10.5 (Unit 2)

REMOVE

6.2.3.3 Chemical Additives

Containment transient analyses show that the chemical additive spray (containment spray), having a pH between 8.5 and 10.5, will be used for approximately 1½ hours if minimum safeguards operate and approximately 50 minutes if normal safeguards operate. During this period, the containment will be cooling from 280°F to approximately 140°F. At the end of the initial containment cooling period, lasting no longer than approximately one hour, the recirculation spray system will continue in service for an indefinite period; however, the pH of the

INSERT during the long-term postaccident period REMOVE INSERT box and italicized text

recirculating spray fluid should be between 7.0 and 9.0 and further addition of chemical spray additives is not contemplated.

ADD Insert B

The following information is only applicable to Unit 2.

Sodium hydroxide is normally stored for many industrial applications in atmospheric-vented tanks. Reaction of sodium hydroxide with atmospheric carbon dioxide to form a large precipitate does not occur. However, to eliminate particulate matter from any potential source, the containment spray subsystem includes a strainer on the suction side of the containment spray pumps. This strainer will have openings smaller than the smallest spray nozzles, and therefore will remove any particulate matter from the containment spray flow that might prevent the system from functioning.

To illustrate the remoteness of a CO_2 + NaOH reaction, calculations were made based on the following assumptions:

1. The tank temperature varies from 35° to 95°F each day, causing the tank to breathe.
2. All CO_2 entering the tank reacts with the caustic.

The calculations indicate that this process must continue for 90 years to react with 1% of the stored caustic. This reaction would not cause a precipitate to form.

Based on past operating experience and calculational results, a sodium carbonate precipitate cannot form; therefore, the functioning of the system will not be impaired because of precipitation.

The major construction materials that will be exposed to the containment spray solution and the corrosion or deterioration rates for each under maximum exposure conditions, are listed in Table 6.2-7.

REMOVE REMOVE REPLACE containment

The materials adversely affected by the chemical additive spray are aluminum and zinc.

containment

The time-temperature exposure conditions under which these materials will be exposed to the chemical additive spray are from approximately 50 minutes to 1½ hours, with the temperature decreasing from 280° to 140°F.

The materials will also be exposed to the recirculation sprays, which have a pH between 7.0 and 9.0 for the postaccident recirculation period with the temperature at approximately 140°F.

The consequence of corrosion and/or deterioration on materials with regard to postaccident operation of the engineered safeguards is negligible because components of the engineered safeguards are constructed of stainless steel.

REMOVE

The corrosion rate of stainless steel is low enough in the spray solution to be of no practical concern (Reference 1).

REMOVE box and italicized text only

Insert B

The following information is only applicable to Unit 1

Sodium Tetraborate Decahydrate stored inside containment is a white crystalline chemical in granular form. The NaTB is stored inside baskets which contain the chemical until it is dissolved by the containment sump water. To eliminate particulate matter from any potential source, the containment spray subsystem includes a strainer on the suction side of the containment spray pumps. This strainer will have openings smaller than the smallest spray nozzles, and therefore will remove any particulate matter from the containment spray flow that might prevent the system from functioning. Additionally, using NaTB as a buffer does not result in any different precipitates than those that form with the original NaOH buffer and the amount of precipitates is reduced, resulting in lower strainer head losses. Therefore, the functioning of the system will not be impaired because of precipitation.

6.3 CONSEQUENCE-LIMITING SAFEGUARDS

6.3.1 Spray System

6.3.1.1 Design Bases

The spray system consists of the containment spray subsystem and the recirculation spray subsystem, which are designed to provide the necessary cooling and depressurization of the containment after any LOCA. Spray system component data are given in Table 6.3-1.

Safety related components, piping, valves, and supports in the spray system are Seismic Category I.

The subsystems, operating together, cool and depressurize the containment to subatmospheric pressure following the design-basis accident.

The recirculation subsystem is, in addition, capable of maintaining the subatmospheric pressure in the containment for an extended period following the design-basis accident.

REMOVE

INSERT

The removal of radioactive iodine from the containment atmosphere after a design-basis accident is accomplished through the addition of sodium hydroxide solution to the containment spray (Section 14.5.4).

