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POWER SYSTEMS

Docket No.: STN-50-470F

February 11, 1982
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Mr. Darrell G. Eisenhut, Director
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Subject: CESSAR and Palo Verde SER Confirmatory Items

Dear Mr. Eisenhut:

Transmitted herewith is Combustion Engineering input which is intended to close out the following confirmatory items identified in Section 1.8 of the CESSAR Safety Evaluation Report (SER):

Enclosure 1 - Confirmatory item 8, Operators for 2 SDCS Valves
Enclosure 2 - Confirmatory item 11, Isolation Valve Power
Enclosure 3 - Confirmatory item 13, Boron Dilution Alarms

Each enclosure contains revised CESSAR Final Safety Analysis Report (CESSAR-F) Round One question responses and marked-up CESSAR-F text pages. These marked-up changes will be incorporated into the next amendment of CESSAR-F.

Also enclosed is CESSAR-F information which is intended to close out part of the following confirmatory item identified in Section 1.10 of the Palo Verde SER:

Enclosure 4 - Confirmatory item 13, Low Temperature Overpressure Protection Alarms

This generic item will be closed out on the CESSAR docket rather than on the CESSAR Applicant dockets.

The final enclosed item was not an SER confirmatory item, but is being submitted to reflect a design change as a result of NRC review:

Enclosure 5 - HPSI Low Flow Alarms

If I can be of any additional assistance in this matter, please contact me or Mr. G. A. Davis of my staff at (203)688-1911, Extension 2803.

Very truly yours,

COMBUSTION ENGINEERING, INC.

A. E. Scherer
Director
Nuclear Licensing

E003
1/1

AES:ctk
Enclosure
cc: C. I. Grimes
J. D. Kerrigan

Enclosure 1

CESSAR Confirmatory Item 8

Operators for 2 SDCS Valves

440.6 (5.4.7) Palo Verde must have the capability to take the plant from full power to a cold shutdown using only safety grade equipment, per the requirements of BTP RSP 5-1. Address your compliance with all provisions of that position and respond to the detailed questions below.

1. Describe the sequence for achieving a cold shutdown condition within 36 hours, assuming the most limiting single failure with only onsite power availability. Identify all manual actions inside or outside containment that must be performed and discuss the capability of remaining at hot standby until manual actions (or repairs) can be performed.

   A. If the steam generator dump valves, operators, air and power supplies are not safety grade, justify how you would cool down the primary system in the event of loss of offsite power and an SSE.

   B. Describe the sequence for depressurizing the primary system using only safety-grade systems assuming a single failure. Identify all manual actions inside or outside containment that must be performed.

   C. Discuss the boration capability using only safety-grade systems, assuming a single failure. Identify all manual actions inside or outside containment that must be performed. If the proposed boration method utilizes the charging pumps (assuming a letdown line failure is proposed), provide an evaluation of this approach with regard to concentration of boron source and liquid volume in primary system.

2. Discuss the provisions for collection and containment of RHR pressure relief valve discharge.

3. Describe tests which will demonstrate adequate mixing of the added borated water and cooldown under natural circulation conditions with and without a single failure of a steam generator atmospheric dump valve. Specific procedures for plant cooldown under natural circulation conditions must be available to the operator. Summarize these procedures.

4. Discuss the availability of the Seismic Category I auxiliary feedwater supply for at least 4 hours at hot shutdown plus cooldown to the RHR system cut-in based on longest time for the availability of only onsite or only offsite power and assuming a single failure. If this cannot be achieved, discuss the availability of an adequate alternate Seismic Category I water source.

5. What provisions in natural circulation cooldown methods have been made to account for possible upper head void formation?

Response: 1. The plant cooldown process to reach cold shutdown conditions is comprised of two phases of heat removal. The initial phase is accomplished by controlling heat rejection to the atmosphere through the secondary atmospheric dump valves. The Reactor Coolant System (RCS) is depressurized by the auxiliary spray system throughout the RCS cooldown while maintaining RCS pressure-temperature requirements in accordance with the Technical Specifications and subcooled margin limitations. Safety Injection Tanks are isolated when depressurizing to reach shutdown cooling entry pressure condition. Normally forced RCS flow is maintained during a plant cooldown. However, adequate natural circulation flow can be maintained throughout the plant cooldown while the steam generators are being used to reject RCS heat.

Once the RCS has been adequately cooled down and depressurized, the Shutdown Cooling System (SDCS) is aligned and the cooldown proceeds by rejecting heat to the SDCS heat exchangers. Assuming loss of offsite power, the most limiting postulated single failure associated with the 36 hour cooldown criteria is a failure of one emergency power train. This single failure disables one train of components associated with the atmospheric dump valves, chemical and volume control systems, auxiliary feedwater system, and shutdown cooling systems. However, the plant can be cooled down to cold shutdown conditions with one emergency power train and one train of plant system components within 36 hours as shown in the following sections.

1.A. Secondary Steam Removal

The steam generated for decay heat removal and for plant cooldown after a loss of offsite power is discharged through the atmospheric dump valves (ADVs). Interface requirements specify that the ADVs are:

a) ASME Code Class 2, Seismic Category I, active and conform to the intent of Reg. Guide 1.48.

b) Designed, fabricated and installed such that the requirements for Inservice Testing and Inspections of ASME Section XI, Subsection IWV can be met.

c) Fail close.

d) Provided with accessible handwheels.

e) Capable of being remote manually positioned to control the plant cooldown rate.

f) Saturatedsteam capacity of not less than 950,000 lb/hr and not more than 1.9×10^6 lb/hr (at 1000 psia).

g) If air-operated ADV's are used, a safety related control air system shall be provided to supply air to the ADV actuators should the normal air supply fail to be available.

Should a single failure occur, making one ADV inoperable, the other three valves may be used to release steam from either or both steam generators. Only two ADVs are required in order to hold the RCS at hot standby for four hours followed by a cooldown to the shutdown cooling system entry temperature of 350°F during natural circulation conditions, assuming that only 300,000 gallons of condensate is available from the condensate storage tank as specified in the interface requirements. Should a single failure of an emergency power train occur making one ADV on each steam generator inoperable, the remaining ADV on each steam generator are capable of releasing the required steam flow.

In addition to the ADVs, the following means are also available for dumping secondary steam:

- Steam may be released from either or both of the steam generators through the auxiliary feeedwater pump turbine steam supply lines.

- Steam may be bypassed to the condenser if it is available.

- Steam traps may be bypassed, if necessary, to relieve steam.

- Vent valves and drain valves may be used, if necessary, to relieve steam.

In summary, four safety grade (Seismic Category I, Quality Class II) atmospheric steam dump valves with multiple, diverse backup means of relieving steam are provided.

Secondary Makeup

During plant cooldown, the Emergency Feedwater System (EFWS) and atmospheric dump valves provide a means to bring the RCS temperature down to the shutdown cooling system entry temperature. If not already automatically actuated, emergency feedwater pump(s) are started and the emergency feedwater valves are opened. Interface requirements specify that an Engineered Safety Feature Grade Emergency Feedwater System be provided as an independent means of supplying secondary makeup water to the steam generators following:

a) Loss of normal feedwater.

b) Minor secondary system pipe breaks with or without a concurrent loss of normal AC power.

c) Steam generator tube rupture with or without a concurrent loss of normal AC power.

d) Major secondary system pipe breaks with or without a concurrent loss of normal AC power.

e) Any incident which will result in a loss of normal onsite and normal offsite AC power.

f) Small LOCA.

The design functions of the EFWS are:

a) Maintaining hot standby with or without normal offsite and normal onsite power available.

b) Facilitating plant cooldown at the maximum administratively controlled rate of 75°F/hr from hot standby to shutdown cooling initiating with or without normal offsite and normal onsite power available. The required feedwater flow is 875 gpm delivered to the steam generator downcomer feedwater nozzle.

The EFWS is designed to safety grade criteria. All piping and components of the EFWS used for containment isolation are required by interface criteria to be designed in accordance with ASME Code Section III Class 2. All other components and piping in the EFWS are designed in accordance with ASME Code Section III Class 3. All components and piping are required to be designed to Seismic Category I requirements. The EFWS is required to be controllable from either the control room or the remote shutdown station.

1.B. All or a portion of the charging flow may be used for auxiliary spray flow to cool and depressurize the pressurizer in the event that the reactor coolant pumps and thus main spray flow are not available. Auxiliary spray flow can be provided by operating one or more of the three safety grade charging pumps (Seismic Category 1, ASME class 2) after opening one or both of the two safety grade auxiliary spray valves, CH-203 and CH-205 (Seismic Category I, ASME Class 2). All of the above listed components have vital power supplied by emergency onsite power (diesel generators). A single failure of one of the two emergency power trains would make one auxiliary spray valve and one charging pump inoperable. The normal loop charging isolation valve, CH-240, is a fail close valve. Only one charging pump and one auxiliary spray isolation valve need be operable in order to provide adequate auxiliary spray system operation.

As the RCS is depressurized, the safety injection tanks (SIT) are drained, vented, or isolated to avoid holding up the normal plant depressurization process to enter shutdown cooling. Normally the SIT vent valves (SI, 605,606,607,608,613,633,643) have power locked out during plant operation, precluding a single failure from opening the vent valves. Electrical power can be restored to the vent valves by control room switches. An interface requirement will be added to CESSAR-F Chapter 6.3.1.3 which requires power restoration ability to the SIT vent valves from the control room. (See 440.9) Each Safety injection tank has safety grade redundant vent valves which assures their depressurization with a single failure during loss of offsite power. A safety injection system Fail Modes and Effects Analysis (FMEA) is provided in CESSAR-F Table 6.3.2-2.

The auxiliary spray valves, charging isolation valve, charging pumps, SIT vent valves and SIT vent valve power restoration capability are all operable from the control room.

