PSNH

Public Service of New Hampshire

SEABROOK STATION
Engineering Office

August 19, 1986
SBN-1178
T.F. # Q2.2.2, B7.1.3

United States Nuclear Regulatory Commission
Washington, DC 20555

Attention: Mr. Vincent S. Noonan, Project Director
PWR Project Directorate No. 5

References:
(a) Construction Permits CPPR-135 and CPPR-136, Docket Nos. 50-443 and 50-444
(b) PSNH Letter (SBN-1162), dated July 18, 1986, "Final 10CFR50.55(e) Report" Emergency Code Cooling Design Deficiency (CDR-86-00-07)", J. DeVincentis to R. W. Starostecki

Subject: Emergency Core Cooling Design

Dear Sir:

In Reference (b), we submitted a final 10CFR50.55(e) Report regarding the valve alignment of the Emergency Core Cooling System (ECCS) at Seabrook Station during the cold leg recirculation phase of post-LOCA ECCS operation. Additionally, in that letter we transmitted the appropriate FSAR changes to reflect our response.

While in our reference letter we apprised NRR of the FSAR changes, your Staff has instructed us to send, under separate cover, those changes made as a result of our resolution to the final 10CFR50.55(e) report.

We trust that by copy of this letter, we have conformed to your Staff's request.

Very truly yours,

John DeVincentis

John DeVincentis
Director of Engineering

cc: Atomic Safety and Licensing Board Service List

B001 1/1 Add: IE/DQAVT/VPB

Diane Curran, Esquire
Harmon & Weiss
2001 S. Street, N.W.
Suite 430
Washington, D.C. 20009

Sherwin E. Turk, Esq.
Office of the Executive Legal Director
U.S. Nuclear Regulatory Commission
Tenth Floor
Washington, DC 20555

Robert A. Backus, Esquire
116 Lowell Street
P.O. Box 516
Manchester, NH 03105

Philip Ahrens, Esquire
Assistant Attorney General
Department of The Attorney General
Statehouse Station #6
Augusta, ME 04333

Mrs. Sandra Gavutis
Chairman, Board of Selectmen
RFD 1 - Box 1154
Kennsington, NH 03827

Carol S. Sneider, Esquire
Assistant Attorney General
Department of the Attorney General
One Ashburton Place, 19th Floor
Boston, MA 02108

Senator Gordon J. Humphrey
U.S. Senate
Washington, DC 20510
(ATTN: Tom Burack)

Richard A. Hampe, Esq.
Hampe and McNicholas
35 Pleasant Street
Concord, NH 03301

Thomas F. Powers, III
Town Manager
Town of Exeter
10 Front Street
Exeter, NH 03833

Brentwood Board of Selectmen
RFD Dalton Road
Brentwood, NH 03833

Gary W. Holmes, Esq.
Holmes & Ells
47 Winnacunnet Road
Hampton, NH 03842

Mr. Ed Thomas
FEMA Region I
442 John W. McCormack PO & Courthouse
Boston, MA 02109

Peter J. Mathews, Mayor
City Hall
Newburyport, MA 01950

Judith H. Mizner
Silvergate, Gertner, Baker,
Fine, Good & Mizner
88 Broad Street
Boston, MA 02110

Calvin A. Canney
City Manager
City Hall
126 Daniel Street
Portsmouth, NH 03801

Stephen E. Merrill, Esquire
Attorney General
George Dana Bisbee, Esquire
Assistant Attorney General
Office of the Attorney General
25 Capitol Street
Concord, NH 03301-6397

Mr. J. P. Nadeau
Selectmen's Office
10 Central Road
Rye, NH 03870

Mr. Angie Machiros
Chairman of the Board of Selectmen
Town of Newbury
Newbury, MA 01950

Mr. William S. Lord
Board of Selectmen
Town Hall - Friend Street
Amesbury, MA 01913

Senator Gordon J. Humphrey
1 Pillsbury Street
Concord, NH 03301
(ATTN: Herb Boynton)

H. Joseph Flynn, Esquire
Office of General Counsel
Federal Emergency Management Agency
500 C Street, SW
Washington, DC 20472

Paul McEachern, Esquire
Matthew T. Brock, Esquire
Shaines & McEachern
25 Maplewood Avenue
P.O. Box 360
Portsmouth, NH 03801

Robert Carrigg
Town Office
Atlantic Avenue
North Hampton, NH 03862

SEABROOK STATION
Engineering Office

PSNH

July 18, 1986

Public Service of New Hampshire

SBN- 1162
T.F. Q2.2.2

NEW HAMPSHIRE YANKEE DIVISION

United States Nuclear Regulatory Commission
Region I
631 Park Avenue
King of Prussia, PA 19406

Attention: Mr. Richard W. Starostecki, Director
Division of Project and Resident Programs

References: (a) Construction Permits CPPR-135 and CPPR-136, Docket Nos. 50-443 and 50-444
(b) Telecon of June 6, 1986, W. J. Daley (YAEC), M. A. Chiasson (NHY), R. W. Gregory (YAEC) to Rick Urban (NRC - Region I)

Subject: Final 10CFR50.55(e) Report: Emergency Core Cooling System Design Deficiency (CDR-86-00-07)

Dear Sir:

In Reference (b), we reported a 10CFR50.55(e) deficiency regarding the valve alignment of the Emergency Core Cooling System (ECCS) at Seabrook Station during the cold leg recirculation phase of post-LOCA ECCS operation.