INSERT

(Unit 2)

The spray system is designed to depressurize the containment to subatmospheric pressure with any one of the two containment spray pumps operating and only two of the four recirculation spray pumps operating.

dissolution of sodium tetraborate decahydrate into the containment sump water which is used by the recirculation spray subsystem (Unit 1) and the

REMOVE

6.3.1.2 Spray System Components

The spray system is designed, fabricated, inspected, and installed to meet the requirements of the General Design Criteria, as discussed in Section 1.4. The spray subsystems and their components are considered to be essential to accident prevention and/or the mitigation of accident consequences that could affect the public health and safety.

REMOVE

6.3.1.2.1 Pumps and Valves

The spray pumps and valves are fabricated, welded, and inspected according to the requirements of the applicable portions of the ASME Code, Sections III, VIII and IX. Materials of construction are stainless steel or equivalent corrosion-resistant materials.

Valve packing and pump seals are selected to minimize or eliminate leakage where necessary. Motor-operated valve operators are selected because their proven superior reliability in past applications ensures reliable valve operation under incident conditions.

The Teflon sleeve and packing of the outside recirculation spray system suction valves have been changed to XOMOX 7. This change reflects the review performed in accordance with NUREG-0578, Section 2.1.6.b. In this review it was found that the valves would be located in a

high-radiation area as a result of a LOCA. The Teflon material is satisfactory to only 1×10^4 rads, whereas the XOMOX 7 material is satisfactory to 8×10^6 rads. The expected 60-year normal plus postaccident integrated radiation dose in this area is conservatively estimated not to exceed 8×10^6 rads.

REPLACE

The containment spray system piping and equipment are fabricated of ASTM A358, Type 304 stainless steel, or equivalent, which has a corrosion rate of less than 0.0001 in/yr at the ~~system operating conditions of 45°F temperature~~ and 8.7 to 10.4 pH.

4.25 to 4.75 pH (Unit 1) and 8.7 to 10.4 pH (Unit 2)

REMOVE REPLACE

The recirculation spray system piping and equipment are also fabricated of Type 304 or Type 316L stainless steel, or equivalent, except for the Recirculation Spray Heat Exchanger (RSHX) tubing which is titanium, and the spray nozzles which are brass. System operating conditions are 200° to 130°F temperature and 7.7 to 8.5 pH during the long-term postaccident period.

REPLACE Per NUREG-0800 (Reference 11), stress 7.0 to 9.0 pH (Unit 1) and 7.7 to 8.5 pH Unit 2)

Stress corrosion cracking of austenitic stainless steel is inhibited in boric acid, sodium hydroxide solutions in the hypothetical environment after the design-basis accident, when the pH is 8.0 or greater.

REMOVE 7.0 REPLACE borated

The systems operate at a relatively low pressure of approximately 100 psi gauge and are not highly stressed during operation, so that the inducement toward cracking is reduced.

Because the pH of the containment spray solution is above 8.0 and the recirculation spray solution pH is essentially 8.0, the potential for caustic stress corrosion cracking in the containment spray system and recirculation spray system is virtually nonexistent.

6.3.1.2.2 M…

The potential for caustic stress corrosion cracking in the containment spray system and recirculation spray system is virtually nonexistent because of the following:

1. The short duration of containment spray system operation (Unit 1)
2. The pH of the containment spray solution is above 7.0 (Unit 2)
3. The recirculation spray solution pH is above 7.0 during the long-term postaccident period (Unit 1 and Unit 2)

Electri… IEEE, and N… is such that n…

REMOVE

Windi… calculated to occur under design-basis accident conditions. This type of insulation is used in motors located inside containment.

REMOVE REPLACE

2.

REPLACE

The containment motors have been selected to ensure operation during LOCA conditions. Motor electrical insulation is in accordance with ANSI, IEEE, and NEMA standards. The motors are tested as required by these standards. Bearings are antifriction type. Bearing loading and high-temperature tests have been performed, and the expected bearing life equals, or exceeds, that specified by the Anti Friction Bearing Manufacturers Association (AFBMA).

6.3.1.2.3 Piping

Piping fabrication, installation, and testing are in accordance with the Specification for Power Plant Piping, ANSI B31.1, with supplemental requirements and inspections as necessary

The suction lines between the containment sump and the ORS pumps are cross connected. This design feature was originally provided to ensure a supply of water to each pump in the event that the suction of either pump become clogged. The current common header strainers that protect the pump suction lines are designed to withstand the full debris load that could be generated by a LOCA.

