2.2.6 Chemical and Volume Control System

Design Description

1.0 System Description

The chemical and volume control system (CVCS) is a non-safety-related system that provides some safety related functions. The CVCS provides the following safety-related functions:

- Boron dilution mitigation.
- Reactor coolant pressure boundary integrity.
- Charging flow isolation.

The CVCS provides the following non-safety-related functions:

- Pressurizer auxiliary spray.
- Reactor coolant pump seal water.
- Reactor coolant chemistry control.

2.0 Arrangement

2.1 The functional arrangement of the CVCS is as described in the Design Description of Section 2.2.6, Tables 2.2.6-1—CVCS Equipment Mechanical Design and 2.2.6-2—CVCS Equipment I&C and Electrical Design, and as shown on Figure 2.2.6-1—Chemical and Volume Control System Functional Arrangement.

2.2 Deleted.

3.0 Mechanical Design Features

3.1 Valves listed in Table 2.2.6-1 will be functionally designed and qualified such that each valve is capable of performing its intended function for a full range of system differential pressure and flow, ambient temperatures, and available voltage (as applicable) under design basis accident conditions.

3.2 Check valves listed in Table 2.2.6-1 will function to change position as listed in Table 2.2.6-1 under normal operating conditions.

3.3 Deleted.

3.4 Equipment identified as Seismic Category I in Table 2.2.6-1 can withstand seismic design basis loads without a loss of the function listed in Table 2.2.6-1.

3.5 Deleted.

3.6 Deleted.

3.7 Deleted.

3.8 Deleted.

3.9 Deleted.

3.10 Deleted.

3.11 Deleted.

3.12 Deleted.

3.13 Deleted.

3.14 Deleted.

3.15 ASME Code Class 1, 2 and 3 piping systems are designed in accordance with ASME Code Section III requirements.

3.16 As-built ASME Code Class 1, 2, and 3 components are reconciled with the design requirements.

3.17 Pressure-boundary welds in ASME Code Class 1, 2 and 3 components meet ASME Code Section III non-destructive examination requirements.

3.18 ASME Code Class 1, 2 and 3 components retain their pressure-boundary integrity at their design pressure.

3.19 ASME Code Class 1, 2 and 3 components are fabricated, installed, and inspected in accordance with ASME Code Section III requirements.

4.0 I&C Design Features, Displays, and Controls

4.1 Displays listed in Table 2.2.6-2 are indicated on the PICS operator workstations in the main control room (MCR) and the remote shutdown station (RSS).

4.2 Controls on the PICS operator workstations in the MCR and the RSS perform the function listed in Table 2.2.6-2.

4.3 Equipment listed as being controlled by a priority and actuator control system (PACS) module in Table 2.2.6-2 responds to the state requested and provides drive monitoring signals back to the PACS module. The PACS module will protect the equipment by terminating the output command upon the equipment reaching the requested state.

4.4 Interlocks for the CVCS initiate the following:

- Isolation of the charging pump suction from the volume control tank and normal letdown path during a boron dilution event by closure of the boron dilution valves.

- Isolation of the charging line by closure of the charging line containment isolation valves and pressurizer spray isolation valve.
- Isolation of the letdown line on a safety injection actuation signal by closure of the RC pressure boundary valves.

5.0 Electrical Power Design Features

5.1 Equipment designated as Class 1E in Table 2.2.6-2 are powered from the Class 1E division as listed in Table 2.2.6-2 in a normal or alternate feed condition.

5.2 Deleted.

6.0 Environmental Qualifications

6.1 Equipment designated as harsh environment in Table 2.2.6-2 will perform the function listed in Table 2.2.6-1 under normal environmental conditions, containment test conditions, anticipated operational occurrences, and accident and post-accident environmental conditions.

7.0 Equipment and System Performance

7.1 Deleted.

7.2 Class 1E valves listed in Table 2.2.6-2 will function to change position as listed in Table 2.2.6-1 under normal operating conditions.

7.3 Deleted.

7.4 The CVCS run-out flow does not exceed the design maximum allowable.

7.5 The CVCS charging pumps listed in Table 2.2.6-1 provide seal water flow for operation of the reactor coolant pumps.

Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.2.6-3 lists the CVCS ITAAC.