1.C. The System 80 design incorporates three safety grade charging pumps (Seismic Category I, ASME Code Class 2), safety grade charging pump source (Refueling Water Tank Seismic Class 1, ASME Code Class 2), redundant charging pump suction paths, and redundant charging pump delivery paths. The charging pumps are manually connected to vital power from the control room if the normal power supply system should fail.

Redundant safety grade gravity-feed suction lines from the refueling water tank to the charging pumps can be made available upon realignment of valve CH-501 from the control room. One pathway is provided by opening valve CH-536 from the control room while the other pathway requires manual realignment of valves CH-327, 755,756, and 757 from outside of the control room. Valves CH-501 and CH-536 are operable from an emergency onsite power source.

The safety grade charging pump discharge line remains aligned to the RCS following a loss of offsite power. Although charging isolation valve CH-240 fails to a closed position during a loss of offsite power, spring check valve CH-435 provides a parellel flow path to the RCS loop charging nozzles. When the auxiliary spray isolation valves are closed, the spring check valve will lift, allowing charging flow to bypass the charging isolation valve. An alternate charging delivery path can be established through the HPSI header. Manual operator actions to realign valves CH-796, 797, 798 and SI-508 are required to establish this backup delivery path.

During the plant cooldown, the charging system borates the RCS to cold shutdown boron concentration and accommodates the reactor coolant shrinkage, taking suction from either the Volume Control Tank of Refueling Water Tank. Normally the RCS boron concentration is changed through a RCS feed and bleed operation through the charging and letdown systems. However, the capability of the Chemical and Volume Control System to borate and to makeup is not compromised by stopping letdown flow. Initial boration occurs at hot standby by charging with refueling water tank makeup which raises pressurizer level. Then as the RCS cooldown progresses, pressurizer level is maintained through the charging and auxiliary spray system providing borated makeup for RCS shrinkage. Refueling water tank makeup will maintain the plant subcritical during the plant cooldown.

A single failure of one emergency power train would leave at least one charging pump operable on the other emergency power train. The third charging pump can be manually aligned to either diesel generator. A high pressurizer level failure in the Pressurizer Level Control System could turn off two of the three charging pumps. A manual override will be provided to the operator in the control room for such a failure in order to regain the capability to operate these two charging pumps. However one charging pump still allows the RCS to be borated and primary inventory to be adequately maintained during a plant cooldown. See FSAR Section 9.3.4 for more information on the Chemical and Volume Control System.

2. System 80 interface requirements specify that the containment sump be designed to accept relief valve discharge from the shutdown cooling suction line overpressure relief valves at temperatures up to 400°F and at flows up to 4000 gpm. Provisions are required for relief valve discharge arrangement in the containment sump area to preclude exposure of personnel to steam discharge.

3. Cooldown under natural circulation conditions was analytically modeled and positively confirmed following two events at an operating C-E reactor plant. St. Lucie Unit 1 (Docket No. 50-335) performed two natural circulation cooldowns following a reactor trip from full power conditions in 1977 and in 1980. A test to verify natural circulation for System 80 is scheduled to be conducted as part of the power ascension testing. See Chapter 14 of CESSAR FSAR for test details.

San Onofre Unit 2 is scheduled to conduct a boron mixing test during their upcoming power ascension testing. Since the boron mixing in the RCS is accomplished in a similar environment and by the same process, the San Onofre natural circulation flow boron mixing test results are considered prototypical for the System 80 standard design. Following completion of the San Onofre test, the results will be assessed for the applicability to System 80.

Specific natural circulation and natural circulation cooldown operator guidelines have been prepared by C-E for the C-E Owners Group. These guidelines were transmitted in CEN-152 to the NRC for review (June, 1981). These guidelines provide instruction to avoid void formation in the reactor vessel upper head that could occur during natural circulation conditions. Also included are instructions that deal with the symptons and follow-up actions for a condensable reactor vessel void if one should occur.

4. Interface requirements specify that a minimum of 300,000 gallons of secondary quality makeup water be available for the intact steam generator(s). This amount of condensate is adequate for at lea . 4 hours at hot standby followed by a cooldown (4.6 hrs.) o the shutdown cooling system entry temperature, assuming that two ADVs are available. As addressed earlier, the most limiting single failure (loss of one emergency train) would leave at least one ADV available on each steam generator. Thus a plant cooldown can be accomplished based on minimum required ADV sizing interface criteria, 300,000 gallons of condensate, and only onsite or only offsite power with a single failure. The condensate storage system for the EFWS is required to be designed to ASME Code Section III, Class 3.

5. Operator guidelines for natural circulation and natural circulation plant cooldown have been developed for the CE Owners Group. These guidelines have been sent to the NRC for review in June 1981. These guidelines provide instructions to avoid void formation in the reactor vessel upper head during natural circulation conditions. Also included are instructions that deal with the symptons and follow-up actions for a condensable reactor vessel void if one should occur.

c. In the event of a failure of a bus, standby equipment connected to other buses shall be capable of being placed in operation.

2. Emergency Power Requirements

a. Charging Pumps - Each emergency power bus shall supply one pump. Additionally, the third charging pump shall be capable of receiving power from either emergency power bus. The charging pumps shall not be automatically sequenced on the emergency power busses.

b. The following are emergency power supply requirements for CVCS instrumentation:

Instrument	Control Location (1)	Emergency Bus
L-200 (RWT level)	A/C	A
L-201 (RWT level)	A/C	B
F-212 (Charging flow)	A/C	B
P-212 (Charging pressure)	A/C	A
L-203A (RWT RAS level)	A	A
L-203B (RWT RAS level)	A	B
L-203C (RWT RAS level)	A	C
L-203D (RWT RAS level)	A	D

c) The following are emergency power supply requirements for CVCS valves:

Valve	Emergency Bus	Control Location (1)
CH-515 (receives SIAS)	B	A/C
CH-516 (receives SIAS & CIAS)	A	A/C
CH-560 (receives CIAS)	A	A
CH-561 (receives CIAS)	B	A
CH-580 (receives CIAS)	A	A
CH-506 (receives CIAS)	A	A/C
CH-505 (receives CIAS)	B	A/C
CH-523 (receives CIAS)	B	A
CH-507	A	A/C
CH-530	B	A
CH-531	A	A
CH-203	B	A/C
CH-205	A	A/C
CH-255	A	A
CH-501	A	A
CH-524	B	A
CH-536	A	A

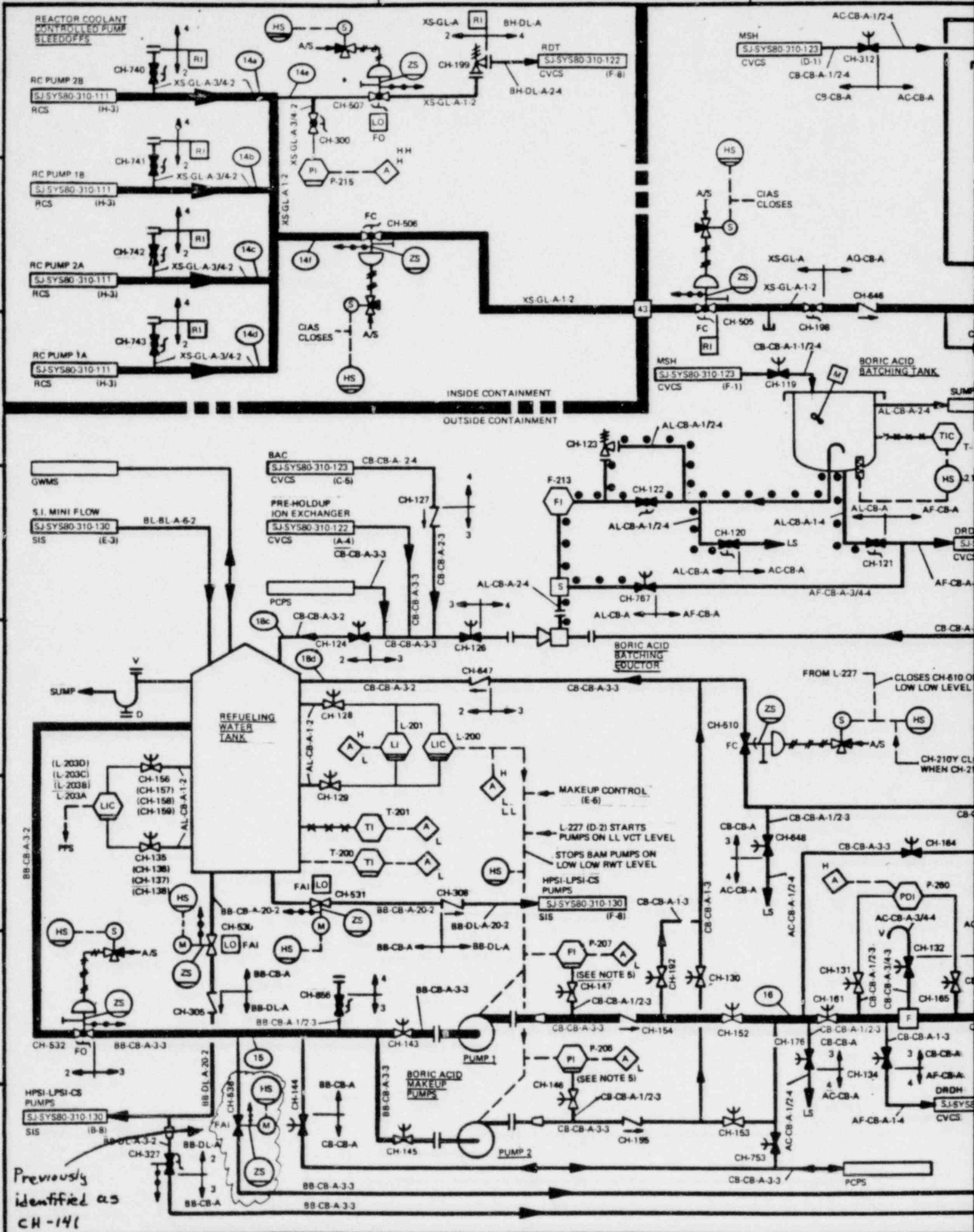
Note (1): Location code is as follows; A-Control Room, B-Local, C-Remote Shutdown Panel, D-Location outside Control Room.

