TABLE 9.3-1

SAMPLING SYSTEM CODE REQUIREMENTS

Primary sample heat exchanger	ASME Boiler and Pressure Vessel Code, Section VIII, Unfired Pressure Vessels, Div. I
Sample pressure vessels	ASME Boiler and Pressure Vessel Code, Section VIII, Unfired Pressure Vessels, Div. I
Piping and valves	ANSI B31.1.0* ANSI B31.7**
Steam generator blowdown sample and steam sample heat exchangers	ASME Boiler and Pressure Vessel Code, Section VIII, Unfired Pressure Vessels, Div. I

* ANSI B31.1.0 - Code for Power Piping, used for design.

** For piping not supplied by the NSSS supplier, material inspection, fabrication, and quality control conform to ANSI B31.7. Where not possible to comply with ANSI B31.7, the requirements of ASME III-1971, which incorporated ANSI B31.7, were adhered to.

TABLE 9.3-2

SAMPLING SYSTEM COMPONENTS

Primary System Sampling Heat Exchanger

General

Number	3	
Type	Shell and coiled tube	
	Shell	Tube
Design pressure, psig	150	2485
Design temperature, °F	350	680
Design flow, gpm	14.1	0.42
Temperature, in, °F	95	652.7 (max)
Temperature, out, °F	125	127 (max)
Material	Carbon steel	Austenitic Stainless Steel
Fluid	Component cooling water	Sample

Steam Generator Blowdown Sampling Heat Exchanger

General

Number	8	
Type	Shell and coiled tube	
	Shell	Tube
Design pressure, psig	150	1500
Design temperature, °F	650	550
Design flow, gpm	6	0.40
Temperature, in, °F	95	550 (max)
Temperature, out, °F	125	127 (max)
Material	Carbon steel	Austenitic Stainless Steel
Fluid	Component cooling water	Sample

Sample Pressure Vessels

Number, total	1
Volume, ml	75
Design pressure, psig	2485
Design temperature, °F	680
Material	Austenitic Stainless Steel

Piping

Design pressure, psig	2485
Design temperature, °F	680

TABLE 9.3-3

MALFUNCTION ANALYSIS OF SAMPLING SYSTEM

Component	Malfunction or Failure	Consequence
Pressurizer Sample Lines or Reactor Coolant Sample Lines	An isolation valve fails to close on containment isolation signal	The second isolation valve closes on containment isolation signal, maintaining containment integrity
Any of the above Sample Lines	Break in line downstream of isolation valves	Isolation valves close on containment isolation signal
Sample Heat Exchangers	Loss of cooling water	Sample lines can be isolated at the containment. Cooling of samples is not required

TABLE 9.3-4

CHEMICAL AND VOLUME CONTROL SYSTEM CODE REQUIREMENTS

Regenerative heat exchanger	ASME III*, Class C
Letdown heat exchanger	ASME III, Class C, Tube Side, ASME VIII, Shell Side
Mixed bed demineralizers	ASME III, Class C
Reactor coolant filter	ASME III, Class C
Volume control tank	ASME III, Class C
Seal water heat exchanger	ASME III, Class C, Tube Side, ASME VIII, Shell Side
Excess letdown heat exchanger	ASME III, Class C, Tube Side, ASME VIII, Shell Side
Cation bed demineralizer	ASME III, Class C
Seal water injection filters	ASME III, Class C
Boric acid filter	ASME III, Class C
Evaporator condensate demineralizers	ASME III, Class C
Concentrates filter	ASME III, Class C
Evaporator feed ion exchangers	ASME III, Class C
Ion exchanger filter	ASME III, Class C
Condensate filter	ASME III, Class C
Piping and valves	ANSI B31.1** ANSI B31.7*** ****

* ASME III - American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, Section III, Nuclear Vessels.

** ANSI B31.1 - Code for Power Piping, used for design.

*** For piping not supplied by the NSSS supplier, material inspection, fabrication, and quality control conform to ANSI B31.7. Where not possible to comply with ANSI B31.7, the requirements of ASME III-1971, which incorporated ANSI B31.7, were adhered to.

**** ASME Section III Code relief was obtained for the Volume Control Tank and regenerative heat exchanger relief systems using administrative controls per NRC approval (Section 9.3.7, Reference 3).

