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ATTACHMENTS

TITLE

SYSTEMS STANDARD DESIGN CRITERIA NUCLEAR STEAM SUPPLY SYSTEM CONTAINMENT ISOLATION

APPLICABLE PLANTS:

PRW, ANG, CQL, CRL, CSL, CTL, CGE, CAE
CBE, GAE, GBE, NEU AND FUTURE PLANTS

FOR EXTERNAL USE

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APPROVAL

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1.0 INTRODUCTION

The purpose of this document is to provide criteria for containment isolation and standard arrangements for meeting this criteria for each of the NSSS lines penetrating the containment wall. Typical diagrams showing NSSS fluid system lines penetrating the containment wall are included in this document. The sketches include brief notes describing the standard isolation valve arrangements shown. The diagrams also indicate recommended locations for gas test connections to be provided by the customer. In many cases, existing vents and drains can be used for these testing functions.

In general this document includes typical containment penetrations for the NSSS for Westinghouse PWR plants. However, for some plants there may be cases which may not be specifically covered by this document. In this event, these special cases shall be handled on an individual basis.

The information contained in this document reflects Westinghouse Nuclear Energy Systems (W NES) interpretation of good design practice as to provisions to be made for meeting current Atomic Energy Commission (AEC) requirements regarding containment isolation. Specifically, the basis for the design requirements included in this document meet Criteria 55, 56 and 57 of the AEC General Design Criteria which became effective in July 1971. This document will be updated as necessary to reflect any new information.

2.0 CONTAINMENT ISOLATION CRITERIA

2.1 General

In general all piping which penetrates the containment must be provided with isolation valves in compliance with the AEC General Design Criteria (55, 56 and 57). These criteria are as follows:

Criterion 55 - Reactor Coolant Pressure Boundary Penetrating Containment

Each line that is part of the reactor coolant pressure boundary and that penetrates primary reactor containment shall be provided with containment isolation valves as follows, unless it can be demonstrated that the containment isolation provisions for a specific class of lines, such as instrument lines, are acceptable on some other defined basis:

(1) One locked closed isolation valve inside and one locked closed isolation valve outside containment, or

(2) One automatic isolation valve inside and one locked closed isolation valve outside containment, or

(3) One locked closed isolation valve inside and one automatic isolation valve outside containment. A simple check valve may not be used as the automatic isolation valve outside containment, or

(4) One automatic isolation valve inside and one automatic isolation valve outside containment. A simple check valve may not be used as the automatic isolation valve outside containment.

Isolation valves outside containment shall be located as close to containment as practical and upon loss of actuating power, automatic isolation valves shall be designed to take the position that provides greater safety.

Other appropriate requirements to minimize the probability or consequences of an accidental rupture of these lines or of lines connected to them shall be provided as necessary to assure adequate safety. Determination of the appropriateness of these requirements, such as higher quality in design, fabrication, and testing, additional provisions for inservice inspection, protection against more severe natural phenomena, and additional isolation valves and containment, shall includ consideration of the population density, use characteristics, and physical characteristics of the site environs.

Criterion 56 - Primary Containment Isolation

Each line that connects directly to the containment atmosphere and penetrates primary reactor containment shall be provided with containment isolation valves as follows, unless it can be demonstrated that the containment isolation provisions for a specific class of lines, such as instrument lines, are acceptable on some other defined basis:

(1) One locked closed isolation valve inside and one locked closed isolation valve outside containment, or

(2) One automatic isolation valve inside and one locked closed isolation valve outside containment, or

(3) One locked closed isolation valve inside and one automatic isolation valve outside containment. A simple check valve may not be used as the automatic isolation valve outside containment, or

(4) One automatic isolation valve inside and one automatic isolation valve outside containment. A simple check valve may not be used as the automatic isolation valve outside containment.

Isolation valves outside containment shall be located as close to the containment as practical and upon loss of actuating power, automatic isolation valves shall be designed to take the position that provides greater safety.