TABLE 9.3-7 (Continued) (Sheet 50 of 100)

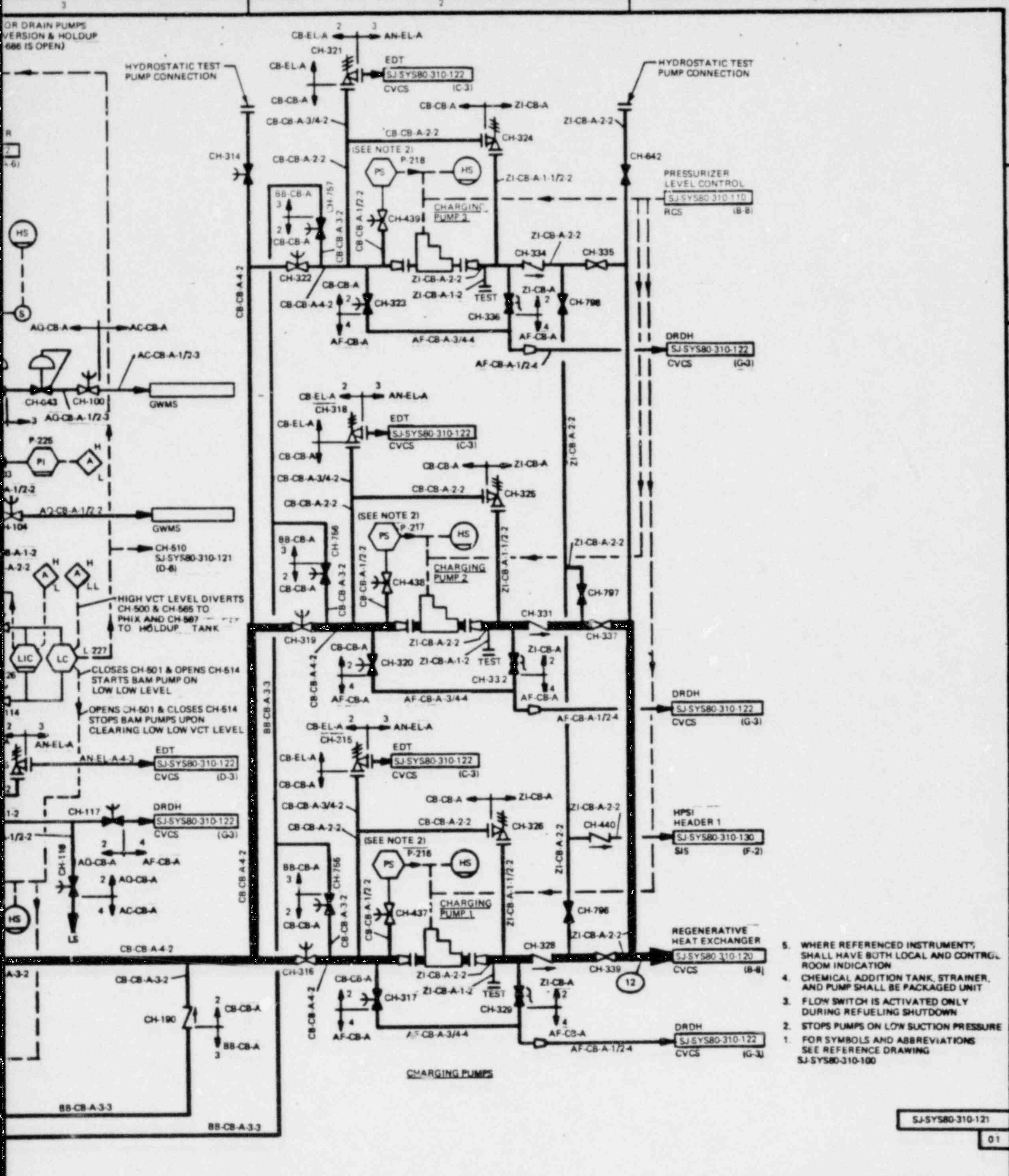
CHEMICAL AND VOLUME CONTROL SYSTEM (CVCS)

FAILURE MODE AND EFFECTS ANALYSIS

No.	Name	Failure Mode	Cause	Symptoms and Local Effects Including Dependent Failures	Method of Detection	Inherent Compensating Provision	Remarks and Other Effects
168)	RWT Gravity Feed to Charging Pump Suction Isolation Valve; CH- 536	a) fails closed	Mech. failure, blockage, loss of power.	No impact on normal operation. Unable to supply boric acid solution from RWT via one gravity feed line to charging pump suction header without the BAMPs	Valve position indication in control room.	Alternate gravity feed path to individual charging pump suction lines	
		b) seat leakage	Contamination mech. damage	Diversion of boric acid solution from RWT to RCS via charging pumps. Possible over boration of RCS	Boronometer indications, sample analysis. Decreasing reactor power	None	
		c) fails open	Mech. failure	Diversion of boric acid solution from RWT to RCS via charging pumps. Possible over boration of RCS.	Boronometer indications, sample analysis. Decreasing reactor power.	None	
169)	RWT Gravity Feed to Charging Pump Suction Header Check Valve, CH-190	a) fails closed	Mech. failure, blockage	Same as 168 a)	None	Same as 168 a)	
		b) fails open	Mech. failure, seat leakage	No impact on normal operation	None	Isolation valve, CH-141	
170)	Boric Acid Filter (BAF) Isolation Valves; CH-161, CH-166	a) fails open	Mech. binding	No impact on normal operation. Unable to isolate BAF for element replacement	Operator	None	
		b) fails closed	Mech binding	Unable to place BAF back in service after maint.	Operator	Boric acid makeup can continue through diversion valve CH-164	
171)	BAF Diversion Valve, CH-164	a) fails closed	Mechanical binding, blockage	No impact on normal operation. Unable to divert boric acid makeup flow past BAF when BAF element replacement needed	Operator	None	



REACTOR COOLANT CONTROLLED PUMP BLEEDOFFS
RC PUMP 2B
SJ-SYS80-310-111
RCS (H-3)
RC PUMP 1B
RC PUMP 2A
RC PUMP 1A
CH-740
CH-741
CH-742
CH-743
XS-GL-A-3/4-2
XS-GL-A-1-2
XS-GL-A-3/4-2
CH-507
CH-300
P-215
CH-506
CH-199
BH-DL-A
BH-DL-A-2-4
RDT
SJ-SYS80-310-122
CVCS (F-8)
CIAS CLOSES
INSIDE CONTAINMENT
OUTSIDE CONTAINMENT
MSH
SJ-SYS80-310-123
CVCS (D-1)
AC-CB-A-1/2-4
CB-CB-A-1/2-4
CH-312
CH-505
CH-198
CH-646
XS-GL-A
AO-CB-A
CB-CB-A-1-1/2-4
SJ-SYS80-310-123
CVCS (F-1)
CH-119
BORIC ACID BATCHING TANK
AL-CB-A-2-4
AL-CB-A-1/2-4
CH-123
CH-122
F-213
CH-120
CH-121
AL-CB-A-1-4
CH-767
AF-CB-A-3/4-4
GWMS
S.I. MINI FLOW
SJ-SYS80-310-130
SIS (E-3)
BL-BL-A-6-2
BAC
SJ-SYS80-310-123
CVCS (C-6)
CB-CB-A-2-4
PRE-HOLDUP ION EXCHANGER
SJ-SYS80-310-122
CVCS (A-4)
CB-CB-A-3-3
CH-127
PCPS
CB-CB-A-3-2
CH-124
CH-126
BORIC ACID BATCHING EDUCTOR
CH-647
SUMP
REFUELING WATER TANK
CH-128
L-201
L-200
CH-129
(L-203D)
(L-203C)
(L-203B)
L-203A
PPS
CH-156
(CH-157)
(CH-158)
(CH-159)
CH-135
(CH-136)
(CH-137)
(CH-138)
T-201
T-200
MAKEUP CONTROL (E-6)
L-227 (D-2) STARTS PUMPS ON LL VCT LEVEL
STOPS BAM PUMPS ON LOW LOW RWT LEVEL
HPSI-LPSI-CS PUMPS
SJ-SYS80-310-130
SIS (F-8)
CH-531
CH-308
BB-CB-A-20-2
BB-DL-A-20-2
CH-530
CH-305
CH-532
CH-855
BB-CB-A-3-3
BB-CB-A-1/2-3
CH-143
PUMP 1
P-207
(SEE NOTE 5)
CH-147
CH-154
CH-192
CH-130
CH-152
P-206
CH-146
CH-144
CH-145
CH-155
CH-153
BORIC ACID MAKEUP PUMPS
PUMP 2
CH-753
CH-176
CH-161
CH-134
CH-131
CH-132
CH-165
CH-164
CH-648
CH-610
FROM L-227
CLOSES CH-610 ON LOW LOW LEVEL
CH-210Y
P-280
AC-CB-A-3/4-4
DRDH
SJ-SYS80
CVCS
AF-CB-A-1-4
HPSI-LPSI-CS PUMPS
SJ-SYS80-310-130
SIS (B-8)
CH-327
CH-536
Previously identified as CH-141



C-E SYSTEM 80

CHEMICAL & VOLUME CONTROL SYSTEM PIPING & INSTRUMENTATION DIAGRAM

Figure 9.3-1

Enclosure 2

CESSAR Confirmatory Item 11

Isolation Valve Power

480.7 Section 6.2.4 - Although we find that remote manual isolation of valves CH-524. (Penetration #41) and CH -255 (Penetration #57) is acceptable instead of automatic isolation because of the importance of manintaining charging capability and RCP seal injection capability, justify why Class IE power is not provided to close these valves should their isolation become necessary following an accident with loss of offsite power.