TABLE 9.3-5

CHEMICAL AND VOLUME CONTROL SYSTEM
DESIGN PARAMETERS

<u>General</u>	
Plant design life, years	40
Seal water supply flow rate:	
Normal, gpm	32
Maximum, gpm	113
Seal water return flow rates:	
Normal, gpm	12
Maximum, gpm	93
Letdown flow:	
Normal, gpm	75
Minimum, gpm	45
Maximum, gpm	120
Charging flow:	
Normal, gpm	55
Minimum, gpm	25
Maximum, gpm	100
Temperature of letdown reactor coolant entering system at full power, □F	542.7
Centrifugal pump miniflow, gpm	60 (each)
Normal temperature of charging flow directed to Reactor Coolant System, □F	495
Temperature of effluent directed to holdup tanks, □F	127

(Volumetric flow rates in gpm are nominal values based upon 130 □F and 2350 psig)

TABLE 9.3-6

PRINCIPAL COMPONENT DATA SUMMARY

Regenerative Heat Exchanger

Number	1
Heat transfer rate at design conditions, Btu/hr	10.28×10^6

Shell Side

Design pressure, psig	2485
Design temperature, °F	650
Fluid	Borated reactor coolant
Material of construction	Austenitic stainless steel

	Normal (Design)	Maximum Purification	Heatup
Flow, lb/hr	37,050	59,280	59,280
Inlet temperature, °F	555	542.7	542.7
Outlet temperature, °F	298	294	369

Tube Side

Design pressure, psig	2825*
Design temperature, °F	650
Fluid	Borated reactor coolant
Material of construction	Austenitic stainless steel

	Normal (Design)	Maximum Purification	Heatup
Flow, lb/hr	27,170	49,400	29,640
Inlet temperature, °F	130	130	130
Outlet temperature, °F	495	466	520

Letdown Orifice

Design pressure, psig	2485
Design temperature, °F	650
Normal operating inlet pressure, psig	2185
Normal operating temperature, °F	290
Material of construction	Austenitic stainless steel

	45 gpm	75 gpm
Number	1	2
Design flow, lb/hr	22,230	27,050
Differential pressure at design flow, psig	1900	1900

* Associated pipe design pressure for Pipe Schedule SPS48B is 2825 psig, based on CV141 setpoint pressure. Per the design code, maximum allowable accumulation for pressure relief is 110% of ASME pressure vessel design pressure (Reference Calculation S-C-CVC-MDC-2348).

Letdown Heat Exchanger

Number	1
Heat transfer rate at design conditions (heatup), Btu/hr	14.8×10^6

Shell Side

Design pressure, psig	150
Design temperature, °F	250
Fluid	Component cooling water
Material of construction	Carbon steel

	Normal	Heatup (Design)	Maximum Purification
Flow, lb/hr	203,000	492,000	320,000
Inlet temperature, °F	95	95	95
Outlet temperature, °F	125	125	125

Tube Side

Design pressure, psig	600
Design temperature, °F	400
Fluid	Borated reactor coolant
Material of construction	Austenitic stainless steel

	Normal	Heatup (Design)	Maximum Purification
Flow, lb/hr	37,050	59,280	59,280**
Inlet temperature, °F	290	380 (max)	380 (max)
Outlet temperature, °F	127	127	127

Mixed Bed Demineralizers

Number	2
Type	Flushable
Vessel design pressure:	
Internal, psig	200
External, psig	15
Vessel design temperature, °F	250
Resin volume, each, ft^3	30
Vessel volume, each, ft^3	43
Design flow rate, gpm	120*
Minimum decontamination factor	10
Normal operating temperature, °F	127
Normal operating pressure, psig	150
Resin type	Cation, anion, or application-specific
Material of construction	Austenitic stainless steel

* Qualified for 180gpm during Low Pressure RHR Letdown operation (Ref. VTD 328295, sht. 002)

** Qualified for 88650 lb/hr during Low Pressure RHR Letdown operation (Ref. VTD 328295, sht. 002)

Resin Fill Tank

Number	1
Capacity, ft^3	8
Design pressure	Atmospheric
Design temperature, °F	200
Normal operating temperature	Ambient
Material of construction	Austenitic stainless steel