Table 2.2.6-1—CVCS Equipment Mechanical Design
Sheet 1 of 2

Description	Tag Number(1)	Location	ASME Code Section III	Function	Seismic Category
RC Pressure Boundary Valve	30KBA10AA001	Reactor Building	Yes	Close	I
RC Pressure Boundary Valve	30KBA10AA002	Reactor Building	Yes	Close	I
Regenerative Heat Exchanger	30KBA10AC001	Reactor Building	Yes	RCPB	I
#1 HP Cooler	30KBA11AC001	Reactor Building	Yes	RCPB	I
#2 HP Cooler	30KBA12AC001	Reactor Building	Yes	RCPB	I
Containment Isolation Valve	30KBA14AA002	Reactor Building	Yes	Close	I
Containment Isolation Valve	30KBA14AA003	Fuel Building	Yes	Close	I
Isolation valve to KTA	30KBA14AA009	Reactor Building	Yes	Close	I
Isolation valve to KTA	30KBA14AA011	Reactor Building	Yes	Close	I
Volume Control Tank	30KBA20BB001	Fuel Building	N/A	Storage Volume	N/A
Boron Dilution Valve	30KBA21AA001	Fuel Building	Yes	Close	I
Boron Dilution Valve	30KBA21AA009	Fuel Building	Yes	Close	I
Boron Dilution Valve	30KBA25AA017	Fuel Building	Yes	Close	I
#1 Charging Pump	30KBA31AP001	Fuel Building	N/A	Run	N/A
#2 Charging Pump	30KBA32AP001	Fuel Building	N/A	Run	N/A
Charging Line Containment Isolation Valve	30KBA34AA002	Fuel Building	yes	Close	I
Charging Line Containment Isolation Check Valve	30KBA34AA003	Reactor Building	Yes	Close	I
Charging Line Isolation Valve	30KBA34AA012	Reactor Building	Yes	Close	I
RC Pressure Boundary Check Valve	30KBA34AA018	Reactor Building	Yes	Close	I
RC Pressure Boundary Check Valve	30KBA34AA019	Reactor Building	Yes	Close	I

Table 2.2.6-1—CVCS Equipment Mechanical Design
Sheet 2 of 2

Description	Tag Number(1)	Location	ASME Code Section III	Function	Seismic Category
RC Pressure Boundary Check Valve	30KBA34AA020	Reactor Building	Yes	Close	I
RC Pressure Boundary Check Valve	30KBA34AA021	Reactor Building	Yes	Close	I
Pressurizer Spray Isolation Valve	30KBA35AA001	Reactor Building	Yes	Close	I
Pressurizer Spray Check Valve	30KBA35AA002	Reactor Building	Yes	Close	I
Seal Injection Containment Isolation Valve	30JEW01AA005	Fuel Building	Yes	Close	I
Seal Injection Containment Isolation Check Valve	30JEW01AA006	Reactor Building	Yes	Close	I
#1 RCP Seal Injection Flow Control Valve	30JEW11AA111	Reactor building	Yes	Open	I
#2 RCP Seal Injection Flow Control Valve	30JEW21AA111	Reactor Building	Yes	Open	I
#3 RCP Seal Injection Flow Control Valve	30JEW31AA111	Reactor Building	Yes	Open	I
#4 RCP Seal Injection Flow Control Valve	30JEW41AA111	Reactor Building	Yes	Open	I
RCP Seal Leak-off to KTA	30JEW50AA021	Reactor Building	Yes	Open, Close	I
RCP Seal Leak-off Containment Isolation Valve	30JEW50AA001	Reactor Building	Yes	Close	I
RCP Seal Leak-off Containment Isolation Valve	30JEW50AA002	Fuel Building	Yes	Close	I