Response

CESSAR-F will be amended to show that valves CH-524 and CH-255 will be powered from a class IE power source.

c. In the event of a failure of a bus, standby equipment connected to other buses shall be capable of being placed in operation.

2. Emergency Power Requirements

a. Charging Pumps - Each emergency power bus shall supply one pump. Additionally, the third charging pump shall be capable of receiving power from either emergency power bus. The charging pumps shall not be automatically sequenced on the emergency power busses.

b. The following are emergency power supply requirements for CVCS instrumentation:

Instrument	Control Location (1)	Emergency Bus
L-200 (RWT level)	A/C	A
L-201 (RWT level)	A/C	B
F-212 (Charging flow)	A/C	B
P-212 (Charging pressure)	A/C	A
L-203A (RWT RAS level)	A	A
L-203B (RWT RAS level)	A	B
L-203C (RWT RAS level)	A	C
L-203D (RWT RAS level)	A	D

c) The following are emergency power supply requirements for CVCS valves:

Valve	Emergency Bus	Control Location (1)
CH-515 (receives SIAS)	B	A/C
CH-516 (receives SIAS & CIAS)	A	A/C
CH-560 (receives CIAS)	A	A
CH-561 (receives CIAS)	B	A
CH-580 (receives CIAS)	A	A
CH-506 (receives CIAS)	A	A/C
CH-505 (receives CIAS)	B	A/C
CH-523 (receives CIAS)	B	A
CH-507	A	A/C
CH-530	B	A
CH-531	A	A
CH-203	B	A/C
CH-205	A	A/C
CH-255	A	A
CH-501	A	A
CH-524	B	A
CH-536	A	A

Note (1): Location code is as follows; A-Control Room, B-Local, C-Remote Shutdown Panel, D-Location outside Control Room.

TABLE 9.3-8 (Cont'd.)

CHEMISTRY AND VOLUME CONTROL
SYSTEM LIST OF ACTIVE VALVES

Reference: Fig. 9.3-1, P&ID

Task Number	P&ID Coordinates	Valve * Type	Line Size (in)	Actuator * Type	Environmental Design Criteria
CH-331	D1	C	2.00	N	C(1)
CH-334	F1	C	2.00	N	C(1)
CH-440	C1	C	2.00	N	C(1)
CH-505	G7	G	1.00	D	C(1)
CH-506	G7	G	1.00	D	A-1, A-2, B
CH-530	B8	T	20.00	M	C, D
CH-531	C7	T	20.00	M	C, D
CH-524	E8	G	2.50	M	C(1)

Reference: Fig. 9.3-3, P&ID

Task Number	P&ID Coordinates	Valve * Type	Line Size (in)	Actuator * Type	Environmental Design Criteria
CH-494	H7	C	1.50	N	A-1, A-2, B
CH-560	D7	G	3.00	D	A-1, A-2, B
CH-561	D7	G	3.00	D	C(1)
CH-580	H6	G	1.50	D	C(1)

* Refer to Table 1.1-1 for definition of Symbols;
Appendix 3.11A for Environmental Design Criteria Legend

Note (1): C, F, G required if valve in annulus building

(2): See Section 3.11 for the extent of environmental qualification testing.

TABLE 6.2.4-1 (Cont'd.) (Sheet 4 of 5)

CONTAINMENT ISOLATION SYSTEM

Penetration Number	Applicable GDC	System[4]	Valve Operator	Primary[2] Actuation Mode	Secondary[2] Actuation Mode	Valve Position: Normal	Valve Position: Shut-down	Valve Position: Post-Accident	Valve Position: Failure	ESF[3] Actuation Signal	Closure Time (Sec)	Power Source
28	55	SCS	Motor	R	M	C	O or C	O or C	FAI	None	30	EA
			Motor	R	M	C	O	O or C	FAI	None	80	EA
			Motor	R	R	C	O	O or C	FAI	None	80	EC
29	55	SIS	None	M	M	C	O or C	C	FAI	None	N.A.	N.A.
			Air	A	R	C	O or C	C	FC	SIAS	5	EA
40	55	CVCS	Air	A	R, M	O	C	C	FC	CIAS/SIAS	5	EB
			Air	A	R	O	C	C	FC	CIAS	5	EA
41	55/56	CVCS	Motor	R	M	O	O	O	FAI	None	5	EB
			None	A	A	C	O or C	O or C	N.A.	None	N.A.	N.A.
			None	A	A	O	O or C	O or C	N.A.	None	N.A.	N.A.
			Hand	M	M	C	C	C	N.A.	None	N.A.	N.A.
			Hand	M	M	C	C	C	N.A.	None	N.A.	N.A.
43	55	CVCS	Air	A	R,M	O	O or C	C	FC	CIAS	5	EB
			Air	A	R	O	O or C	C	FC	CIAS	5	EA
44	55	CVCS	Air	A	R	O or C	C	C	FC	CIAS	5	EA
			Air	A	R, M	O or C	C	C	FC	CIAS	5	EB
45	55	CVCS	None	A	A	O or C	C	C	N.A.	None	N.A.	N.A.
			Air	A	R, M	O or C	C	C	FC	CIAS	5	EA
57	55	CVCS	Motor	R	M	O	O	O or C	FAI	None	5	EA
			None	A	A	O	O	O or C	N.A.	None	N.A.	N.A.

Enclosure 3

CESSAR Confirmatory Item 13

Boron Dilution Alarms

440.71 (15.D) You have provided, in Section 15D, the results of an inadvertent boron dilution event without a single failure under plant cold shutdown conditions. This information is not sufficient. You should provide results of analyses for all possible boron dilution events under various plant operational modes (e.g., refueling, startup, power operation, hot standby and cold shutdown). Also provide the results of analyses of these events with a single failure. Confirm that the results of these analyses meet the acceptance criteria for these events per SRP 15.5.1. In particular, the available times per operator action between the time of alarm and time to loss of shutdown margin should be shown to meet the SRP guidelines. The results of the analyses should be presented in the FSAR including tabulations of sequence of events, disposition of normally operating systems, utilization of safety systems, and all necessary transient curves for the events.

In your analysis, indicate for all modes of operation what alarms would identify to the operators that a boron dilution event was occurring. Consider the failure of the first alarm. Provide the time interval from this alarm to when the core would go critical. If a second alarm is not provided, show that the consequences of the most limiting unmitigated boron dilution event that meet the staff criteria and are acceptable.

Response

The times to loss of shutdown margin from event initiation for each of the six operational modes with three charging pumps operating are summarized below:

Operational Mode	Time to Loss of Shutdown Margin in Minutes
1	662
2	264
3	486
4	529
5	95
6	196

SRP 15.4.6 requires that at lest 15 minutes be available from the time the operator is made aware of an unplanned boron dilution event, to the time a loss of shutdown margin occurs during power operation (automatic control and manual modes), startup, hot standby, and cold shutdown. During refueling, a minimum time interval of 30 minutes must be available.

Any of the alarms and/or indications discussed below for MODES 1 through 6 will provide the operators with at least 15 minutes (30 minutes for MODE 6) to terminate the event before the shutdown margin is lost.

The times to loss of shutdown margin presented in the summary above represent the fastest dilution rates and, therefore, the shortest time for each mode. Consideration of additional single failures would not reduce the time to loss of shutdown margin. The only failure of significance involves the loss of the indications that alert the operators of a boron dilution. In MODES 1 and 2, there are no single active failures that result in the loss of any of the RPS alarms used to alert the operators that a boron dilution is in progress. In MODES 3,4,5, or 6, in case one or both startup flux channel alarms become inoperable, the operators would be required to implement operational procedure guidelines which would assure detection of a boron dilution event. In MODES 3, 4, and 5; the guidelines are based on determining the RCS boron concentration by either boronmeter or RCS sampling at frequencies which depend on the mode of operation. No single active failure can eliminate more than one of the methods of monitoring or determining the RCS boron concentration. Furthermore, in MODE 6, the boron dilution event is precluded because the manual isolation valve (CH-183) in the makeup water line is normally locked closed. When this valve needs to be opened to allow filling of the refueling water tank, the charging pump suction valve from the refueling water tank (CH-327) and makeup control valve to the volume control tank (CH-152) are closed, and remain closed, whenever the isolation valve is opened. In addition, the primary makeup water supply to charging pump isolation valve (CH-527) is locked closed at all times in MODE 6. Therefore, no single failure will result in boron dilution.

The results including tabulations of sequence of events, disposition of normally operating systems, utilization of safety systems, and transient curves for the limiting event will be presented in Section 15.4.6 of the FSAR.

The indications and/or alarms available to alert the operators that a boron dilution event is occuring in each of the six operational modes are outlined below.

(1) In MODES 1 and 2, the operator will be alerted to a boron dilution event from any of the following control room indications and corresponding pre-trip alarms: a high power or, for some set of conditions, a high pressure pressurizer trip in MODE 1 or a high logarithmic power level trip in MODE 2. Furthermore, a high TAVG alarm may also occur prior to trip.

(2) In MODES 3 and 4 with CEAs withdrawn, the high logarithmic power level trip and pre-trip alarm will provide an indication to alert the operator of an inadvertent boron dilution.