Description of Deficiency

During the cold leg recirculation phase of post-LOCA ECCS operation, each Low Head Safety Injection (RHR) pump takes suction from the containment sump and discharges directly to two Reactor Coolant System (RCS) cold legs and to a suction header common to both High Head Safety Injection (SI) pumps and both High Head Centrifugal Charging (CS) pumps. In the event that one of the fully redundant RHR pumps failed, the remaining active RHR pump would discharge directly to two RCS cold legs, to the common suction header, and to the alternate two RCS cold legs via the discharge line of the failed pump. The availability of the latter flowpath, which was previously unaccounted for in system design analyses or testing, would reduce the NPSH provided to the CS pumps below the required NPSH.

~~8608110036~~

19pp.

Safety Implications

Failure of an RHR pump during the cold leg recirculation phase of Post-LOCA ECCS operation could result in damage to both high head CS pumps. This in turn would reduce the long term core cooling capabilities of the ECCS.

Corrective Action

A low head safety injection system valve alignment will be used which is different than that provided in the FSAR for the cold leg recirculation mode. This alignment will provide acceptable system hydraulic characteristics and still meet core cooling requirements. The FSAR changes reflecting the new alignment are provided herewith in Attachment 1. In addition the new alignment has already been incorporated in Seabrook Station's emergency operating procedures.

The above referenced FSAR change will be incorporated into the FSAR by a future amendment. In this regard it should be noted that we are also sending a copy of this letter to NRR to apprise them of these FSAR changes.

This letter is being filed as a final 10CFR50.55(e) report.

Very truly yours,

John DeVincentis
Director of Engineering

Attachment

cc: Atomic Safety and Licensing Board Service List

Director, Office of Inspection and Enforcement
United States Nuclear Regulatory Commission
Washington, DC 20555

Mr. Vincent S. Noonan, Project Director
PWR Project Directorate No. 5
United States Nuclear Regulatory Commission
Washington, DC 20555

Diane Curran, Esquire
Harmon & Weiss
2001 S. Street, N.W.
Suite 430
Washington, D.C. 20009

Sherwin E. Turk, Esq.
Office of the Executive Legal Director
U.S. Nuclear Regulatory Commission
Tenth Floor
Washington, DC 20555

Robert A. Backus, Esquire
116 Lowell Street
P.O. Box 516
Manchester, NH 03105

Philip Ahrens, Esquire
Assistant Attorney General
Department of The Attorney General
Statehouse Station #6
Augusta, ME 04333

Mrs. Sandra Gavutis
Chairman, Board of Selectmen
RFD 1 - Box 1154
Kennsington, NH 03827

Carol S. Sneider, Esquire
Assistant Attorney General
Department of the Attorney General
One Ashburton Place, 19th Floor
Boston, MA 02108

Senator Gordon J. Humphrey
U.S. Senate
Washington, DC 20510
(ATTN: Tom Burack)

Richard A. Hampe, Esq.
Hampe and McNicholas
35 Pleasant Street
Concord, NH 03301

Thomas F. Powers, III
Town Manager
Town of Exeter
10 Front Street
Exeter, NH 03833

Brentwood Board of Selectmen
RFD Dalton Road
Brentwood, NH 03833

Gary W. Holmes, Esq.
Holmes & Ells
47 Winnacunnet Road
Hampton, NH 03842

Mr. Ed Thomas
FEMA Region I
442 John W. McCormack PO & Courthouse
Boston, MA 02109

[illegible]
City Hall
Newburyport, MA 01950

Judith H. Mizner
Silvergate, Gertner, Baker,
Fine, Good & Mizner
88 Broad Street
Boston, MA 02110

Calvin A. Canney
City Manager
City Hall
126 Daniel Street
Portsmouth, NH 03801

Stephen E. Merrill, Esquire
Attorney General
George Dana Bisbee, Esquire
Assistant Attorney General
Office of the Attorney General
25 Capitol Street
Concord, NH 03301-6397

Mr. J. P. Nadeau
Selectmen's Office
10 Central Road
Rye, NH 03870

Mr. Angie Machiros
Chairman of the Board of Selectmen
Town of Newbury
Newbury, MA 01950