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

Table 2.2.6-2—CVCS Equipment I&C and Electrical Design
Sheet 1 of 2

Description	Tag Number(1)	Location	IEEE Class 1E (2)	EQ – Harsh Env.	PACS	MCR/RSS Displays	MCR/RSS Controls
RC Pressure Boundary Valve	30KBA10AA001	Reactor Building	1^N 2^A	Yes	Yes	Position / Position	Open-Close / Open-Close
RC Pressure Boundary Valve	30KBA10AA002	Reactor Building	4^N 3^A	Yes	Yes	Position / Position	Open-Close / Open-Close
Containment Isolation Valve	30KBA14AA002	Reactor Building	1^N 2^A	Yes	Yes	Position / Position	Open-Close / Open-Close
Containment Isolation Valve	30KBA14AA003	Fuel Building	4^N 3^A	N/A	Yes	Position / Position	Open-Close / Open-Close
Boron Dilution Valve	30KBA21AA001	Fuel Building	4^N 3^A	N/A	Yes	Position / Position	Open-Close / Open-Close
Boron Dilution Valve	30KBA21AA009	Fuel Building	1^N 2^A	N/A	Yes	Position / Position	Open-Close / Open-Close
Boron Dilution Valve	30KBA25AA017	Fuel Building	4^N 3^A	N/A	Yes	Position / Position	Open-Close / Open-Close
#1 Charging Pump	30KBA31AP001	Fuel Building	N/A	N/A	N/A	On-Off / On-Off	Start-Stop / Start-Stop
#2 Charging Pump	30KBA32AP001	Fuel Building	N/A	N/A	N/A	On-Off / On-Off	Start-Stop / Start-Stop
Charging Line Containment Isolation Valve	30KBA34AA002	Fuel Building	1^N 2^A	N/A	Yes	Position / Position	Open-Close / Open-Close

Table 2.2.6-2—CVCS Equipment I&C and Electrical Design
Sheet 2 of 2

Description	Tag Number(1)	Location	IEEE Class 1E (2)	EQ – Harsh Env.	PACS	MCR/RSS Displays	MCR/RSS Controls
Charging Line Isolation Valve	30KBA34AA012	Reactor Building	4^N 3^A	Yes	Yes	Position / Position	Open-Close / Open-Close
Pressurizer Spray Isolation Valve	30KBA35AA001	Reactor Building	4^N 3^A	Yes	Yes	Position / Position	Open-Close / Open-Close
Seal Injection Containment Isolation Valve	30JEW01AA005	Fuel Building	1^N 2^A	N/A	Yes	Position / Position	Open-Close / Open-Close
RCP Seal Leak-off Containment Isolation Valve	30JEW50AA001	Reactor Building	4^N 3^A	Yes	Yes	Position / Position	Open-Close / Open-Close
RCP Seal Leak-off Containment Isolation Valve	30JEW50AA002	Fuel Building	1^N 2^A	N/A	Yes	Position / Position	Open-Close / Open-Close

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

2. ^{N} denotes the division the equipment is normally powered from; ^{A} denotes the division the equipment is powered from when alternate feed is implemented.

Table 2.2.6-3—Chemical and Volume Control System ITAAC
Sheet 1 of 6

Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
2.1	The functional arrangement of the CVCS is as described in the Design Description of Section 2.2.6, Tables 2.2.6-1 and 2.2.6-2, and as shown on Figure 2.2.6-1.	An inspection of the as-built CVCS functional arrangement will be performed.	The CVCS conforms to the functional arrangement as described in the Design Description of Section 2.2.6, Tables 2.2.6-1 and 2.2.6-2, and as shown on Figure 2.2.6-1.
2.2	Deleted.	Deleted.	Deleted.
3.1	Valves listed in Table 2.2.6-1 will be functionally designed and qualified such that each valve is capable of performing its intended function for a full range of system differential pressure and flow, ambient temperatures, and available voltage (as applicable) under design basis accident conditions.	Tests or type tests of valves will be performed to demonstrate that the pumps and valves function under design basis accident conditions.	A report concludes that the valves listed in Table 2.2.6-1 are capable of performing their intended function for a full range of system differential pressure and flow, ambient temperatures, and available voltage (as applicable) under design basis accident conditions.
3.2	Check valves listed in Table 2.2.6-1 will function to change position as listed in Table 2.2.6-1 under normal operating conditions.	Tests will be performed to verify the ability of check valves to change position under normal operating conditions.	The check valves change position as listed in Table 2.2.6-1 under normal operating conditions.
3.3	Deleted.	Deleted.	Deleted.