The design data of the spray system components are given in Table 6.3-1.

6.3.1.3 **Description**

6.3.1.3.1 Containment Spray System

The containment spray system consists of two completely separate trains of spray rings located in the containment dome and one common spray ring located outside the crane wall. Each train is rated at 100% capacity. The recirculation spray system is composed of two trains, each consisting of an inside recirculation spray subsystem and an outside recirculation spray subsystem. Each subsystem is approximately 50% capacity, and consists of one recirculation spray pump, one recirculation spray heat exchanger (RSHX), and one 180° coverage spray header with nozzles.

REPLACE

An additional ring header common to both containment spray trains is installed at Elevation 95 ft. 6 in. outside the crane wall. Check valves are installed in each branch connection from the riser to the common header to limit fill time, should one containment spray pump train fail to start.

REPLACE Figure 6.3-1 → Figure 6.3-1a (Unit 1) and Figure 6.3-1b (Unit 2)

The containment spray subsystem is shown in Figure 6.3-1 and the recirculation spray subsystem is shown in Figure 6.3-2. Elevations of all piping and components of these subsystems are shown in Figure 6.3-4.

REMOVE (Unit 2 only) INSERT (Unit 2 only) REMOVE

Each of the containment spray headers draws water independently from the refueling water storage tank. The sodium hydroxide solution used for iodine removal from the containment atmosphere is added to the containment spray water by a balanced gravity feed from the chemical addition tank. The refueling water storage tank is a vertical cylinder with a flat bottom and a dome top, and is secured to a reinforced-concrete foundation. The refueling water storage tank is fabricated of ASTM A240, Type 304L stainless steel, in accordance with API STD-650. The requirements for welding, welding procedures, welder qualification, weld point efficiency, and weld inspection are in accordance with Section IX of the ASME Code and the Specification for Field Fabricated Storage Tanks (Reference 4). The chemical addition tank is a vertical cylindrical vessel with flanged and dished heads mounted on a skirt and secured to the reinforced concrete foundation. The chemical addition tank is fabricated of ASTM A240, Type 304 stainless steel in accordance with Section VIII of the ASME Code.

Both tanks are designed as Class I components, as described in Section 2.5, to withstand design seismic loading in accordance with the design stress criteria of ASME Code Section III, Figure N-414, *Nuclear Vessels*. The connecting piping is designed to withstand seismic loading to

REPLACE → The refueling water storage tank is designed as a Class I component

ensure the functioning of the system. The refueling water storage tank is provided with a manhole for inspection access.

Prior to unit operation, the water in the refueling water storage tank is cooled to a temperature of slightly below 45°F by either circulating the water through a heat exchanger that uses chilled water from the chilled water subsystem of the component cooling system (Section 9.4) or by using mechanical refrigeration units. Mechanical refrigeration units then maintain the tank water below 45°F. The tank is insulated. The refueling water storage tank also has a nozzle connection that supplies water to the safety injection system (Section 6.2).

The refueling water storage tank (RWST) is a passive component and is required only during a short period following an accident. It is provided with four channels of level indication, which provide signals to level indicators. The level indication range for the RWST is approximately 14,000 gallons at 0% level to approximately 399,000 gallons at 100% level. The RWST is maintained at greater than 387,100 gallons of borated water at or below a temperature of 45°F during normal plant power operations. Level transmitters provide input to a low level alarm and an empty alarm when RWST level drops below these respective setpoints. When two of four channels have sensed a low RWST level condition, an interlock signal is generated to allow for the start of the IRS and ORS pumps on a CLS Hi-Hi Actuation. Additionally, when two of four channels have sensed a low-low RWST level condition, a signal is generated to realign safety injection to the recirculation mode automatically. It takes approximately three minutes to realign the valves from injection to recirculation mode. The key values for the RWST assumed in the safety analysis are presented in Table 5.4-17. The safety analysis values are conservative with respect to plant operation.