Mr. William S. Lord
Board of Selectmen
Town Hall - Friend Street
Amesbury, MA 01913

Senator Gordon J. Humphrey
1 Pillsbury Street
Concord, NH 03301
(ATTN: Herb Boynton)

H. Joseph Flynn, Esquire
Office of General Counsel
Federal Emergency Management Agency
500 C Street, SW
Washington, DC 20472

Paul McEachern, Esquire
Matthew T. Brock, Esquire
Shaines & McEachern
25 Maplewood Avenue
P.O. Box 360
Portsmouth, NH 03801

Robert Carrigg
Town Office
Atlantic Avenue
North Hampton, NH 03862

TWO

the automatic and manual switchover sequence, the two residual heat removal pumps would take suction from the containment sump and deliver borated water directly to the RCS cold legs. A portion of the Number 1 residual heat removal pump discharge flow would be used to provide suction to the two charging pumps which would also deliver directly to the RCS cold legs. A portion of the discharge flow from the Number 2 residual heat removal pump would be used to provide suction to the two safety injection pumps which would also deliver directly to the RCS cold legs. As part of the manual switchover procedure (see Table 6.3-7, Step 4), the suctions of the safety injection and charging pumps are cross connected so that one residual heat removal pump can deliver flow to the RCS and both safety injection and charging pumps, in the event of the failure of the second residual heat removal pump.

After approximately 18 hours, cold leg recirculation is terminated and hot leg recirculation is initiated. This is done to terminate any boiling in the core should the break be in one of the RCS cold legs. During this phase of recirculation, the SIP's discharge is aligned to supply water to all four RCS hot legs and the RHRP's discharge is aligned to supply water to RCS hot legs 1 and 4. The CCP's do not have the capability to feed the hot legs and continue to supply the cold legs.

6.3.2.2 Equipment and Component Descriptions

The component design and operating conditions listed in Table 6.3-1 are specified as the most severe conditions to which each respective component is exposed during either normal plant operation, or during operation of the ECCS. For each component, these conditions are considered in relation to the code to which it is designed. By designing the components in accordance with applicable codes, and with due consideration for the design and operating conditions, the fundamental assurance of structural integrity of the ECCS components is maintained. Components of the ECCS are designed to withstand the appropriate seismic loadings in accordance with their safety class as given in Table 3.2-2. 56

Descriptions of the major mechanical components of the ECCS follow:

a. Accumulators

The accumulators are pressure vessels partially filled with borated water and pressurized with nitrogen gas. During normal operation, each accumulator is isolated from the RCS by two check valves in series. Should the RCS pressure fall below the accumulator pressure, the check valves open and borated water is forced into the RCS. One accumulator is attached to each of the cold legs of the RCS. Mechanical operation of the swing disc check valves is the only action required to open the injection path from the accumlators to the core via the cold leg.

b. Passive Failure Criteria

The following design philosophy assures the necessary redundancy in component and system arrangement in order to meet the intent of the General Design Criteria on single failure as it specifically applies to failure of passive components in the ECCS. Thus, for the long term, the system design is based on accepting either a passive or an active failure.

1. Redundancy of Flow Paths and Components for Long Term Emergency Core Cooling

In design of the ECCS, Westinghouse utilizes the following criteria:

(a) During the long term cooling period following a loss of coolant, the emergency core cooling flow paths shall be separable into two subsystems, either of which can provide minimum core cooling functions and return spilled water from the floor of the containment back to the RCS.

(b) Either of the two subsystems can be isolated and removed from service in the event of a leak outside the containment. Redundant motor operated valves arranged in series are provided for this isolation function.

(c) Adequate redundancy of check valves is provided to tolerate failure of a check valve during the long term as a passive component.

(d) Should one of these two subsystems be isolated in this long term period, the other subsystem remains operable.

(e) Provisions are also made in the design to detect leakage from components outside the containment, to collect this leakage, and to provide for maintenance of the affected equipment.

A single passive failure analysis is presented in Table 6.3-6. It demonstrates that the ECCS can sustain a single passive failure during the long term phase and still retain an intact flow path to the core to supply sufficient flow to maintain the core covered and affect the removal of decay heat. The procedure followed to establish the alternate flow path also isolates the component which failed.