(3) In MODES 3, 4, and 5 with CEAs fully inserted and in MODE 6, two redundant high neutron flux alarms on the startup flux channels will provide indication of any boron dilution event. Limiting boron dilution events in subcritical operating modes will be analyzed to establish the startup channel alarm setpoint and reset time. The times to complete loss of shutdown margin, and hence reactivity insertion rates, and neutron flux responses satisfy the requirements of SRP 15.4.6.

This alarm will be powered by an onsite power source in the event the offsite power is lost

The fixed and movable in-core instrumentation systems are designed to perform the following functions:

a. To determine the gross power distribution in the core during different operating conditions from 20% to 100% power;

b. To provide data to estimate fuel burn-up in each fuel assembly;

c. To provide data for the evaluation of thermal margins in the core;

The fixed and movable in-core detectors can be used to assist in the calibration of the ex-core detectors by providing azimuthal and axial power distribution information. The ex-core system is used to provide indication of the flux power and axial distribution for the Reactor Protective System.

7.7.1.1.9 Ex-Core Neutron Flux Monitoring System (Non-Safety Channels)

The ex-core neutron flux monitoring system includes neutron detectors located around the reactor core and signal conditioning equipment located in the control room area. Neutron flux is monitored from source levels through full power operation and signal outputs are provided for reactor control and for information display.

Two startup channels provide source level neutron flux information to the reactor operator for use during extended shutdown periods, initial reactor startup, startups after extended shutdown periods, and following 5
reactor refueling operations. Each channel consists of a dual section proportional counter assembly, with each section having multiple BF_3 proportional counters, one preamplifier located outside the reactor shield, and a signal processing drawer containing power supplies, a logarithmic amplifier, and test circuitry. High voltage power to the proportional counters is terminated several decades of neutron flux above the source level to extend detector life. These channels provide readout and audio count rate information but have no direct control or protective functions.

Two control channels provide neutron flux information, in the power operating range of 1% to 125%, to the Reactor Regulating System for use during automatic turbine load-following operation (see Section 7.7.1.1.1). Each control channel consists of a dual section uncompensated ionization chamber detector and a signal conditioning drawer containing power supplies, a linear amplifier, and test circuitry. The detector is operated in the current mode only. These channels are completely independent of the safety channels.

7.7.1.1.10 Boron Dilution Alarm System

Reactivity control in the reactor core is effected, in part, by soluble boron in reactor coolant system. The Boron Dilution Alarm System (Figure 7.7-10) utilizes the startup channel nuclear instrumentation signals to detect a possible inadvertent boron diultion event while in Modes 3-6. There are two redundant and independent channels in the Boron Dilution Alarm System (BDAS) to ensure detection and alarming of the event.

The BDAS contairs logic which will detect a possible inadverent boron dilution event by monitoring the startup channel neutron flux indications. When these neutron flux signals increase (during shutdown) to equal or greater than the calculated alarm setpoint, alarm signals are initiated to the Plant Annunciation System. The alarm setpoint is periodically, automatically lowered to be a fixed amount above the current neutron flux signal. The alarm setpoint will only follow decreasing or steady flux levels, not an increasing signal. The current neutron flux indication and alarm setpoint (per channel) are displayed. There is also a reset capability to allow the operator to acknowledge the alarm and initialize the system.

7.7.1.2 Design Comparison

The functional design of the following, non-safety, control systems was performed by Combustion Engineering. The design differences between the control systems in the CESSAR Licensing scope and the control systems provided for the reference plant (Arkansas Nuclear One - Unit 2 - (ANO-2) NRC Docket No. 50-368) are discussed in this section.

b. This system controls feedwater to the upper (downcomer) and lower (economizer) steam generator nozzles; and

c. Each nozzle has one valve to control instead of a main and bypass valve for a single nozzle.

None of these design differences discussed above have been taken credit for in the safety analysis since they have no safety significance.

7.7.1.2.5 Steam Bypass Control System

The SBCS has the following design differences from the Steam Dump and Bypass Control System (SDBCS) of the reference plant.

a. This system controls eight turbine bypass valves, the SDBCS controls three turbine bypass valves and four atmospheric dump valves;

b. Singals are provided to the RPCS upon a major load rejection.

Neither of these design differences have been taken credit for in the safety analysis since they have no safety significance.

7.7.1.2.6 Reactor Power Cutback System

The RPCS did not exist in the reference plant. It has not been taken credit for in the Safety Analysis.

7.7.1.2.7 Boron Control System

The BCS is functionally identical to that used in the reference plant.

7.7.1.2.8 In-Core Instrumentation System

The in-core instrumentation system is functionally identical to that of the reference plant with the following changes:

a. There are 61 in-core instrument assemblies rather than 44;

b. The in-core instrumentation system is designed for bottom rather than top entry; and

c. The movable in-core system uses fission chambers.

None of these design differences have been taken credit for in the safety analysis since they have no safety significance.

7.7.1.2.9 Ex-Core Nuetron Flux Monitoring System

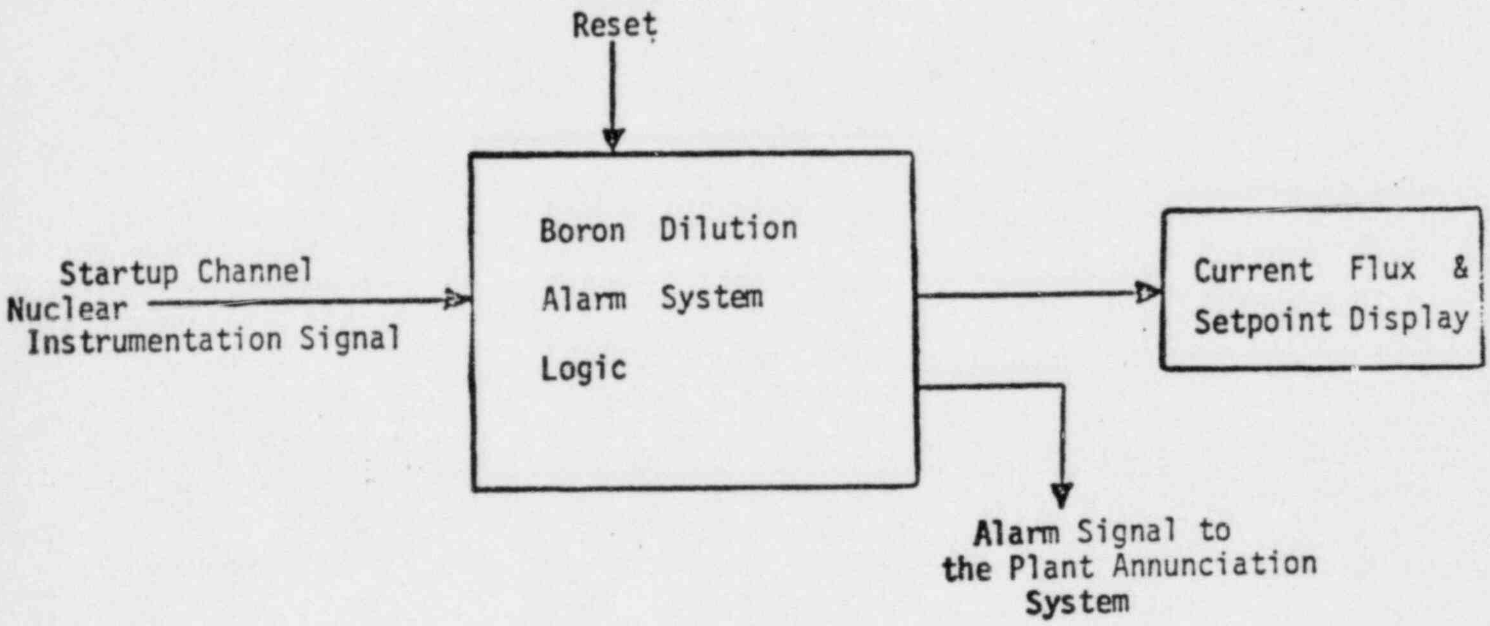
The ex-core monitoring system is identical to the reference plant except that it uses uncompensated ion chambers instead of fission chambers for the control channel detectors. This difference has no impact on the functioning of the system and has no safety significance.

7.7.1.2.10 Boron Dilution Alarm System

The Boron Dilution Alarm System is an addition to the CESSAR design. There is no functional comparison to the reference plant.

FIGURE 7.7-10

BOROIN DILUTION ALARM
SYSTEM SIMPLIFIED BLOCK DIAGRAM



Note: Only one of two identical channels is shown.

Enclosure 4

Palo Verde Confirmatory Item 13

Low Temperature Overpressure Protection Alarms

440.1 (5.2.2) A description of the design features which will be used to mitigate the consequences of overpressurization events while operating at low temperatures is not provided in the CESSAR System 80 FSAR. Provide a description of the features which will be provided on the CESSAR System 80. Specific design criteria regarding overpressurization protection while operating at low temperatures are as follows:

Operator Action: No credit can be taken for operator action for 10 minutes after the operator is aware of a transient.

Single Failure: The system must be designed to relieve the pressure transient given a single failure in addition to the failure that initiated the pressure transient.

Testability: The system must be testable on a periodic basis consistent with the system's employment.

Seismic and IEEE 279 Criteria: Ideally, the system should meet seismic Category 1 and IEEE 279 criteria. The basic objective is that the system should not be vulnerable to a common failure that would both initiate a pressure transient and disable the overpressure mitigating system. Such events as loss of instrument air and loss of offsite power must be considered.

1. An alarm must be provided to monitor the position of the pressurizer relief valve isolation valves to assure that the overpressure mitigating system is properly aligned for shutdown conditions.

2. In demonstrating that the mitigation system meets these criteria, the applicant should include the following information in his submittal:

   A. Identify and justify the most limiting pressure transients caused by mass input and heat input.

   B. Show that overpressure protection is provided (do not violate Appendix G limits) over the range of conditions applicable to shutdown/heatup operation.