REMOVE

(Unit 2 only) INSERT

The chemical addition tank is located close to the refueling water storage tank. The normal operating capacity of the CAT, including instrument uncertainties, is greater than the minimum CAT volume of 3800 gallons assumed in the safety analysis. Flow of the sodium hydroxide solution is from the chemical addition tank directly to the containment spray pump suction via a caustic addition line. This flow path provides for a reduced caustic transit time and introduces the caustic at an essentially constant rate. The constant addition rate provides for a more constant spray pH during the various modes of safeguards system operation.

(Unit 2 only) INSERT

A line from the chemical addition tank circulating pump is installed to permit periodic circulation of caustic solution in the piping and maintain the capability of recirculating the chemical addition tank.

(Unit 2 only) INSERT

The chemical addition tank is insulated and the recirculation line is electrically heat traced to keep the tank and recirculation line contents at a temperature well above the freezing point of the chemical spray solution. The chemical addition tank has a low-temperature alarm set at 35°F.

The containment spray pumps are capable of supplying approximately 3200 gpm of borated water to two separate circular containment spray ring headers located approximately 96 feet above the operating floor in the dome of the containment structure and the common crane wall

Note to As-Builder:
This page is included for reference only

The recirculation spray subsystem nozzles will be subject to an inspection or smoke or air test following maintenance or an activity which could cause blockage to provide indication that plugging of the nozzles has not occurred. The testing of system controls is discussed in Section 7.5.

Electrical insulation resistance tests are performed during the lifetime of the RS motors to verify the integrity of the insulation. Periodic tests are also performed to ensure the motors remain in a reliable operating condition.

The Recirculation Spray System is subject to the applicable inservice inspection and inservice testing requirements of the ASME Code, as required by 10 CFR 50 (Code of Federal Regulations, Title 10, Part 50).

6.3 REFERENCES

1. NRC Bulletin No. 93-02: *Debris Plugging of Emergency Core Cooling Suction Strainers,* dated May 11, 1993.
2. Letter from Virginia Electric and Power Company to the NRC, dated June 10, 1993, Serial No. 93-307, *Response to NRC Bulletin 93-02.*
3. Letter from Virginia Electric and Power Company to USNRC dated February 7, 1996 (Serial No. 95-566A), *Generic Letter 95-07 Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves, Surry and North Anna Power Station.*
4. Stone & Webster Specification NUS-258, *Specification for Field Fabricated Storage Tanks*, Revision 2.
5. NRC Generic Letter GL 2004-02, *Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors*, dated September 13, 2004.
6. Nuclear Energy Institute (NEI) Document NEI 04-07, *Pressurized Water Reactor Sump Performance Evaluation Methodology*, dated December 2004.
7. Safety Evaluation by the Office of Nuclear Reactor Regulation Related to NRC Generic Letter 2004-02, *Nuclear Energy Institute Guidance Report Pressurized Water Reactor Sump Performance Evaluation Methodology.*
8. Letter from Dominion Resources Inc. to the NRC, dated September 1, 2005, Serial No. 05-212, *Response to NRC Generic Letter 2004-02.*
9. Westinghouse Document WCAP-16406-P, Revision 1, *Downstream Wear Evaluation Methodology for Containment Sump Screens in Pressurized Water Reactors.*
10. Westinghouse Document WCAP-16793-NP, Revision 0, *Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid.*

ADD
Insert C

Insert C

REMOVE

11. U.S. Nuclear Regulatory Commission Standard Review Plan NUREG-0800, Chapter 6, Section 6.1.1, Rev 2, *Engineered Safety Features Materials.*

12. WCAP-7153, *Investigation of Chemical Additives for Reactor Containment Sprays*, dated March 1968.

13. WCAP-16596-NP, Revision 0, *Evaluation of Alternative Emergency Core Cooling System Buffering Agents*, dated July 2006.