Criterion 57 - Closed System Isolation Valves

Each line that penetrates primary reactor containment and is neither part of the reactor coolant pressure boundary nor connected directly to the containment atmosphere shall have at least one containment isolation valve which shall be either automatic, or locked closed, or capable of remote manual operation. This valve shall be outside containment and located as close to the containment as practical. A sir ck valve may not be used as the automatic isolation valve.

In general, the methods of providing isolation for NSSS lines penetrating containment fall into the following categories:

Case A

Isolation valve outside and isolation valve inside (both incoming and outgoing lines).

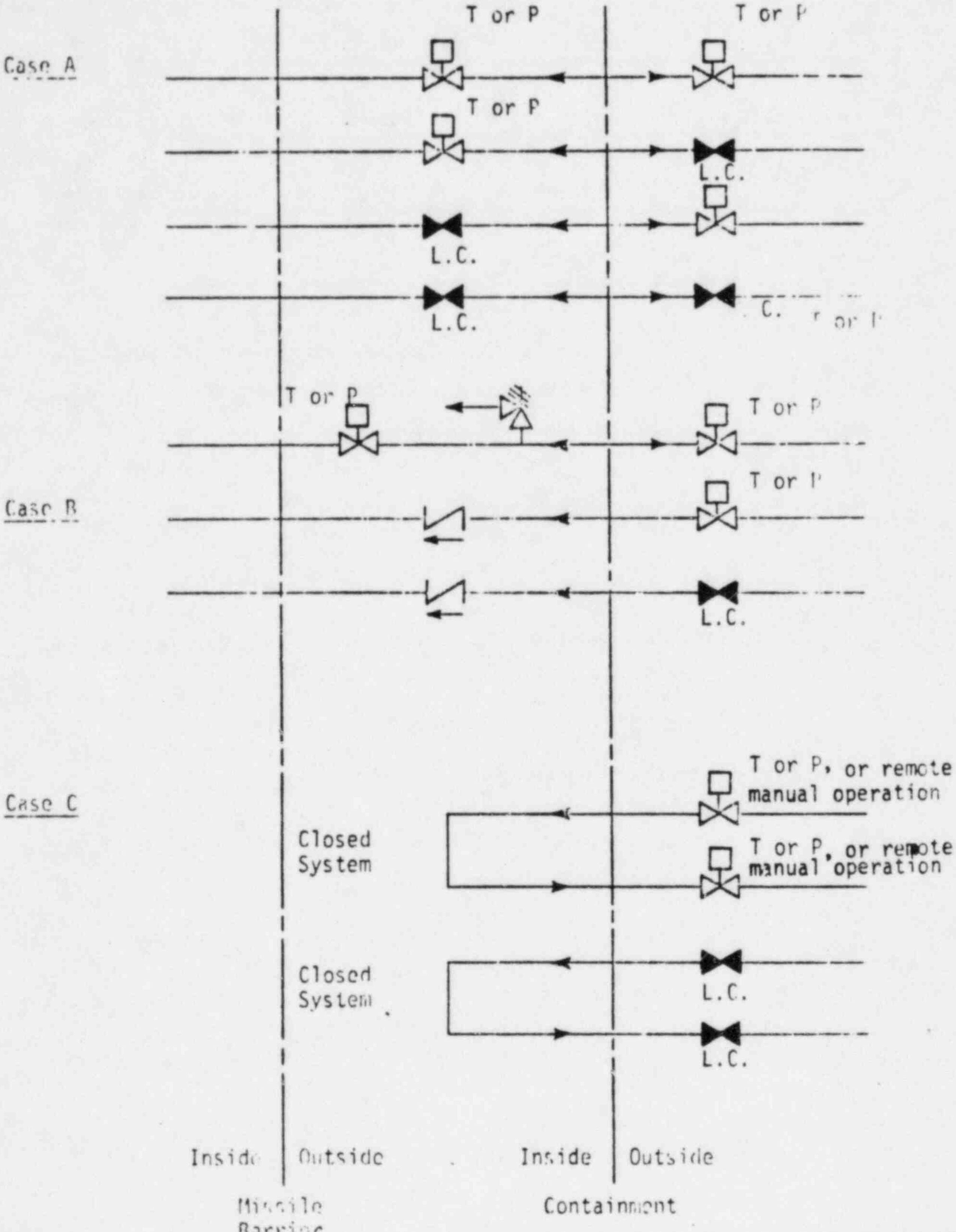
Case B

Isolation valve outside and check valve inside (incoming lines only).