Thus, for the long term emergency core cooling function, adequate core cooling capacity exists with one flow path removed from service.

to actuate the spray, but not high enough to seat the check valves referenced above. This would result in a continued high flow rate from the tank until the RWST isolation valves (CBS-V2, V5) are closed (approximately 75 seconds after "lo-lo-1" signal by Table 6.3-10. From this point there is at least 5.1 minutes of operation at 1,800 gpm, for a total of 6.4 minutes before the "empty" alarm sounds. There is at least 31.0 minutes of operation between the "lo-lo-1" and possible vortexing in this case. 53

The limiting single failure for the design is the failure of one of the RWST isolation valves (CBS-V2, -V5) to close. If one of these valves does not close, the flow rate drops from 16,400 to 9,100 gpm (not 1,800). At this high flow rate, the "empty" alarm will sound, alerting the operator to immediately shut off any pumps still taking suction from the tank. There is sufficient volume between the "empty" alarm and the calculated vortexing level for at least 1.9 minutes of operation for shutting off the pumps. 45 55 53

Following the automatic and manual switchover sequence, the two residual heat removal pumps would take suction from the containment sump and deliver borated water directly to the RCS cold legs. A portion of the Number 1 residual heat removal pump discharge flow would be used to provide suction to the two charging pumps which would also deliver directly to the RCS cold legs. A portion of the discharge flow from the Number 2 residual heat removal pump would be used to provide suction to the two safety injection pumps which would also deliver directly to the RCS cold legs. As part of the manual switchover procedure (see Table 6.3-7, Step 4), the suctions of the safety injection and charging pumps are cross-connected so that one residual heat removal pump can deliver flow to the RCS and both safety injection and charging pumps, in the event of the failure of the second residual heat removal pump.

See Section 7.5 for process information available to the operator in the control room following an accident.

45

6.3.3 Performance Evaluation

Chapter 15 accidents that result in ECCS operation are as follows:

a. Inadvertent opening of a steam generator relief or safety valve (see Section 15.1.4).

b. Small break LOCA (see Section 15.6.5).

c. Large break LOCA (see Section 15.6.5).

d. Major secondary system pipe failure (see Section 15.1.5).

e. Steam generator tube failure (see Section 15.6.3).

Safety injection is actuated from any of the following:

a. Low pressurizer pressure.

b. Low steamline pressure.

c. High containment pressure.

d. Manual initiation.

A safety injection signal will rapidly trip the main turbine, close all feedwater control valves, trip the main feedwater pumps, and close the feedwater isolation valves.

Following the actuation signal, the suction of the centrifugal charging pumps is diverted from the volume control tank to the refueling water storage tank. Simultaneously, the valves isolating the charging pumps from the injection header automatically open. The safety injection pumps also start automatically but operate at shut off head when the RCS is at normal pressure. The passive injection system (accumulators) and the low head system (residual heat removal pumps) also provide no flow at normal RCS pressure. 5-

Figure 6.3-2 is a simplified illustration of the ECCS. The notes provided with Figure 6.3-2 contain information relative to the operation of the ECCS in its various modes. The modes of operation illustrated are full operation of all ECCS components, cold leg recirculation with residual heat removal pump Number 2 operating, and hot leg recirculation with residual heat removal pump Number 1 operating. These are representative of the operation of the ECCS during accident conditions.

Lag times for initiation and operation of the ECCS are limited by pump startup time and consequential loading sequence of these motors onto the safeguard

NOTES TO FIGURE 6.3-2
(Sheet 1 of 19)

MODES OF OPERATION

MODE A - INJECTION

This mode presents the process conditions for the case of maximum safeguards, i.e., all pumps operating, following accumulator delivery. Two residual heat removal (RHR) pumps, two safety injection (SI) pumps, and two centrifugal charging (CC) pumps operate, taking suction from the refueling water storage tank and delivering to the reactor through the cold leg connections. Note that the flow from each pump is less than its maximum runout since the pump discharge piping is shared by the two pumps of each subsystem. Note also that the SI pump branch connections to the residual lines are close to their discharge into the accumulator lines. thereby minimizing any increase in the RHR branch line head loss due to the combined flows of the RHR and SI pumps.

MODE B - COLD-LEG RECIRCULATION

This mode presents the process conditions for the case of cold-leg recirculation assuming residual heat removal (RHR) pump No. 2 operating, safety injection pumps 1 and 2 operating, and centrifugal charging (CC) pumps 1 and 2 operating. It is assumed that the spray pumps have emptied the RWST at this time.

In this mode the safeguards pumps operate in series, with only the RHR pump capable of taking suction from the containment sump. The recirculated coolant is then delivered by the RHR pump to both of the SI pumps which deliver to the reactor through their cold-leg connections and to both of the CC pumps which deliver to the reactor through their cold-leg connections. The RHR pump also delivers flow directly to the reactor through two cold legs since the RHR discharge cross connect valves are closed when making the transfer from injection to recirculation.

MODE C - HOT-LEG RECIRCULATION

This mode presents the process conditions for the case of hot-leg recirculation, assuming residual heat removal (RHR) pump No. 1 operating, centrifugal charging (CC) pumps 1 and 2 operating, and safety injection (SI) pumps 1 and 2 operating.