   C. Identify and justify that the equipment will meet pertinent parameters assumed in the analyses (e.g., valve opening times, signal delay, valve capacity).

   D. Provide a description of the system including relevant P&I drawings.

   E. Discuss how the system meets the criteria.

   F. Discuss all administrative controls required to implement the protection system.

3. The staff will require the following Technical Specification provisions:

   A. A Technical Specification shall be imposed to ensure that the RCS is protected against low temperature overpressurization in conformance with RSB BTP 5-2 whenever the reactor coolant temperature is below an appropriate temperature.

   B. A Technical Specification shall be imposed to prohibit actuation of a reactor coolant pump if the associated steam generator to RCS ΔT is greater than the value support by analysis.

   C. The setpoint for automatic isolation of the SDCS will be raise to 700 psig or a pressure determined appropriate for CESSAR.

   D. A Technical Specification shall be imposed to test the SDCS safety-relief valves at intervals not to exceed 30 months.

4. Since the SDCS safety-relief valves are not included in the EPRI testing program, the staff will require additional information concerning the valve design. Specifically, identify the version of the ASME Code used for the design of the valves and quantify the margin in relieving capacity (i.e., maximum expected relief flow versus design relief flow) for the worst overpressure transient for which these valves provide protection.

<u>Response</u>: 1. The relief valves used for low temperature overpressure protection (LTOP) are the Shutdown Cooling System (SCS) relief valves. The SCS is specified by the Technical Specifications to be aligned to the Reactor Coolant System when LTOP protection is required. If the SCS is not aligned to the RCS before LTOP is required, an alarm will notify the operator to open SCS suction isolation valves (SI-651, 652, 653, 654).

2.A. The most limiting pressure transients produced by mass input and heat input have been identified through individual analyses. They are an inadvertent safety injection actuation and a reactor coolant pump start when a positive steam generator to reactor vessel temperature differential exists. Subsection 5.2.2.10.2.1 of CESSAR-FSAR will identify the above events as the most limiting, while also providing the results of the pressurization analyses.

2.B. Overpressure protection during heatup and cooldown is provided by the two Shutdown Cooling System (SCS) suction line relief valves. Administrative controls require the SCS isolation valves to be open, aligning the SCS to the Reactor Coolant System (RCS) during the LTOP mode.

The LTOP mode corresponds to RCS temperatures below approximately 330°F during heatup and 240°F during cooldown. These conditions are within the SCS operating range. Therefore, the SCS relief valves, having a setpoint at 450 psia, will prevent any pressure transient from exceeding the lowest P-T limit of 540 psia while it is aligned to the RCS.

2.C. The SCS relief valve is a self actuating spring-loaded liquid relief valve which does not require control circuitry. The valve opens when the RCS pressure exceeds its setpoint. The following comparison between System 80 and San Onofre 2 and 3 plants demonstrates that the ratio of the SCS relief valve capacities of each plant exceeds the ratios of the following factors in the most limiting transients. Since the San Onofre valve provides more than adequate relief, the System 80 relief valve should also provide sufficient relief capacity.

LTOP Comarison - System 80/San Onofre

Critical Parameter	San Onofre 2 & 3	System 80	Plant Ratio System 80/SONGS
RCS Pressure Limit	540 psia	540 psia	N/A
SCS Relief Valve Setpressure	417 psia	450 psia	N/A
Capacity	3089 gpm	4000 gpm	1.29
Two HPSI Pump Runout Flow *	1868 gpm	2250 gpm	1.20
SG Heat Transfer Area	103568 ft^2/SG	120253 ft^2/SG	1.16

NOTE: Same Limiting Transients as San Onofre. Specific plant transient calculations are being performed for System 80 to show that the LTOP system will meet specific criteria. These will be included in Subsection 5.2.2.10.2.1 of CESSAR-FSAR.

2.D. Section 5.4.7 provides a description of the SCS. The SCS is schematically shown on the RCS P&ID (Figure 5.1.2-1) and on the Safety Injection System (SIS) P&ID (Figure 6.3.2-1B). The SCS relief valves are self actuating spring-loaded liquid relief valves requiring no control circuitry. The electrical schematic for the SCS isolation valves is provided in the SIS P&ID (Figure 6.3.2-1B).

2.E. The LTOP system meets the specific criteria for system performance as follows:

Credit for Operator Action.

No credit is taken for operator action for 10 minutes after the operator is made aware that a transient is in progress.

Single Failure

Each SCS relief valve is designed to protect the reactor vessel, given any event initiating a pressure transient as a result of an operator error or equipment malfunction. The redundant SCS suction line trains between the RCS and SCS relief valves meet the single failure criteria as described in the CESSAR-FSAR paragraph 5.4.7.1.2 and Table 5.4.7-3. No single failure of an isolation valve or its associated interlock will prevent a relief valve from performing its intended function.

Testability

Periodic testing of the SCS isolation valves is defined in the Technical Specifications CESSAR-FSAR paragraph 16.3/4.5.2.

Seismic Design and IEEE 270 Criteria

The SCS suction line relief valves, isolation valves, associated interlocks, and instrumentation are designed to Seismic Category I requirements as discussed in CESSAR-FSAR subsections 3.2.1, paragraph 5.4.7.2.5 and Table 3.2-1. The interlocks and instrumentation associated with the SCS suction isolation valves satisfy the appropriate portions of IEEE 279 criteria as discussed in paragraphs 5.4.7.2.5, 7.6.2.1.1 and 7.6.2.2.1.

2.F. Technical Specifications require the SCS suction line isolation valves to be open when operating in the LTOP mode. The SCS will not be aligned to the RCS until the pressure is below the maximum pressure allowing SCS operation and T_H is below the SCS design temperature (400 psia and 350°F, respectively). Plant operating procedures will also limit the temperature differential between a steam generator and reactor vessel to less than 20°F in order to minimize a pressure transient in the event of an inadvertent RCP start.

3.A. A low temperature overpressure protection Technical Specification will be added to CESSAR-F.

3.B. Preliminary analysis results show that protection is afforded for a steam generator to RCS ΔT of at least 150°F. C-E believes that a steam generator to RCS ΔT of greater than 150°F is not a realistic possibility. Therefore C-E believes that there is no need for a Technical Specification on this criteria for System 80.

3.C. CESSAR will use the 700 psig setpoint valve.

3.D. CESSAR Technical Specifications will incorporate this criteria.

4. This information will be included in the SAR admendment which addresses low temperature overpressure protection.

5.2.2.10.2.2 Provision for Overpressure Protection

During heatup, RCS pressure is maintained below the maximum pressure for SCS operation until RCS cold leg temperature exceeds the applicable P-T operating curve temperature corresponding to 2500 lb/in.^{2}a (see Figure 3.4-2 in the Technical Specifications). If SI-651 and 653 or SI-652 and 654 SCS suction isolation valves are open and RCS pressure exceeds the maximum pressure for SCS operation, an alarm will notify the operator that a pressurization transient is occurring during low temperature conditions. Either SCS relief valve will terminate inadvertent pressure transients occurring during RCS temperature below the applicable P-T operating curve temperature corresponding to 2500 lb/in.^{2}a. Above the maximum LTOP temperature, overpressure protection is provided by the pressurizer safety valves when the SCS relief valve is isolated from the RCS.

During cooldown whenever RCS cold leg temperature is below the applicable temperature for LTOP, the SCS relief valves provide the necessary protection. If the SCS is not aligned to the RCS before cold leg temperature is decreased to the maximum temperature requiring LTOP, an alarm will notify the operator to open the SCS suction isolation valves (SI-651, 652, 653, 654). The maximum temperature requiring LTOP is based upon the evaluation of the applicable P-T curves. However, the SCS can not be aligned to the RCS until the pressure is below the maximum pressure allowing SCS operation (see paragraph 5.4.7.2.3, item a.2).

These LTOP conditions are within the SCS operating range. Technical Specification section 16.3/4.4.9.3 requires the SCS suction line isolation valves to be open when operating in the LTOP mode. Also, this Technical Specification ensures that appropriate action is taken if one or more SCS relief valves are out of service during the LTOP mode of operation.

Either SCS relief valve will provide sufficient relief capacity to prevent any pressure transient from exceeding the isolation interlock setpoint (See figures 5.2-1 and 5.2-2).

5.2.2.10.2.3 Equipment Parameters

The SCS relief valves are spring-loaded (bellows) liquid relief valves with sufficient capacity to mitigate the most limiting overpressurization event. Pertinent valve parameters are as follows:

Parameter

Setpoint 450 lb/in.^{2} a
Accumulation 10%
Capacity 4000 (@ 10% acc) gal/min

Since each SCS relief valve is a self actuating spring-loaded liquid relief valve, control circuitry is not required. The valve will open when RCS pressure exceeds its setpoint.

5. Pumps Used During Shutdown Cooling

The LPSI pumps are used as part of the SCS. During shutdown cooling, these pumps take suction from the reactor hot leg pipes and discharge through the shutdown cooling heat exchangers. The flow is then returned to the RCS through the LPSI header to the four cold legs. One LPSI pump is aligned to each shutdown cooling heat exchanger. At the start of shutdown cooling, both of the LPSI pumps are in service. When the RCS temperature is below 200°F, the containment spray pumps may be realigned and started to provide additional flow through the heat exchangers. The LPSI pumps are described in Section 6.3.2.2.2.

5.4.7.2.3 Overpressure Prevention

a. Overpressurization of the SCS by the RCS is prevented in the following ways:

   1. The shutdown cooling suction isolation valves (SI-651, 652, 653, and 654) are powered by four independent power supplies such that a fault in one power supply or valve will neither line up the RCS to either of the two SCS trains inadvertently nor prevent the initiation of shutdown cooling with at least one train when pressure permits.