Case C

Isolation valve outside and closed system inside (both incoming and outgoing lines).

Illustrations of the above cases are shown in Figure 2.1.


T or P
T or P
Case A
T or P
L.C.
L.C.
L.C.
T or P
T or P
Case B
T or P
L.C.
T or P, or remote manual operation
Case C
Closed System
T or P, or remote manual operation
Closed System
L.C.
L.C.
Inside
Outside
Inside
Outside
Missile Barrier
Containment

Any exceptions to the above configurations (such as for engineered safety systems which must operate after an accident) will be explained on an individual basis. These special cases will be described in the diagrams and appendices in this document.

To conform to GDC 55, 56 and 57, containment isolation valves outside the containment must be located as close as practical to the containment wall. This practice should also be followed for containment isolation valves located inside containment.

2.2 Isolation Valves

All containment isolation valves must be capable of tight shutoff against gas leakage with a pressure equal to containment design pressure down to approximately zero psig. A containment isolation valve can be an automatic trip valve (air or motor operated), a locked closed valve, a check valve located inside containment, or a remote manual valve outside containment for the closed system case.

Automatic trip valves close on a T signal (HI containment pressure and/or safety injection) or a P signal (HI-HI containment pressure). The containment isolation signals (T or P) override all other automatic control signals to the isolation valves. These trip valves may be gate, globe or diaphragm type valves. Air-operated isolation valves fail to the closed position on loss of air or control signal.

Control features are provided for the containment isolation valves such that:

a) The valves will remain in the closed position if the T or P trip signal is reset.

b) Each valve can be opened and closed normally after the T or P signal is reset.

c) Even with the T or P signal present, a containment isolation valve can be re-opened in an emergency, such as a spurious T or P signal, by manually holding the control switch in the open position.

Locked closed manual valves have a mechanical device under administrative control which locks the valve in the closed position.

Normally closed motor operated valves may be "locked closed" by locking the power breaker in the "off" position or by electrical interlocks which prevent power from being supplied to the valve. Manual operation (hand cranking) of remote valves used for containment isolation is under strict administrative control.

A check valve inside containment may be used as a containment isolation valve. It must be capable of tight shutoff against gas leakage and be located as cloas as practical to the containment.

In some instances relief valves form part of an isolation barrier. These are special cases and are discussed in Appendix A.

2.3 Closed System Inside Containment

The requirements for a closed system inside containment include the following:

1. Must not communicate with either the Reactor Coolant System or the containment atmosphere.
2. Must be missile protected.
3. Must meet ANS Safety Classification 2.

4. Must withstand external pressure and temperature equal to containment design pressure and temperature.
5. Must withstand accident transient and environment.

2.4 Overpressure Protection

In some cases following a loss of coolant accident it is possible that the fluid contained between two closed isolation barriers may be heated and expand. This expansion may result in overpressurization of the piping and valves. On lines where overpressurization may occur, relief protection is provided. On some lines, a small line containing a check valve is installed to bypass the isolation valve inside the containment. The check valve allows fluid between the valves to discharge to the line further inside the containment. This check valve is regarded as part of the isolation barrier and is air tested accordingly. Pressure between air operated globe or diaphragm valves will cause the stem to lift slightly providing relief.

In several cases relief valves are located between isolation valves for system protection. An overpressure will cause the valve to lift and relieve toward the inside of the containment. These are special cases and are discussed in Appendix A.

3.0 TESTING OF ISOLATION VALVES

As a general requirement, containment isolation valves must be tested periodically with gas to determine their leaktightness. These test requirements are set forth in Appendix J of 10CFR50, Reactor Containment Leakage Testing for Water Cooled Power Reactors. Testing will be done by establishing a test volume in the piping so that the valve is exposed to gas at containment design pressure. Check valves and single disk gate valves must have the test pressure applied to the inboard side of the valve (the side toward the center of the containment). Diaphragm valves may be tested from either side since their leakage characteristics are the same in either direction. Double-disk gate valves may be tested by applying the test pressure between the disks. Globe valves may be tested either by pressurizing the inboard side or by pressurizing under the seat.