Table 2.2.6-3—Chemical and Volume Control System ITAAC
Sheet 2 of 6

Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
3.4	Equipment identified as Seismic Category I in Table 2.2.6-1 can withstand seismic design basis loads without a loss of the function listed in Table 2.2.6-1.	a. Type tests, analyses, or a combination of type tests and analyses will be performed on the equipment identified as Seismic Category I in Table 2.2.6-1 using analytical assumptions, or under conditions, which bound the Seismic Category I design requirements. b. An inspection will be performed of the as-built equipment identified as Seismic Category I in Table 2.2.6-1 to verify that the equipment, including anchorage, are installed per the approved design requirements.	a. Test/analysis reports conclude that the equipment identified as Seismic Category I in Table 2.2.6-1 can withstand seismic design basis loads without a loss of the function listed in Table 2.2.6-1 including the time required to perform the listed function. b. Inspection reports conclude that the equipment identified as Seismic Category I in Table 2.2.6-1, including anchorage, are installed per the approved design requirements.
3.5	Deleted.	Deleted.	Deleted.
3.6	Deleted.	Deleted.	Deleted.
3.7	Deleted.	Deleted.	Deleted.
3.8	Deleted.	Deleted.	Deleted.
3.9	Deleted.	Deleted.	Deleted.
3.10	Deleted.	Deleted.	Deleted.
3.11	Deleted.	Deleted.	Deleted.
3.12	Deleted.	Deleted.	Deleted.
3.13	Deleted.	Deleted.	Deleted.
3.14	Deleted.	Deleted.	Deleted.
3.15	ASME Code Class 1, 2 and 3 piping systems are designed in accordance with ASME Code Section III requirements.	An inspection of piping design and analysis documentation required by the ASME Code Section III will be performed. {{DAC}}	ASME Code Section III Design Report(s) exist that meet the requirements of NCA-3550 and conclude that the design of the ASME Code Class 1, 2 and 3 piping system complies with the requirements of the ASME Code Section III. {{DAC}}

Table 2.2.6-3—Chemical and Volume Control System ITAAC
Sheet 3 of 6

Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
3.16	As-built ASME Code Class 1, 2, and 3 components are reconciled with the design requirements.	A reconciliation analysis of ASME Code Class 1, 2, and 3 components will be performed.	ASME Code Design Report(s) exist that meet the requirements of NCA-3550, conclude that the design reconciliation has been completed for as-built ASME Code Class 1, 2 and 3 components, and document the results of the reconciliation analysis.
3.17	Pressure-boundary welds in ASME Code Class 1, 2 and 3 components meet ASME Code Section III non-destructive examination requirements.	An inspection of the as-built pressure-boundary welds in ASME Code Class 1, 2 and 3 components will be performed.	ASME Code reports(s) exist that conclude that ASME Code Section III requirements are met for non-destructive examination of pressure-boundary welds in ASME Code Class 1, 2 and 3 components.
3.18	ASME Code Class 1, 2 and 3 components retain their pressure-boundary integrity at their design pressure.	A hydrostatic test will be conducted on ASME Code Class 1, 2 and 3 components that are required to be hydrostatically tested by the ASME Code Section III.	ASME Code Data Report(s) exist and conclude that the results of the hydrostatic test of ASME Code Class 1, 2 and 3 components comply with the requirements of ASME Code Section III.
3.19	ASME Code Class 1, 2 and 3 components are fabricated, installed, and inspected in accordance with ASME Code Section III requirements.	An inspection of the as-built construction activities and documentation for ASME Code Class 1, 2 and 3 components will be conducted.	ASME Code Data Report(s) exist that conclude that ASME Code Class 1, 2, and 3 components are fabricated, installed, and inspected in accordance with ASME Code Section III requirements.

Table 2.2.6-3—Chemical and Volume Control System ITAAC
Sheet 4 of 6

Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
4.1	Displays listed in Table 2.2.6-2 are indicated on the PICS operator workstations in the MCR and the RSS.	a. Tests will be performed to verify that the displays listed in Table 2.2.6-2 are indicated on the PICS operator workstations in the MCR by using test input signals to PICS. b. Tests will be performed to verify that the displays listed in Table 2.2.6-2 are indicated on the PICS operator workstations in the RSS by using test input signals inputs to PICS.	a. Displays listed in Table 2.2.6-2 are indicated on the PICS operator workstations in the MCR. b. Displays listed in Table 2.2.6-2 are indicated on the PICS operator workstations in the RSS.
4.2	Controls on the PICS operator workstations in the MCR and the RSS perform the function listed in Table 2.2.6-2.	a. Tests will be performed using controls on the PICS operator workstations in the MCR. b. Tests will be performed using controls on the PICS operator workstations in the RSS.	a. Controls on the PICS operator workstations in the MCR perform the function listed in Table 2.2.6-2. b. Controls on the PICS operator workstations in the RSS perform the function listed in Table 2.2.6-2.
4.3	Equipment listed as being controlled by a PACS module in Table 2.2.6-2 responds to the state requested and provides drive monitoring signals back to the PACS module. The PACS module will protect the equipment by terminating the output command upon the equipment reaching the requested state.	A test will be performed using test input signals to verify equipment controlled by a PACS module responds to the state requested and provides drive monitoring signals back to the PACS module.	Equipment listed as being controlled by a PACS module in Table 2.2.6-2 responds to the state requested and provides drive monitoring signals back to the PACS module. The PACS module will protect the equipment by terminating the output command upon the equipment reaching the requested state.