   2. Interlocks associated with the shutdown cooling suction isolation valves prevent the valves from being opened if RCS pressure exceeds 400 psia, and close these valves automatically if RCS pressure should rise above the accumulation pressure of the shutdown cooling suction line reliefs valves. This value is 500 psia. The instrumentation and controls which implement this are discussed in Section 7.6.

   3. The SCS suction valves inside the containment are designed for full RCS pressure with the second valve forming the pressure boundary and class change.

   4. Alarms on SI-651, 652, 653 and 654 annunciate when the shutdown cooling system suction isolation valves are not fully closed. Also, if SI-651 and 653 or SI-652 and 654 valves are open and RCS pressure exceeds the maximum pressure for SCS operation, an alarm will notify the operator that a pressurization transient is occurring during low temperature conditions.

   5. Relief valves are provided as discussed in Section 5.4.7.2.2.

   The effects of inadvertent operation are discussed in Table 5.4.7-3.

5.4.7.2.4 Applicable Codes and Classifications

a. The SCS is a Safety Class 2 System, except for that portion discussed in b. below, which is Safety Class 1.

b. The piping and valves from the RCS up to and including SI-653 and 654 are designed to ASME B&PVC Section III, Class 1.

SIS to the refueling water tank or by opening the Safety Injection Tank isolation valves. The affected SCS train can then be isolated and core cooling continued with the other train.

A limited leakage passive failure is defined as the failure of a pump seal or valve packing, whichever is greater. The maximum leakage is expected to be from a failed LPSI pump seal.

This leakage to the pump compartment will normally drain to the room sump. From there it is pumped to the water management system. The sump pumps in each room will handle expected amounts of leakage. If leakages are greater than the sump pump capacity, the room will be isolated.

5.4.7.2.6 Manual Actions

1. Plant Cooldown

Plant cooldown is the series of manual operations which bring the reactor from hot shutdown to cold shutdown. Cooldown to approximately 350°F is accomplished by releasing steam from the secondary side of the steam generators. When the RCS pressure falls below 2150 psia, the Safety Injection Actuation Signal (SIAS) setpoint can be manually decreased as discussed in Section 7.2.1.1.1.6. When RCS pressure reaches 625 psig, the safety injection tank pressure is reduced to 400 psig. When RCS pressure reaches 400 psig, the safety injection tank isolation valves are closed.

When RCS temperature and pressure decrease below 350°F and the maximum pressure for SCS operation, the SCS may be used. If the SCS is not aligned to the RCS before cold leg temperature is reduced to below the maximum RCS cold leg temperature requiring LTOP, an alarm will notify the operator to open the SCS isolation valves (SI-651, 652, 653, 654). The maximum temperature requiring LTOP is based upon the evaluation of the applicable P-T curves. This operator action requires that the RCS be depressurized to below the maximum pressure for SCS operation, in order to clear the permissive SCS interlock (see paragraph 5.4.7.2.3, item a.2). Interlocks associated with the six valves on the two SCS suction lines prevent overpressurization of the SCS. See Section 7.6 and 5.4.7.2.3 for details. Also, if SI-651 and 653 or Si-652 and 654 SCS suction isolation valves are open and RCS pressure exceeds the maximum pressure for SCS operation, an alarm will notify the operator that a pressurization transient is occurring during low temperature conditions.

Shutdown cooling is initiated using only the LPSI pumps (LPSIP), with the CSS lined up for automatic initiation of spray, bypassing the shutdown cooling heat exchanger. The SCS is warmed up and placed in operation as follows (refer to Figures 6.3.2-1A, 1B, 1I, 1J, 1K, and 1L):

a. The containment spray isolation valves for the shutdown cooling heat exchangers (SI-684*, 687*, 689, 695) are shut.

b. The containment spray valves bypassing the shutdown heat exchangers (SI-688*, 693) are opened.

Enclosure 5

HPSI Low Flow Alarms

440.28 (6.3) Describe the means provided for ECCS pump protection including instrumentation and alarms available to indicate degradation of ECCS pump performance. Our position is that suitable means should be provided to alert the operator to possible degradation of ECCS pump performance. All instrumentation associated with monitoring the ECCS pump performance should be operable without offsite power, and should be able to detect conditions of low discharge flow.

Response: Listed below is the instrumentation used in conjunction with the low and high pressure safety injection pumps (LPSIP and HPSIP). This instrumentation is used in determining pump performance:

1. P-306 and P-307 are used for LPSIP 1 and 2 respectively. They indicate LPSIP discharge pressure in the control room.

2. P-308 is used for HPSI header #1 pressure. It measures the total pressure of HPSIP #1 and the charging pump. The location of this indication is in the control room.

3. P-309 measures the HPSIP #2 discharge pressure. Indication of the pressure reading is located in the control room.

4. P-303X and P-304Y measure the shutdown cooling heat exchanger (SDCHX) inlet pressures for SDCHX's 1 and 2 respectively. The pressures are indicated in the control room.

5. P-319, P-329, P-339 and P-349 determine the safety injection line pressures corresponding to RCS loops 2A, 2B, 1A and 1B respectively. They indicate and alarm in the control room.

6. P-390 and P-391 measure the HPSIP hot leg injection pressures for loops 1 and 2 respectively. They indicate and alarm in the control room.

7. F-306 and F-307 determine pump flowrates (minus miniflow) for LPSIP's 1 and 2, respectively. Indication of the LPSIP flowrates is located in the control room and locally. The signal from F-306 and F-307 is also sent to the Plant Monitoring System (PMS). The PMS will provide an audible alarm whenever a low flow condition is established in either LPSI pump discharge header. The PMS is provided with back-up power during loss of offsite power, although the PMS is not a safety grade system. Thus low flow protection is continously provided for both LPSI pumps.

8. F-311 (HPSIP discharge flow to RCS loop 2A), F-321 (HPSIP discharge flow to RCS loop 2B), F-331 (HPSIP discharge flow to RCS loop 1A), F-341 HPSIP discharge flow to RCS loop 1B), measure HPSIP cold leg flow rates. Indication of the flowrates is located in the control room.

Also, individual HPSI pump ultrasonic flow meters provide low flow alarming. Figure 6.3.2-1A (Amendment No. 7) shows a clamp-on type sonic sensor on each HPSI pump discharge pipe which will alarm in the control room during a low-flow condition. The HPSI pump discharge piping integrity is not broken with this instrumentation.

9. F-390 and F-391 measure HPSIP hot leg injection flowrates for loops 1 and 2, respectively. The location of this indication is in the control room.

The above instrumentation is used by the operator in regards to pump performance. If a loss of offsite power is incurred, the onsite diesel generators are used as a power supply.

CESSAR-F Table 7.5-2 is a listing of those parameters which have indications provided in the control room, allowing post-accident operational monitoring. The control room display information consists of pump operating status and flow indications which would indicate possible ECCS pump operation degradation. This table also indicates power supplies. The SIS shares common piping with the Containment Spray System (CSS). Piping and some components of the CSS are used during shutdown cooling operations. Some of this instrumentation may also be used by the operator in regards to ECCS pump performance, providing indication beyond that delineated in items 1 thru 9 above.

Testing to confirm ECCS pump performance within specification is included in the High Pressure and Low Pressure Safety Injection Subsystem Test sections of Preoperational Test, Section 14.2.12.1. In addition, Technical Specification 16.3/45.2 provides requirements for testing the safety injection system flowrates. Surveillance requirement 16.4.5.2.g specifies a maximum allowed ECCS pump flow as a criteria to ensure that the maximum pump flow will not result in any runout-related problems.

The high-pressure safety injection pumps are sized such that one HPSI pump (after consideration of spillage directly out the break) will supply adequate water to the core to match decay heat boiloff rates soon enough to minimize core uncovery and allow small break LOCA's to meet the performance criteria of 10CFR50.46. A typical pump characteristic curve is shown in Figure 6.3.2-3. The effectiveness of the pump during a steam line break is also analyzed to assure that the pumps are adequately sized.

Mechanical shaft seals are used and are provided with leakoffs which collect any leakage past the seals. The seals are designed for operation with a pumped fluid temperature of 350°F.

The pump motors are specified to have the capability of starting and accelerating the driven equipment, under load, to design point running speed within 5 seconds based on an initial voltage of 75% of the rated voltage at the motor terminals, increasing linearly with time to 90% voltage in the first 2 seconds, and increasing to 100% voltage in the next 2 seconds.

The pumps are provided with drain and flushing connections to permit reduction of radiation before maintenance. The pressure containing parts of the pump are stainless steel with internals selected for compatibility with boric acid solutions. The materials selected are analyzed to ensure that differential expansion during design transients can be accommodated.

The pumps are provided with minimum flow protection to prevent damage resulting from operation against a close discharge. Also, individual HPSI pump ultrasonic flow meters provide low flow alarming.

The design temperature is based on the saturation temperature of the reactor coolant at the containment design pressure plus a design tolerance. The design pressure for the high pressure pumps is based on the shutoff head plus maximum containment pressure plus a design tolerance. The High-Pressure Pump Data is summarized in Table 6.3.2-1.