12

REPLACE

Table 6.3-1 (CONTINUED)
SPRAY SYSTEM COMPONENT DATA

Chemical Addition Tank (Unit 2 only)	
Number	2 (1 per unit)
Type	Vertical cylindrical
Capacity	4311 gal
Design pressure	25 psig
Design temperature	150°F
Material	SS 304
Design code	ASME Section VIII
Operating pressure	Atmospheric
Operating temperature	Ambient
NaOH concentration	17-18%
Chemical Addition Tank Pump (Unit 2 only)	
Number	2 (1 per unit)
Type	Vertical centrifugal
Rated flow	50 gpm
Rated head	7 ft
Theoretical horsepower	0.1 hp
Seal	Mechanical
Design pressure	225 psig
Material	
Pump casing	SS 316
Shaft	SAE 4140
Impeller	SS 316
Recirculation Spray System Strainer Assembly	
Number	1 (for both ORS and IRS Systems)
Material	SS 304
Design Code	ASME Section III, Subsection NF, Class 3
Structural DP	9.0 psid
Perforations	0.0625 in. diameter
Operating Pressure	9.0-59.7 psia
Operating Temperature	75-280°F
Fluid Flowing	Borated water

INSERT INSERT 1 REPLACE 1 REPLACE REMOVE

ADD Insert D

Piping

Piping is designed to the Code for Pressure Piping, ANSI B31.1.

Valves

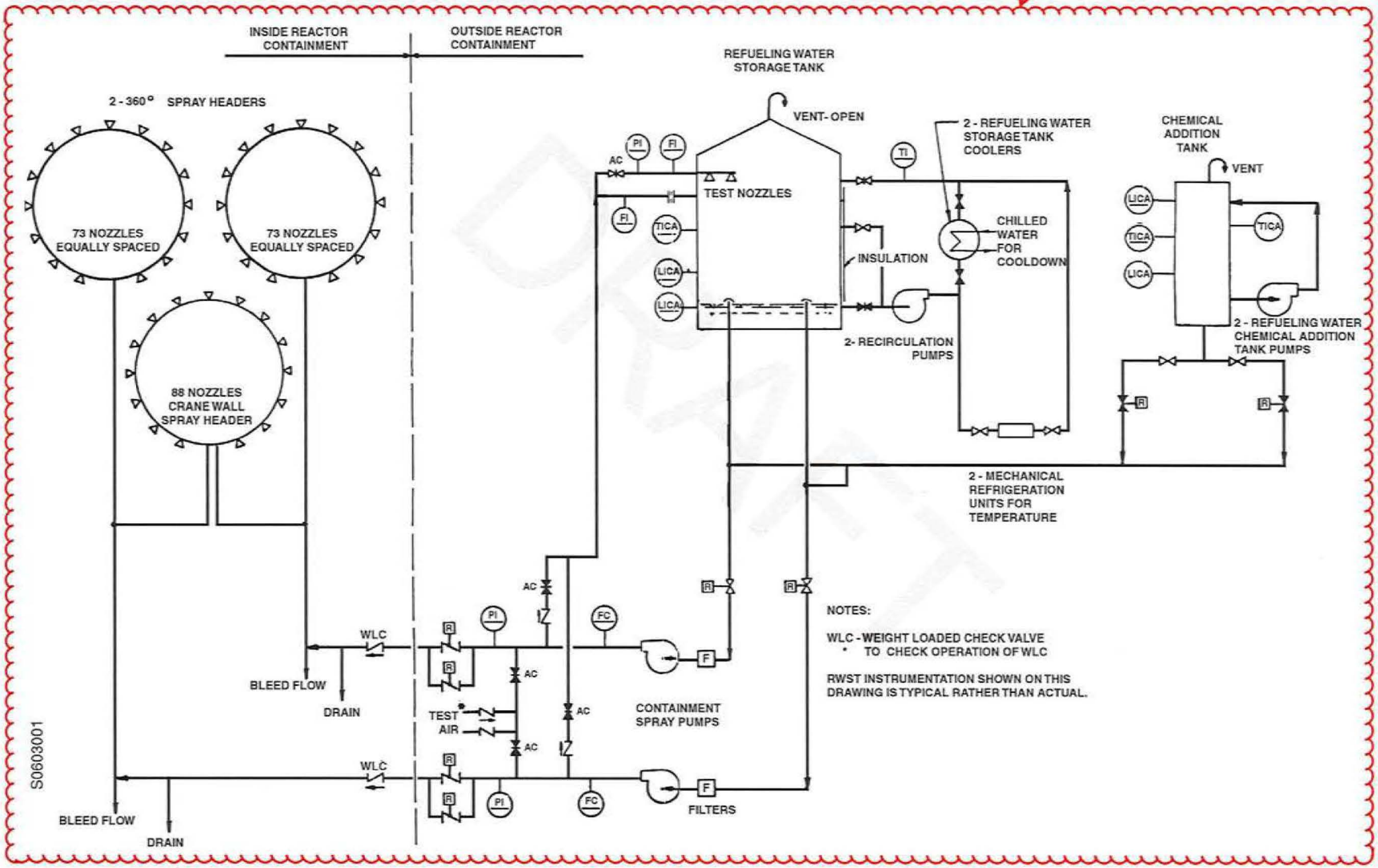
Recirculation Spray system valves are designed in accordance with ANSI B16.5, Steel Piping Flanges and Flanged Fittings, or ANSI B16.34, Steel Butt-Welded End Valves.