In this mode, the safeguards pumps again operate in series with only the RHR pump taking suction from the containment sump. The recirculated coolant is then delivered by the RHR pump to both of the CC pumps which continue to deliver to the reactor through their cold-leg connections and to both of the SI pumps which deliver to the reactor through their hot-leg connections. The RHR pump also delivers directly to the reactor through two hot-leg connection

NOTES TO FIGURE 6.3-2
(Sheet 3 of 19)

VALVE ALIGNMENT CHART (Cont'd)

OPERATIONAL MODES

VALVE NUMBER	A	B	C
21	C	0	0
22	0	[illegible] - 0	0
23	0	[illegible] - 0	0
24	0	0	C
25	C	C	0
26	0	[illegible] - C	C
27	C	C	C
28	0	C	C
29	C	0	0
30	C	C	C
31	C	C	C
35	0	0	0

---

0 = OPEN
C = CLOSED

Motor operated gate valve RH-V14	Fails to close on demand	Recirculation - cold legs of RC loops.	Failure reduces redundancy of providing LHSI/RHR pump discharge flow path isolation to cold legs of RCS. No effect on safety for system operation. Alternate isolation valve RH-V26 will be closed to isolate alternate flow path to cold legs.	Same method of detection as that stated for item #4.	

TABLE 6.3-5
(Sheet 5 of 10)

Component	Failure Mode	ECCS Operation Phase	*Effect on System Operation	**Failure Detection Method	Remarks
11. Motor operated gate valve CBS-V2 (CBS-V5 analogous)	Fails to close on demand.	Recirculation - cold legs of RC loops.	Failure reduces redundancy of providing flow isolation of Containment Sump from RWST. No effect on safety for system operation. Alternate check isolation valve CBS-V55 provides backup isolation.	Same method of detection as that stated for item #4.	Valve is electrically interlocked with isolation valve CBS-V8 and RH-V35 and may not be opened unless these valves are closed, for manual operation from main control board. Valve opens automatically on "S" signal. 56
12. Motor operated gate valve RH-V22 (RH-V21 analogous)	Fails to close on demand.	Recirculation - cold legs of RC loops.	Failure reduces redundancy of providing LHSI/RHR pump train separation for recirculation of fluid to cold legs of RCS. No effect on safety for system operation. Alternate isolation valve RH-V21 provides backup isolation for LHSI/RHR pump train separation.	Same method of detection as that stated for item #4.	56
13. Motor operated globe valve SI-V93	Fails to close on demand.	Recirculation - cold legs of RC loops.	Failure reduces redundancy of providing isolation of HHSI/SI pump's miniflow line isolation from RWST. No effect on safety for system operation. Alternate isolation valves SI-V89 and SI-V90 in each pump's miniflow line provide backup isolation.	Same method of detection as that stated for item #4.	Valve is electrically interlocked with isolation valves RH-V35 and RH-V36 and may not be opened unless these valves are closed. 56
14. Motor operated globe valve SI-V90 (SI-V89 analogous)	Fails to close on demand.	Recirculation - cold legs of RC loops.	Failure reduces redundancy of providing isolation of HHSI/SI pump SI-P-6A miniflow isolation from RWST. No effect on safety for system operation. Alternate isolation valve SI-V93 in main miniflow line provides backup isolation.	Same method of detection as that stated for item #4.	Same remark as that stated for item #16. 56

TABLE 6.3-5
(Sheet 6 of 10)

Component	Failure Mode	ECCS Operation Phase	*Effect on System Operation	**Failure Detection Method	Remarks
15. Motor operated gate valve RH-V35	Fails to open on demand.	Recirculation - cold legs of RC loops.	Failure reduces redundancy of providing NPSH to suction of HHSI/CH pumps from LHSI/RHR pumps. No safety effect on system operation. Minimum NPSH to HHSI/CH pump suction will be met by flow from LHSI/RHR pump RH-P-8B via cross-tie line and opening of isolation valve CS-V460 or CS-V461 and isolation valve RH-V36.	Same method of detection as that stated for item [illegible] #4.	Valve is electrically interlocked with isolation valves SI-V90, SI-V89, SI-V93, RC-V23, RC-V22 and CBS-V8. Valve can not be opened unless valve SI-V93 or SI-V90 and SI-V89 valves are closed; valve RCS-V23 or RCS-V22 is closed, and CBS-V8 is open.
16. Motor operated gate valve RH-V36	Fails to open on demand.	Recirculation - cold legs of RC loops.	Failure reduces redundancy of providing NPSH to suction of HHSI/SI pumps from LHSI/RHR pumps. No effect on safety for system operation. Minimum NPSH to HHSI/SI pump suction will be met by flow from LHSI/RHR pump RH-P-8A via cross-tie line and opening of isolation valve CS-V460 or CS-V461 and isolation valve RH-V35.	Same method of detection as that stated for item [illegible] #4.	Valve is electrically interlocked with isolation valves, SI-V90, SI-V89, SI-V93, CBS-V14, RC-V88 and RC-V87. Valve cannot be opened unless valve SI-V93 or SI-V90 and SI-V89 valves are closed; valve RC-V88 or RC-V87 is closed and valve CBS-V14 is open.
17. Motor operated gate valve CS-V460 (CS-V461 analogous)	Fails to open on demand.	Recirculation - cold legs of RC loops.	Failure reduces redundancy of providing fluid flow through cross-tie between suction of HHSI/CH pumps and HHSI/SI pumps. No effect on safety of system operation. Alternate isolation valve (CS-V461 opens to provide backup flow path through cross-tie line.	Same method of detection as stated for item [illegible] #4.	
18. Motor operated gate valve CBS-V47 (CBS-V51 analogous)	Fails to close on demand.	Recirculation - cold legs of RC loops.	Failure reduces redundancy of providing flow isolation of HHSI/SI pump suction from RWST. No effect on safety for system operation. Alternate check isolation valve (CBS-V48) provides backup isolation.	Same method of detection as that stated for item #4.	