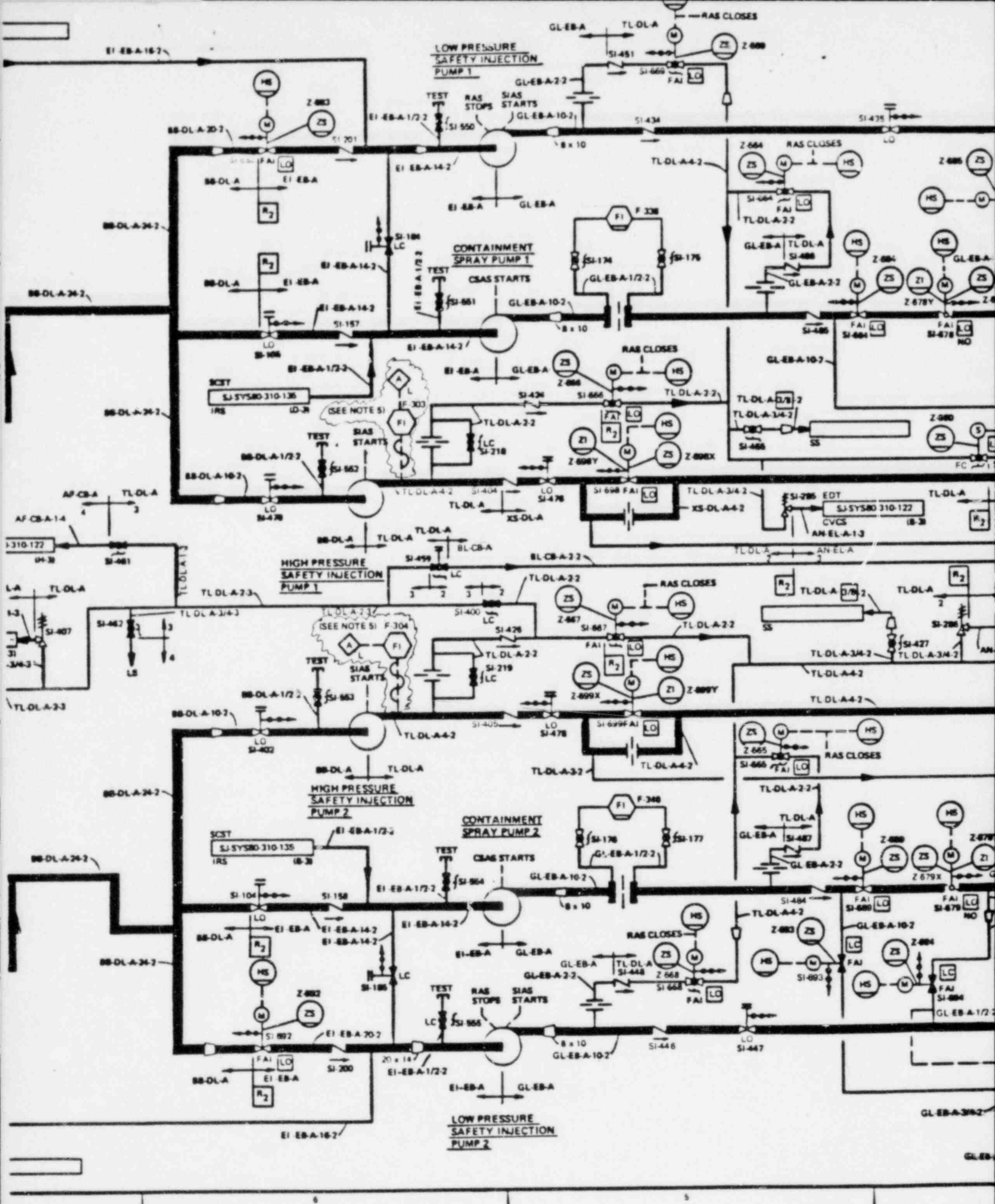
6.3.2.2.4 Piping

Piping is specified to deliver borated safety injection water from the safety injection tanks and from the refueling water tank via the safety injection pumps, to the safety injection nozzles in the RCS. The major piping sections are (refer to Figures 6.3.2-1A & 1B):

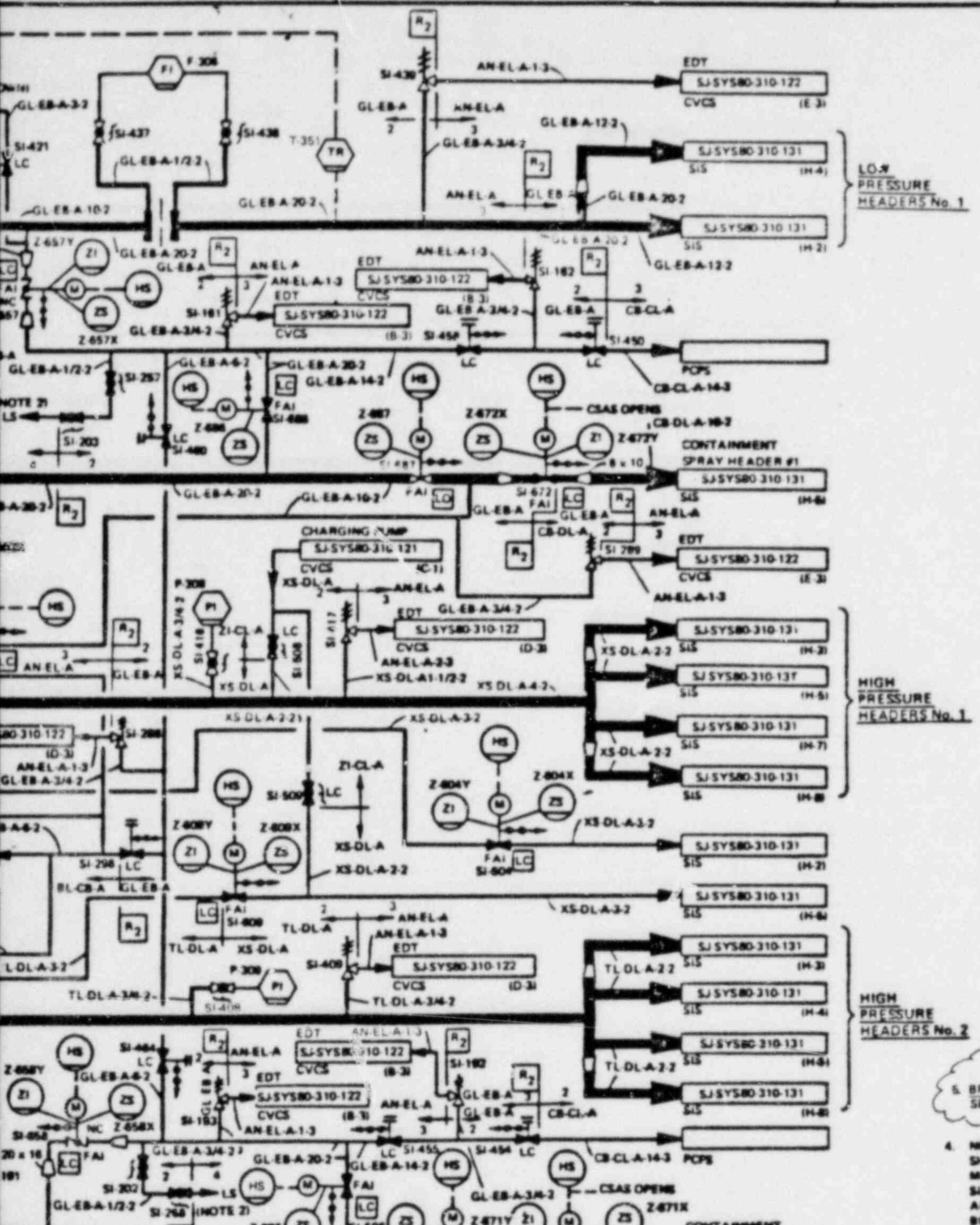
a. From each safety injection tank to its respective RCS cold leg safety injection nozzle;

b. Redundant piping from the refueling water tank and containment sump to the suction of the high- and low-pressure safety injection pumps;

c. Redundant piping from the high-pressure safety injection pumps discharge to redundant high-pressure injection headers each of which serves the four safety injection nozzles on the cold legs and one nozzle on each shutdown cooling suction line;



LOW PRESSURE SAFETY INJECTION PUMP 1
CONTAINMENT SPRAY PUMP 1
HIGH PRESSURE SAFETY INJECTION PUMP 1
HIGH PRESSURE SAFETY INJECTION PUMP 2
CONTAINMENT SPRAY PUMP 2
LOW PRESSURE SAFETY INJECTION PUMP 2
RAS CLOSES
RAS STOPS
SIAS STARTS
CSAS STARTS
TEST
(SEE NOTE 5)
F-303
F-304
SCST
SJ-SYS80-310-135
IRS
SJ-SYS80 310-122
CVCS
EDT
8 x 10
20 x 14
EI-EB-A
GL-EB-A
TL-DL-A
BB-DL-A
XS-DL-A
AN-EL-A
AF-CB-A
BL-CB-A
SS
LO
LC
FAI
NO
FC
6
5



5. BROKEN LINE INDICATES CLAMP-ON TYPE SONIC SENSOR, PIPE INTEGRITY NOT BROKEN.

4. NOMINAL SIZES OF C-E SUPPLIED COMPONENTS ARE SHOWN ON THE P&ID. FOR DETAILED EQUIPMENT PARAMETERS, SEE THE EQUIPMENT SPECIFICATION. PIPE SIZES ARE TYPICAL. HEAD LOSS/Δ P REQUIREMENTS ARE FOUND IN THE INTERFACE DOCUMENT. DUE TO BUILDING ARRANGEMENTS, PIPE SIZES MAY HAVE TO DIFFER FROM THOSE SHOWN.

3. FOR SYMBOLS & ABBREVIATIONS SEE DRAWING SJ-SYS80-310-100 SEE FIGURE (1.1-1)

2. THIS LINE MUST BE LEAD OUT OF SAFEGUARDS ROOM.

1. ENCAPSULATED VALVES OR EQUIVALENT CONTAINMENT PENETRATION SATISFYING GENERAL DESIGN CRITERIA 54 AND 56.

SJ-SYS80-310-130

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C - E SYSTEM 80	SAFETY INJECTION SYSTEM PIPING AND INSTRUMENTATION DIAGRAM	Figure 6.3.2-1A