Insert D

Sodium Tetraborate Decahydrate Baskets (Unit 1 only)		REMOVE
Number	7	14 (7 per unit) REPLACE
Material		
Basket	SS 304	
Wheels	Duplex SS 2205	
Nominal size (internal dimensions)	6 ft x 5 ft x 1.5 ft	
Operating Pressure	9.0-59.7 psia	
Operating Temperature	75-280°F	
Technical Specification minimum	10760 lbm	(total per unit) INSERT
Chemical Grade	SQ Granular	
Chemical Specification		
B_2O_3	36.5-38.3%	
Equivalent $Na_2B_4O_7 \cdot 10H_2O$	99.9-105.0%	
Na_2O	16.2-17.1%	
SO_4	≤ 3.0 ppm	
Cl	≤ 0.4 ppm	
Fe	≤ 2.0 ppm	
Chemical Sieve Specification		
Standard No.	8	
Retained	≤ 0.1%	

REPLACE 6.3-1 → 6.3-1a REPLACE
INSERT Unit 1 REMOVE
REPLACE WITH INSERT E

Figure 6.3-1
CONTAINMENT SPRAY SUBSYSTEM



REPLACE 6.3-26 → 6.3-26a REPLACE

REMOVE FIGURE AND PAGE

ADD NEW FIGURE 6.3-1b ON NEW PAGE AFTER FIGURE 6.3-1a

Figure 6.3-1b
UNIT 2 CONTAINMENT SPRAY SUBSYSTEM

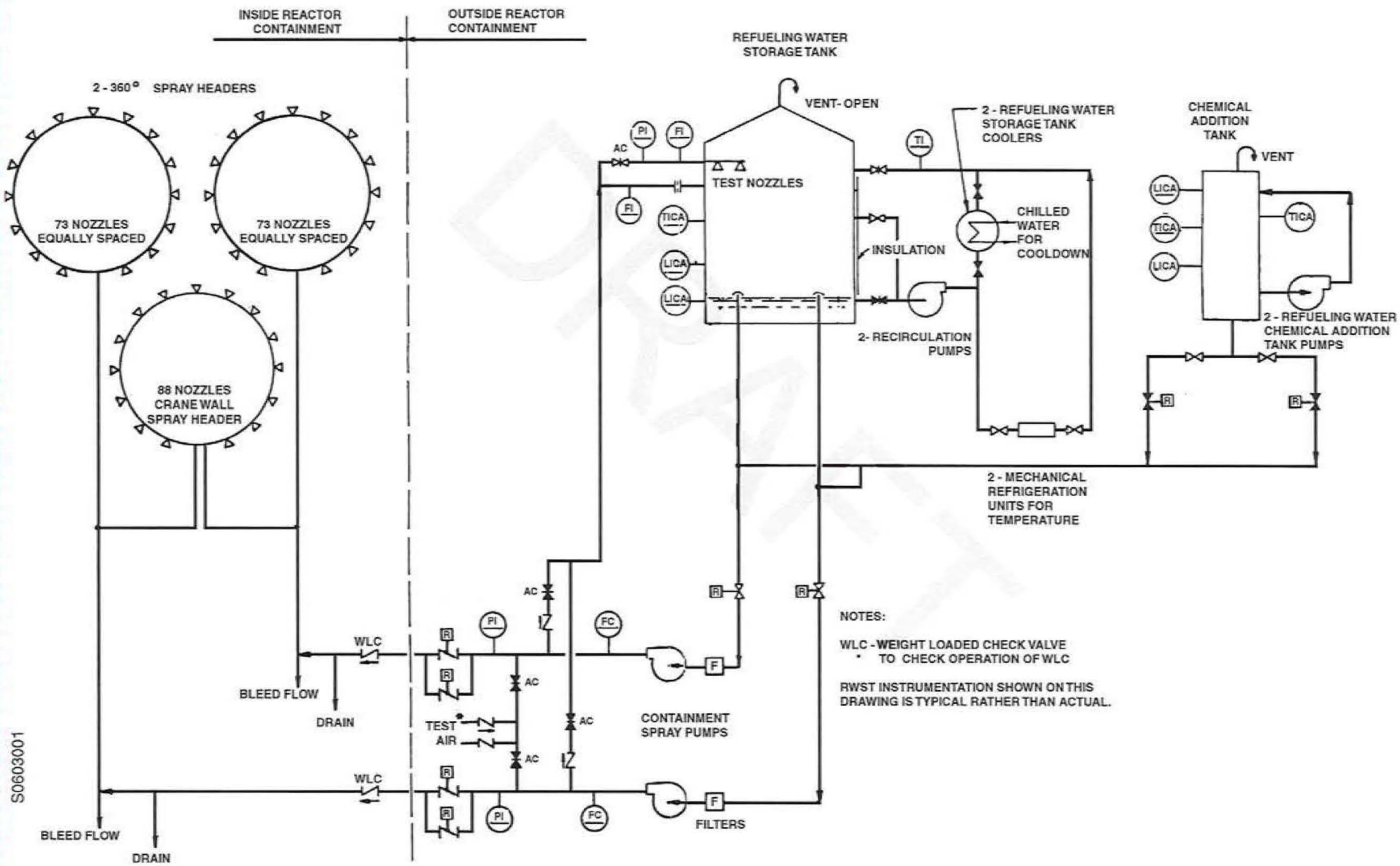


Table 7.5-2 (CONTINUED)
VALVES/DAMPERS ACTUATED BY ENGINEERED SAFEGUARDS SIGNALS

2-CS-MOV-202A[d]
2-CS-MOV-202B[d]
REPLACE
REMOVE

Designation (Valve or Damper Tag No.) (Similar for Unit 2)	Service (Actuated Valve or Damper Description)	Function (Actuated Valve or Damper Position)	Signal (Actuation Signal)	Override/Bypass (Override or bypass condition following actuation)
1-CS-MOV-101A [a]	Cont spray pump A discharge isolation valve	Open	CLS-HiHi	None
1-CS-MOV-101B [a]	Cont spray pump A discharge isolation valve	Open	CLS-HiHi	None
1-CS-MOV-101C [a]	Cont spray pump B discharge isolation valve	Open	CLS-HiHi	None
1-CS-MOV-101D [a]	Cont spray pump B discharge isolation valve	Open	CLS-HiHi	None
1-CS-MOV-102A [a]	Cont spray chem add tank isolation valve	Open	CLS-HiHi	None
1-CS-MOV-102B [a]	Cont spray chem add tank isolation valve	Open	CLS-HiHi	None