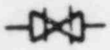
Wherever isolation valve testing is to be done, various connections must be made to supply test gas to the appropriate sections of piping. The general locations of these test connections are indicated by the TC symbol on the following diagrams. It would also be necessary to vent the piping connected to the valve on the side opposite the test volume. The locations of these test vents are indicated by the TV symbol on the following diagrams. In most cases, existing equipment vents or drains can be used to perform this function. Since the test gas must impinge directly upon the valve being tested, the test connections and/or vents should be located so as to facilitate adequate draining of the test volume. The piping should be layed out and the valves which are the boundaries of the test volume should be located so as to minimize the size of the test volume. Loop seals, sloping pipe, etc. can be used to help keep the test volume small thus minimizing the amount of water to be drained and providing more accurate leak rate measurements. In some cases, TV's and TC's can be combined in a single connection. In general, TV's and TC's should be connected to the bottom of the pipe to facilitate draining. The connections used for TC's and TV's should contain a valve and be closed with a blank flange or preferably with 3/8" tubing with a swaglok cap downstream of the valve.

The testing of relief valves which form part of an isolation barrier is discussed in Appendix A.

4.0 Legend

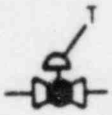
 ------ INDICATES NORMALLY CLOSED VALVE

 ------ INDICATES NORMALLY OPEN VALVE

 ------ PARALLEL DISC GATE VALVE

TC  ------ TEST CONNECTION LOCATION

TV  ------ TEST VENT LOCATION



------ INDICATES VALVE CLOSES ON T SIGNAL (CONTAINMENT ISOLATION SIGNAL, PHASE A. DERIVED FROM SAFETY INJECTION OR MANUALLY) (1)

------ INDICATES VALVE CLOSES ON P SIGNAL (CONTAINMENT ISOLATION SIGNAL, PHASE B. HIGH HIGH CONTAINMENT PRESSURE) (1)

 SC ------ INDICATES MINIMUM EXTENT OF ANS SAFETY CLASSIFICATION 2 EQUIPMENT REQUIRED TO MEET CONTAINMENT ISOLATION CRITERIA.

F.C. ------ VALVE FAILS CLOSED

F.O. ------ VALVE FAILS OPEN

OMB ------ OUTSIDE MISSILE BARRIER

IMB ------ INSIDE MISSILE BARRIER

V ------ VENT TO ATMOSPHERE

VH ------ VENT HEADER

LC ------ LOCKED CLOSED

(1) "T" or "P" SIGNALS OVERRIDE ALL OTHER CONTROLS

RCS - Pressurizer Relief Tank Connections

RCS - Dead Weight Calibrator (If Applicable)