Reactor Coolant Filter

Number	1
Type	Replaceable assembly
Design pressure, psig	200
Design temperature, °F	250
Flow rate:	
Nominal, gpm	120
Maximum, gpm	150*
Material of construction	Austenitic stainless steel
Filtration Requirement	≥98 Percent retention of particles above 25 micron

Volume Control Tank

Number	1
Internal volume, ft^3	400
Design pressure:	
Internal, psig	75
External, psig	15
Design temperature, °F	250
Operating pressure range, psig	0 - 60
Normal operating pressure, psig	15
Spray nozzle flow (maximum), gpm	120*
Material of construction	Austenitic stainless steel

Centrifugal Charging Pumps

Number	2
Type	Horizontal centrifugal
Design pressure, psig	2800
Design temperature, °F	300
Shutoff head, psi	2670
Normal suction temperature, °F	127
Design flowrate, gpm	150
Design head, ft	5800
Required NPSH at 150 gpm, ft	10
Material	Austenitic stainless steel

* Qualified for 180gpm during Low Pressure RHR Letdown operation (Ref. VTD 328295, sht. 002)

Positive Displacement Charging Pump

Number	1
Type	Positive displacement with variable speed drive
Design head, ft	5800
Design temperature, °F	250
Design pressure, psig	3200
Design flow rate*, gpm	98
Suction temperature, °F	127
Discharge pressure at 130°F, psig	2500
Material of construction	Austenitic stainless steel
Maximum operating pressure, psia	3125

Chemical Mixing Tank

Number	1
Capacity, gal	5
Design pressure, psig	150
Design temperature, °F	200
Normal operating temperature	Ambient
Material of construction	Austenitic stainless steel

Boric Acid Tank

Number	2
Capacity (each), gal	8000
Design pressure	Atmospheric
Design temperature, °F	250
Normal operating temperature, °F	Ambient
Material of construction	Austenitic stainless steel

Boric Acid Tank Electric Immersion Heater

Number (two per tank)	4
Heat transfer rate, each, kW	7.5
Material of construction	Austenitic stainless steel sheath

Batching Tank and Batching Tank Heater Jacket

Number	1
Type	Cylindrical with steam panel coils
Capacity, gal	400
Design pressure	Atmospheric
Design temperature, °F	300
Steam temperature, °F	250
Initial ambient temperature, °F	32
Final fluid temperature, °F	>80
Heatup time, hr	≈ 3
Tank material of construction	Austenitic stainless steel
Panel coils, material of construction	Carbon steel

* At 130°F, 2500 psig

Table 9.3-6 (Cont)

Batching Tank Agitator

Number	1
Fluid handled, boric acid, wt percent	12
Service	Continuous
Tank volume, gal	400
Operating temperature, °F	165
Operating pressure	Atmospheric
Material of construction	Austenitic stainless steel

Excess Letdown Heat Exchanger

Number	1
Heat transfer rate at design conditions, Btu/hr	4.61×10^6

	Shell Side	Tube Side
Design pressure, psig	150	2485
Design temperature, °F	250	650
Design flow rate, lb/hr	115,000	12,380
Inlet temperature, °F	95	545
Outlet temperature, °F	135	195
Fluid	Component cooling water	Borated reactor coolant
Material of construction	Carbon Steel	Austenitic stainless steel

Seal Water Heat Exchanger

Number	1
Heat transfer rate at design conditions, Btu/hr	2.49×10^6

	Shell Side	Tube Side
Design pressure, psig	150	150
Design temperature, °F	250	250
Design flow rate, lb/hr	99,500	160,600
Design operating inlet temperature, °F	95	143
Design operating outlet temperature, °F	120	127
Fluid	Component cooling water	Borated reactor coolant
Material of construction	Carbon steel	Austenitic stainless steel