Table 2.2.6-3—Chemical and Volume Control System ITAAC
Sheet 5 of 6

Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
4.4	Interlocks for the CVCS initiate the following: • Isolation of the charging pump suction from the volume control tank and normal letdown path during a boron dilution event by closure of the boron dilution valves. • Isolation of the charging line by closure of the charging line containment isolation valves and pressurizer spray isolation valve. • Isolation of the letdown line on a Safety Injection actuation signal by closure of the RC pressure boundary valves.	Tests will be performed using test input signals to verify the operation of the following interlocks: • Isolation of the charging pump suction from the volume control tank and normal letdown path by closure of the boron dilution valves. • Isolation of the charging line by closure of the charging line containment isolation valves and pressurizer spray isolation valve. • Isolation of the letdown line on a safety injection actuation signal by closure of the RC pressure boundary valves.	The following interlocks respond as specified below when activated by a test input signal: • Isolation of the charging pump suction from the volume control tank and normal letdown path by closure of the boron dilution valves. • Isolation of the charging line by closure of the charging line containment isolation valves and pressurizer spray isolation valve. • Isolation of the letdown line on a safety injection actuation signal by closure of the RC pressure boundary valves.
5.1	Equipment designated as Class 1E in Table 2.2.6-2 are powered from the Class 1E division as listed in Table 2.2.6-2 in a normal or alternate feed condition.	a. Testing will be performed by providing a test input signal in each normally aligned division. b. Testing will be performed by providing a test input signal in each division with the alternate feed aligned to the divisional pair.	a. The test input signal provided in the normally aligned division is present at the respective Class 1E equipment identified in Table 2.2.6-2. b. The test input signal provided in each division with the alternate feed aligned to the divisional pair is present at the respective Class 1E equipment identified in Table 2.2.6-2.
5.2	Deleted.	Deleted.	Deleted.

Table 2.2.6-3—Chemical and Volume Control System ITAAC
Sheet 6 of 6

Commitment Wording		Inspections, Tests, Analyses	Acceptance Criteria
6.1	Equipment designated as harsh environment in Table 2.2.6-2 will perform the function listed in Table 2.2.6-1 under normal environmental conditions, containment test conditions, anticipated operational occurrences, and accident and post-accident environmental conditions.	a. Type tests or type tests and analysis will be performed to demonstrate the ability of the equipment designated as harsh environment in Table 2.2.6-2 to perform the function listed in Table 2.2.6-1 under normal environmental conditions, containment test conditions, anticipated operational occurrences, and accident and post-accident environmental conditions. b. An inspection will be performed of the as-built equipment designated as harsh environment in Table 2.2.6-2 to verify that the equipment, including anchorage, are installed per the approved design requirements.	a. EQDPs conclude that the equipment designated as harsh environment in Table 2.2.6-2 can perform the function listed in Table 2.2.6-1 under normal environmental conditions, containment test conditions, anticipated operational occurrences, and accident and post-accident environmental conditions, including the time required to perform the listed function. b. Inspection reports conclude that the equipment designated as harsh environment in Table 2.2.6-2, including anchorage, are installed per the approved design requirements.
7.1	Deleted.	Deleted.	Deleted.
7.2	Class 1E valves listed in Table 2.2.6-2 will function to change position as listed in Table 2.2.6-1 under normal operating conditions.	Tests will be performed to verify the ability of Class 1E valves to change position under normal operating conditions.	Class 1E valves listed in Table 2.2.6-2 change position as listed in Table 2.2.6-1 under normal operating conditions.
7.3	Deleted.	Deleted.	Deleted.
7.4	The CVCS run-out flow does not exceed the design maximum allowable.	A test will be performed to verify the CVCS run-out flow does not exceed the design maximum allowable.	The CVCS run-out flow is equal to or less than 112.66 lb_m/s total with both CVCS pumps running.
7.5	The CVCS charging pumps listed in Table 2.2.6-1 provide seal water flow for operation of the reactor coolant pumps.	Testing will be performed to verify each CVCS charging pump provides seal water flow to the reactor coolant pumps.	One CVCS charging pump delivers a minimum seal water flow of 6.15 gpm to each operating reactor coolant pump.