TABLE 6.3-5
(Sheet 7 of 10)

Component	Failure Mode	ECCS Operation Phase	*Effect on System Operation	**Failure Detection Method	Remarks
19. Motor operated gate valve LCV-112D (LCV-112E analogous)	Fails to close on demand.	Recirculation - cold legs of RC loops.	Failure reduces redundancy of providing flow isolation of suction of HHSI/CH pumps from RWST. No effect on safety for system operation. Alternate check isolation valve (CBS-V58) provides backup isolation.	Same method of detection as that stated previously for failure of item during injection phase of ECCS operation.	56
20. Residual heat pump RH-P-8A (pump RH-P-8B analogous)	Fails to deliver working fluid.	Recirculation - cold legs of RC loops.	Failure reduces redundancy of providing recirculation of coolant to the RCS from the Containment Sump. Fluid flow from LHSI/RHR pump RH-P-8A will be lost. Minimum recirculation flow requirements for LHSI flow will be met by LHSI/RHR pump RH-P-8B delivering fluid.	Same method of detection as that stated previously for failure of item during injection phase of ECCS operation.	56
21. Safety injection pump SI-P-6A (pump SI-P-6B analogous)	Fails to deliver working fluid.	Recirculation - cold or hot legs of RC loops.	Failure reduces redundancy of providing recirculation of coolant to the RCS from the Containment Sump to cold legs of RC loops via RHR and SI pumps. Fluid flow from HHSI/SI pump SI-P-6A will be lost. Minimum recirculation flow requirements for HHSI flow will be met by HHSI/SI pump SI-P-6B delivering working fluid.	Same method of detection as that stated previously for failure of item during injection phase to ECCS operation.	56
22. Motor operated gate valve RH-V14	Fails to close on demand.	Recirculation - hot legs of RC loops.	Failure reduces redundancy of providing recirculation of coolant to the RCS from the Containment Sump to hot legs of RC loops. Fluid flow from LHSI/RHR pump RH-P-8A will continue to flow to cold legs of RC loops. Minimum recirculation flow requirements to hot legs of RC loops will be met by LHSI/RHR pump RH-P-8B recirculating [illegible] Closure of backup isolation valve RH-V22 permits minimum recirculation flow requirements to hot legs of RC loops to be met by LHSI/RHR p[illegible] RH-P-8B recirculating fluid to RC hot [illegible]	Same method of detection as that stated for item #4.	5[illegible]

TABLE 6.3-5
(Sheet 8 of 10)

Component	Failure Mode	ECCS Operation Phase	*Effect on System Operation	**Failure Detection Method	Remarks
23. Motor operated gate valve RH-V22 (RH-V21 analogous)	Fails to open on demand.	Recirculation - hot legs of RC loops.	Failure reduces redundancy of providing recirculation of coolant to the RCS from the Containment Sump to the hot legs of RC loops. Fluid flow from LHSI/RHR pump RH-P-8A will be lost. Minimum recirculation flow requirements to hot legs or RC loops will be met by LHSI/RHR pump RH-P-8B recirculating fluid to RC hot legs directly and via HHSI/SI pumps.	Valve position indication (closed to open position change) at MCB. Valve close position monitor light and alarm at MCB. In addition, RHR pump discharge pressure (PI-614) at MCB.	56
24. 23 Motor operated gate valve RH-V32 (RH-V70 analogous)	Fails to open on demand.	Recirculation - hot legs of RC loops.	Failure reduces redundancy of providing recirculation of coolant to the RCS from the containment sump to the hot legs of RC loops. No effect on safety for system operation. Alternate isolation valve (RH-V70) opens to provide flow path to RCS hot legs via LHSI/RHR pumps.	Same method of detection as that stated for item 23 #4.	56
25. 24 Motor operated gate valve RH-V26	Fails to close on demand.	Recirculation - hot legs of RC loops.	Failure reduces redundancy of providing recirculation of coolant to the RCS from the Containment Sump to hot legs of RC loops. Fluid flow from LHSI/RHR pump RH-P-8B will continue to flow to cold legs of RC loops. Minimum recirculation flow requirements to hot legs of RC loops will be met by LHSI/RHR pump RH-P-8A recirculating fluid directly to RC hot legs and by LHSI/RHR pump RH-P-8B recirculating fluid to the RC hot legs via HHSI/SI pumps. — Closure of backup isolation valve RH-V21 permits minimum recirculation flow requirements to hot legs of RC loops to be met by LHSI/RHR pump RH-P-8A recirculating fluid to RC hot legs directly and via HHSI-SI pumps.	Same method of detection as that stated for item #4.	56