1-CV-TV-150A	Cont vacuum pump B outside cont isolation valve	Closed	SI	None
1-CV-TV-150B	Cont vacuum pump B outside cont isolation valve	Closed	SI	None
1-CV-TV-150C	Cont vacuum pump A outside cont isolation valve	Closed	SI	None
1-CV-TV-150D	Cont vacuum pump A outside cont isolation valve	Closed	SI	None
1-CW-MOV-100A [a]	Circ water condenser outlet isolation valve	Closed	CLS-HiHi *	None
1-CW-MOV-100B [a]	Circ water condenser outlet isolation valve	Closed	CLS-HiHi *	None
1-CW-MOV-100C [a]	Circ water condenser outlet isolation valve	Closed	CLS-HiHi *	None
1-CW-MOV-100D [a]	Circ water condenser outlet isolation valve	Closed	CLS-HiHi *	None
1-CW-MOV-106A [a]	Circ water condenser inlet isolation valve	Closed	CLS-HiHi *	None

a. These circuits have features that could prevent immediate operation of the component when the engineered safeguards signal is actuated. Such features are a necessary part of the circuit (such as a limit switch), or they require conscious effort by an operator to prevent operation (such as manipulation of a pushbutton or a selector switch). A valve limit switch could act to delay safeguards-initiated operation if the valve was in mid-travel and had to complete the travel sequence before operating in response to the safeguards signal. A pushbutton or selector switch held in the actuated position gives the operators an option, in some cases, of delaying component response to an emergency safeguards signals.

b. A key-operated switch is under administrative control to prevent inadvertent component operation and to satisfy the requirements of IEEE Standard 279-1971.

c. A mode switch is under administrative control to prevent inadvertent alignment of this damper during refueling (Section 9.13.4.1).

d. The valve tag number listed is for Unit 2 because there is no equivalent valve tag number for Unit 1.