<u>Seal Water Filter</u>	
Number	1
Type	Replaceable Assembly
Design pressure, psig	200
Design temperature, °F	250
Maximum flow rate, gpm	325
Vessel material of construction	Austenitic stainless steel
Filtration Requirement	98 percent retention of particles above 25 microns
<u>Boric Acid Filter</u>	
Number	1
Type	Replaceable Assembly
Design pressure, psig	200
Design temperature, °F	250
Design flow, gpm	150
Vessel material of construction	Austenitic stainless steel
Filtration Requirement	98 percent retention of particles above 25 microns
<u>Boric Acid Transfer Pump</u>	
Number	2
Type	Two-speed horizontal centrifugal
Design flow rate, each, gpm	75*
Design pressure, psig	150
Design discharge head, ft	235
Design temperature, °F	250
Temperature of pumped fluid, °F	70
Required NPSH at 75 gpm, ft	6
Material of construction	Austenitic stainless steel
<u>Boric Acid Blender</u>	
Number	1
Design pressure, psig	150
Design temperature, °F	250
Material of construction	Austenitic stainless steel
<u>Cation Bed Demineralizer</u>	
Number	1
Type	Flushable
Vessel design pressure:	
Internal, psig	200
External, psig	15
Vessel design temperature, °F	250
Normal operating temperature, °F	127
Normal operating pressure, psig	150
Design flow, gpm	75
Resin type	Cation
Material of construction	Austenitic stainless steel

*Because of the severe duty from pumping boric acid, the minimum required flow, which is verified by the In-Service Testing Program for pumps, has been set as 45 gpm.

Chemical Mixing Tank Orifice

Number	1
Design pressure, psig	150
Design temperature, °F	200
Design flow, gpm	2
Material of construction	Austenitic stainless steel

Boric Acid Tank Orifice

Number	2
Design pressure, psig	150
Design temperature, °F	200
Design flow, gpm	3
Material of construction	Austenitic stainless steel

Deborating Demineralizers

Number	2
Type	Regenerable
Vessel design pressure:	
Internal, psig	200
External, psig	15
Vessel design temperature, °F	250
Normal flow, gpm	127
Normal operating temperature, °F	127
Normal operating pressure, psig	150
Resin type	Cation, anion, or Application-specific
Material of construction	Austenitic stainless steel

Seal Injection Filters

Number	2
Design pressure, psig	2735
Design temperature, °F	200
Design flow, gpm	80
Particle retention	98 percent above 5 micron
Fluid	Reactor coolant containing up to 4.0 weight percent boric acid
Material of construction, vessel	Austenitic stainless steel
Type	Replaceable Assembly

No. 1 Seal Bypass Orifice

Number	4
Design pressure, psig	2485
Design temperature, °F	250
Design flow, gpm	1.0
Differential pressure at design flow, psi	300

TABLE 9.3-6 (Cont)

<u>Holdup Tanks</u>

Number	*3
Design temperature, °F	200
Design pressure, psig	15
Volume, each, ft^3	8500
Normal operating pressure, psig	3
Normal operating temperature, °F	130
Material of construction	Austenitic stainless steel

<u>Recirculation Pump</u>

Number	1
Type	Centrifugal
Design flow, gpm	500
Design head, ft	100
Design pressure, psig	75
Design temperature, °F	200
Normal operating temperature, °F	115
Material of construction	Austenitic stainless steel

<u>Gas Stripper Feed Pumps</u>

Number	2
Type	Canned
Design flow, gpm	30
Design head (TDH), ft	320
Design pressure, psig	150
Design temperature, °F	200
Normal fluid temperature, °F	115
Material of construction	Austenitic stainless steel

<u>Gas Stripper and Evaporator Package Unit</u>

Number of Units	1
Design flow/unit; gas stripper feed, gpm	30
Evaporator condensate, gpm	30
Evaporator concentrates (batch flow), gpm	40
Decontamination factors (design):	
Gas stripper	Approx 10^5 (for gas)
Evaporator	Approx 10^6 (for liquid)
Concentration of concentrates, boric acid, wt percent	12
Concentration of distillate	<10 ppm boron as H_3BO_3 <0.1 ppm oxygen Conductivity <2.0 µmhos/cm pH = 6.0 to 8.0
Material of construction	Austenitic stainless steel

* Unit No. 1 has only two CVCS Hold-up Tanks. The No. 12 Tank has been abandoned in place.