SB 1 & 2
FSAR

Amendment 56
November 1985

TABLE 6.3-5

(Sheet 9 of 10)

Component	Failure Mode	ECCS Operation Phase	*Effect on System Operation	**Failure Detection Method	Remarks
~~26~~ 25. Motor operated gate valve SI-V112 (SI-V111 analogous)	Fails to close on demand.	Recirculation - hot legs of RC loops.	Failure reduces redundancy of providing flow isolation of HHSI/SI pump flow to cold legs of RC loops. No effect on safety for system operation valve SI-V114 provides backup isolation against flow to cold legs of RC loops.	Same method of detection as that stated for item #4.	
~~27~~ 26. Motor operated gate valve SI-V102 (SI-V77 analogous)	Fails to open on demand.	Recirculation - hot legs of RC loops.	Failure reduces redundancy of providing recirculation of coolant to the hot legs of RCS from the Containment Sump via HHSI/SI pumps. Minimum recirculation flow requirements to hot legs of RC loops will be met by LHSI/RHR pump RH-P-8A and RH-P-8B recirculating fluid from Containment Sump to hot legs of RC loops and HHSI/SI pump SI-P-6B recirculating fluid to hot legs 2 and 3 of RC loops through the opening of isolation valve SI-V77.	Same method of detection as that stated for item #6. In addition, SI pump discharge pressure (PI-919) and flow (FI-918) at MCB.	
~~28~~ 27. Motor operated gate valve SI-V114	Fails to close on demand.	Recirculation - hot legs of RC loops.	Failure reduces redundancy of providing flow isolation of HHSI/SI pump flow to cold legs of RC loops. No effect on safety for system operation. Alternate isolation valves SI-V112 and SI-V111 in cross-tie line between HHSI/SI pumps provides backup isolation against flow to cold legs of RC loops.	Same method of detection as that stated for item #4.	

TABLE 6.3-5
(Sheet 10 of 10)

Component	Failure Mode	ECCS Operation Phase	*Effect on System Operation	**Failure Detection Method	Remarks
28. Residual heat removal pump RH-P-8A (Pump RH-P-8B analogous)	Fails to deliver working fluid.	Recirculation - hot legs of RC loops.	Failure reduces redundancy of providing recirculation of coolant to the RCS from the Containment Sump to the hot legs of RC loops. Fluid flow from LHSI/RHR pump RH-P-8A will be lost. Minimum flow requirements to hot legs of RC loop will be met by LHSI/RHR pump RH-P-8B recirculating fluid to RC hot legs directly and via HHSI/SI pumps.	Same method of detection as that stated previously for failure of item during injection phase of ECCS operation.	

56

List of abbreviations and acronyms

CH, CS - Charging

HHSI - High Head Safety Injection

LHSI - Low Head Safety Injection

LOCA - Loss of Coolant Accident

MCB - Main Control Board

NPSH - Net Positive Suction Head

RC - Reactor Coolant

RCS - Reactor Coolant System

RHR, RH - Residual Heat Removal

RWST - Refueling Water Storage Tank

SI - Safety Injection

VCT - Volume Control Tank

CBS - Containment Spray

56

TABLE 6.3-7
(Sheet 1 of 3)

SEQUENCE OF SWITCHOVER OPERATIONS
(BASED ON NO SINGLE FAILURES)

The following manual operator actions are required to complete the switchover from the injection mode to the recirculation mode. During the injection mode, the operator verifies that all ECCS pumps are operating and monitors the RWST and reactor building recirculation sump levels in anticipation of switchover. Component cooling water flow to the residual heat removal heat exchangers is automatically initiated on a 'T' signal. The operator verifies that the component cooling water inlet isolation valves to the residual heat removal heat exchangers are open prior to switchover initiation. Motor control centers E522 and E622 are energized and the engineered safeguards signal is reset prior to switchover.