INSERT

REMOVE

Table 15.2-1 (CONTINUED)
STRUCTURES, SYSTEMS, AND COMPONENTS DESIGNED FOR SEISMIC AND TORNADO CRITERIA

(Refer to the equipment classification list (Q-list) for a more comprehensive list of components. See Note 1.)

Item	Earthquake Criterion	Tornado Criterion	Sponsor[a]	Note
c. Pressurizer surge line was reanalyzed per NRC Bulletin 88-11, dated December 20, 1988.				
Systems (continued)				
Reactor coolant system (continued)				
Pressurizer safety and relief valves	I	P	W	
Safety injection system				
Accumulators and supports	I	NA	W	
Low-head safety injection pumps and piping	I	P	W	P for containment integrity
Boric acid injection tanks and piping	I	P	W	
Piping, valves, and supports	I	NA	SW	Except drain/sample lines
Containment spray system				
Refueling water storage tank	I	NA	SW	
Containment spray pumps	I	NA	SW	
Piping, valves, and supports	I	NA	SW	Except recirculation lines
Refueling water chemical addition tank (Unit 2) INSERT	I	NA	SW	
Recirculation spray systems				
Recirculation spray pumps and piping	I	P	SW	P for containment integrity
Recirculation spray heat exchangers	I	NA	SW	
Reactor containment sump and screens	I	NA	SW	
Piping, valves, and supports	I	NA	SW	

REMOVE

- Diesel-driven fire pump fuel oil storage tanks
- Refueling water storage tanks
- Chemical addition tanks

Chemical addition tank (Unit 2 only) REPLACE

REMOVE

- Emergency condensate storage tanks
- Fire Protection/Domestic water storage tanks (re-inspection required during the Period of Extended Operation)
- Emergency service water pump diesel fuel oil storage tank

An engineering evaluation may determine that the observed condition is acceptable or requires repair; or, in the case of degraded coatings, may direct removal of the coating, non-destructive examination of the substrate material, and replacement of the coating. Re-inspections are dependent upon the observed surface condition, and the results of this engineering evaluation. For the one-time inspections, tank conditions were confirmed to be acceptable, but the fire protection/domestic water storage tanks require re-inspection during the Period of Extended Operation. Corrective actions for conditions that are adverse to quality are performed in accordance with the Corrective Action System. Corrective action provides reasonable assurance that conditions adverse to quality are promptly corrected.

In addition to the one-time inspections of specified tanks, a second aspect of Item 10, Table 18-1 is to evaluate the need for ongoing inspections. The one-time inspection results for all tanks, except the fire protection/domestic water storage tanks, indicated acceptability during the complete Period of Extended Operation (PEO). The fire protection/domestic water storage tank will require re-inspection during the PEO based on an engineering evaluation of the one-time inspection results.

The combination of acceptable results from the one-time inspections, and the development of plans for future inspection of the fire protection/domestic water storage tanks, completes the tasks required for Item 10, Table 18-1.

18.1.4 Non-Environmental Qualification (EQ) Cable Monitoring

The purpose of the Non-EQ Cable Monitoring activities is to perform inspections on a limited, but representative, number or accessible cable jackets and connector coverings that are utilized in non-EQ applications (Item 19, Table 18-1). In order to confirm that ambient conditions are not changing sufficiently to lead to age-related degradation of the in-scope cable jackets and connector coverings, initial visual inspections for the non-EQ application insulated power cables, instrumentation cables, and control cables (including low-voltage instrumentation and control cables that are sensitive to a reduction in insulation resistance) are performed in accordance with a station procedure. Visual inspection of the representative samples of non-EQ power, instrumentation, and control cable jackets and connector coverings detect the presence of