Evaporator Distillate Demineralizers

Number	2
Type	Regenerable
Design temperature, °F	250
Design pressure:	
Internal, psig	200
External, psig	15
Design flow, gpm	30
Normal operating pressure, psig	50
Normal operating temperature, °F	130
Resin type	Anion
Material of construction	Austenitic stainless steel

Monitor Tanks

Number	2
Volume, each, gal	21,600
Design pressure	Atmospheric
Design temperature, °F	150
Material of construction	Stainless steel

Monitor Tank Pumps

Number	2
Type	Centrifugal
Design flow, gpm	150
Design head, ft	200
Design pressure, psig	150
Design temperature, °F	200
Material of construction	Austenitic stainless steel
NPSH, ft	15

Evaporator Feed Ion Exchangers

Number	4
Type	Flushable
Design temperature, °F	250
Design pressure:	
Internal, psig	200
External, psig	15
Minimum decontamination factor for ions removed	10
Design flow, gpm	30
Normal operating temperature, °F	130
Normal operating pressure, psig	75
Resin type	Cation
Material of construction	Austenitic stainless steel

Concentrates Filter

Number	1
Type	Cage type
Design pressure, psig	200
Design temperature, °F	250
Design flow rate, gpm	35
Retention for 25 micron particles	98 percent
Material of construction (vessel)	Austenitic stainless steel

Concentrates Holding Tank

Number	1
Type	Cylindrical, heated
Volume, gal	1000
Design pressure	Atmospheric
Design temperature, °F	250
Normal operating temperature, °F	150
Material of construction	Austenitic stainless steel

Concentrates Holding Tank Transfer Pump

Number	2
Type	Centrifugal canned
Design flow rate, gpm	40
Design head, ft	150
Design temperature, °F	250
Design pressure, psig	100
Required NPSH at 40 gpm, ft	8
Material of construction	Austenitic stainless steel

Concentrates Holding Tank Electric Heater

Number	1
Heat transfer rate, kW	3.0
Material of construction	Austenitic stainless steel

Ion Exchanger Filter

Number	1
Type	Cage assembly
Design pressure, psig	200
Design temperature, °F	250
Design flow rate, gpm	35
Retention of 25 micron particles	98 percent
Material of construction	Austenitic stainless steel

Distillate Filter

Number	1
Type	Cage assembly
Design pressure, psig	200
Design temperature, °F	250
Design flow rate, gpm	35
Retention of 25 micron particles	98 percent
Material of construction	Austenitic stainless steel

TABLE 9.3-6 (Cont)

Relief Valves	No.	Fluid Discharged	Fluid Inlet Temperature °F	Set Pressure psig	Backpressure, psig Constant	Backpressure, psig Building	Capacity gpm
Letdown line (HP)	1	Water-Steam Mixture	385 (max)	600	3	50	98,000 lb/hr
Seal water return line	1	Water	150	150	3	50	180
Charging pump's discharge	1	Water	130	2735	15	75	100
Letdown line (LP)	1	Water	127	200	15	12	200
Volume control tank	1	Hydrogen, nitrogen, or water	130	75	3	12	350
Boric acid batch tank heater	1	Steam	250	20	0	0	320 lb/hr
Holdup tanks	3	Nitrogen, water	130	12	3	3	235

TABLE 9.3-7

FAILURE ANALYSIS OF THE CHEMICAL AND VOLUME CONTROL SYSTEM

Component	Failure	Comments and Consequences
1. Letdown Line	Rupture in the line inside the reactor containment	The two remote air-operated valves located near the main coolant loop are closed on low pressurizer level to prevent supplementary loss of coolant through the letdown line rupture. The containment isolation valves in the letdown line are automatically closed by the containment isolation signal. The closure of these valves prevents any leakage of the reactor containment atmosphere outside the reactor containment.
2. Normal and Alternate Charging Line	See above.	The check valves located near the main coolant loops prevent supplementary loss of coolant through the line and isolate the Reactor Coolant System from the rupture. The check valve located at the boundary of the reactor containment prevents any leakage of the reactor containment atmosphere outside the reactor containment. The two motor-operated valves outside the containment are automatically closed by the containment isolation signal.
3. Seal Water Return Line	See above.	The motor-operated isolation valves located inside and outside the containment are automatically closed by the containment isolation signal. The closure of these valves prevents any leakage of the reactor containment atmosphere outside the reactor containment.