The following manual actions must be completed in a timely manner following switchover initiation to align the charging pumps and safety injection pumps suction to the residual heat removal pumps discharge.

SWITCHOVER STEPS

The RWST "low-low" level signal in conjunction with an 'S' signal automatically initiates the opening of the containment sump isolation valves (CBS-V8/V14).

STEP 1 When each sump isolation valve (CBS-V8/V14) has reached the full open position, take immediate action to close the corresponding RWST/RHR pump suction isolation valve (CBS-V2/V5).

STEP 2 Close the three safety injection pump miniflow isolation valves (SI-V89/V90/V93).

STEP 3 ~~Close the two valves in the RHR crossover line downstream of the RHR heat exchangers (RH-V21/V22).~~

STEP 4 Open the two parallel valves in the common suction line between the charging pump suction and the safety injection pump suction (CS-V460/V461).

STEP 5 Open each valve from each RHR pump discharge line to the charging pump suction and to the safety injection pump suction (RH-V35/V36).

STEP 6 All ECCS pumps are now aligned with suction flow from the containment sump. Verify proper operation and alignment of all ECCS components and proceed to complete the following manual actions to provide redundant isolation of the RWST from the recirculation fluid.

Close one cold leg injection path isolation valve downstream of RHR heat exchangers (RH-V14 or RH-V26).

TABLE 6.3-7
(Sheet 2 of 3)

STEP 7 Close the valves in the lines from the RWST to the safety injection pump suction (CBS-V47/V51).

STEP 8 Close the valves in the lines from the RWST to the charging pump suction (LCV-112 D and E).

The ECCS is now aligned for cold leg recirculation as follows:

a. Both residual heat removal pumps are delivering from the containment sump directly to the RCS cold legs and are also delivering to the suction of the safety injection and charging pumps.

b. Both safety injection and charging pumps are delivering to the RCS cold legs.

SWITCHOVER FROM COLD LEG RECIRCULATION TO HOT LEG RECIRCULATION

At approximately 18 hours after the accident, hot leg recirculation shall be initiated. The following manual operator actions are required to perform the switchover operation from the cold leg recirculation mode to the hot leg recirculation mode.

SWITCHOVER STEPS

STEP 1 Close the residual heat removal pump discharge cold leg header isolation valves (RH-V14/V26).

~~STEP 2 Open the residual heat removal pump discharge crossover isolation valves (RH-V21/V22).~~

STEP 3 Open the residual heat removal pump discharge hot leg header isolation valves (RH-V32/V70).

STEP 4 Stop safety injection pump No. 1.

STEP 5 Close the corresponding safety injection pump discharge crossover header isolation valve (SI-V112).

STEP 6 Open the corresponding safety injection pump discharge hot leg header isolation valve (SI-V102).

STEP 7 Restart safety injection pump No. 1.

STEP 8 Stop safety injection pump No. 2.

STEP 9 Close the corresponding safety injection pump discharge crossover isolation valve (SI-V111).

TABLE 6.3-7
(Sheet 3 of 3)

STEP 9 Close the safety injection pump discharge cold leg header isolation valve (SI-V114).

STEP 10 Open the corresponding safety injection pump discharge hot leg header isolation valve (SI-V77).

STEP 11 Restart safety injection pump No. 2.

The ECCS is now aligned for hot leg recirculation as follows:

a. Both residual heat removal pumps are delivering from the containment sump directly to the RCS hot legs and are also delivering to the suction of the safety injection and charging pumps.

b. Both safety injection pumps are delivering to the RCS hot legs.

c. Both charging pumps are delivering to the RCS cold legs.

TABLE 6.3-10

MANUAL SWITCHOVER SEQUENCE

Time (Sec) From To	Action	Estimated Duration (Sec)	Maximum RWST Outflow (GPM)
Start	RWST lo-lo-1 signal	-	-
0-29	CBS-V8, -V14 opening	29	16,400
30-60	Locate CBS-V2, -V5 switches	30	16,400
60-75	CBS-V2, -V5 closing	15	16,400
75-105	Locate SI-V89, -V90, -V93 switches	30	1,800
105-115	SI-V89, -V90, -V93 closing	10	1,800
~~115-145~~	~~Locate RH-V21, -V22 switches~~	~~30~~	~~1,800~~
~~145-155~~	~~RH-V21, -V22 closing~~	~~10~~	~~1,800~~
~~155-185~~ 160-190	Locate CS-V460, -V461 switches	30	1,800
~~185-195~~ 190-200	CS-V460, -V461 opening	10	1,800
~~195-225~~ 200-230	Locate RH-V35, -V36 switches	30	1,800
~~225-235~~ 230-245	RH-V35, -V36 opening	~~10~~ - 15	1,800
115-145	Locate RH-V14 switch	30	1,800
145-160	RH-V14 closing	15	1,800

45