6.1 CVCS - Letdown Line

6.2 CVCS - Charging Line

6.3 CVCS - Seal Return Line

6.4 CVCS - Seal Injection Lines (Typical 4-Loop Plant)

6.4 CVCS - Seal Injection Lines (Typical 4-Loop Plant)

7.2 RHRS Residual Heat Removal Supply

8.1 CCS - Component Cooling Water to Excess Letdown HX and Reactor Coolant Drain Tank HX

8.2 CCS - Component Cooling Water for Reactor Coolant Pumps

9.1 WPS - Reactor Coolant Drain Tank Connections

9.2 WPS - Reactor Coolant Drain Tank Pumps

10.1 SIS - Accumulator N_2 Supply

10.2 SIS - Safety Injection Test Line Connection

10.3 SIS - Low-Head Safety Injection Lines (3-Loop)
(RHR Discharge Lines)

10.4 SIS - Low-Head Safety Injection Lines 4-Loop
(RHR Discharge Lines)

10.5 SIS - High Head Safety Injection Connections Typical 3-Loop

10.6 SIS - High Head Safety Injection Connections Typical 4-Loop

10.7 SIS - Safety Injection Recirculation Suction Line from Containment Sump

11.0 Spray System

12.0 Sampling System

13.0 Containment Pressure Instruments

APPENDIX A

RELIEF VALVES

In a few special instances pressure relief valves form part of containment isolation barriers. In all cases the containment atmosphere impinges only on the discharge side of the valve and in all cases the relief valves are located inside containment. The relief valves are spring loaded closed and if an overpressure in the system causes the valve to lift, the fluid would be discharged into containment (to the pressurizer relief tank or directly to the containment sump). In a post-accident situation any containment atmosphere which leaks into the valve through the discharge line or through the valve bonnet will be prevented from entering the piping system by the closed valve.

All relief valves are periodically removed from the lines and bench tested to check their set pressures. Any relief valve which forms part of an isolation barrier is leak tested from the discharge side with gas at containment design pressure before removal. The valve is then removed, bench tested, and re-installed in its line. Another gas leakrate test is then performed on the valve. The leakrates as determined by these gas tests must be within the limits of Appendix J of 10CFR50 and within the Westinghouse limits for leakage through containment isolation valves.

The following is a list of the relief valves which are part of isolation barrier and a description of the function of each.

APPENDIX A (Cont.)

LETDOWN LINE RELIEF VALVE

This relief valve protects the letdown heat exchanger and piping downstream of the letdown orifices from overpressurization if the orifice isolation valves are open and flow is stopped downstream. The valve is sized to relieve 43,400 lb/hr of steam at 600 psig. This discharge is routed to the pressurizer relief tank where the steam is quenched. The relief valve cannot be located outside containment because there is no tank available which could handle this steam discharge without danger of releasing radioactivity to the atmosphere.

RESIDUAL HEAT REMOVAL SUCTION LINE RELIEF VALVE

The relief valve in each suction line protects the RHRS from overpressurization during residual heat removal operation. The design basis assumes that the RCS is water solid and that the charging line control valves go fully open. This could result in a large flowrate (approximately 900 gpm) through the relief valve. This flow is discharged to the pressurizer relief tank which is designed to handle large flows of hot water and/or steam. The relief valve in located inside containment in order to minimize the amount of radioactive fluid which must be handled outside containment and to minimize the danger of a possible release caused by a large volume of hot water ot steam discharged to one of the available holdup tanks.

COMPONENT COOLING WATER SYSTEM TO THE EXCESS LETDOWN HX AND REACTOR COOLANT DRAIN TANK HX

The relief valves for each of these heat exchangers are designed to relieve overpressurization caused by a tube rupture or by thermal expansion if the HX's are isolated. The relief valves are located inside containment because the heat exchangers can be completely isolated by the isolation valves immediately outside

APPENDIX A (Cont.)

containment and also because a tube rupture would cause a hot radioactive discharge which should be kept inside containment. The valves discharge to the sump rather than the pressurizer relief tank in order to prevent the chromates in the component cooling water from getting into the pressurizer relief tank and possibly the CVCS.

APPENDIX B

CONTAINMENT PRESSURE INSTRUMENTS

There are four instrument lines which penetrate the containment and which are required to remain functional following a LOCA or steam break. These lines sense the pressure of containment atmosphere on the inside and are connected to presure transmitters on the outside. Signals from these transmitters can initiate safety injection and containment isolation on high containment press . They also, upon hi-hi containment pressure, produce the only signal to initiate containment spray. In view of this function it is essential that the line remain open and not be isolated following an accident. Based on this requirement, a sealed sensing line as described below is used.

Each of the four channels has a separate penetration and each pressure transmitter is located immediately adjacent to the outside of the containment wall. It is connected to a sealed bellows located immediately adjacent to the inside containment wall by means of a sealed fluid filled tube. This tubing along with the transmitter and bellows is conservatively designed and subject to strict quality control and to regular in-service inspections to assure its integrity. This arrangement provides a double barrier (one inside and one outside) between the containment and the outside atmosphere. Should a leak occur outside containment, the sealed bellows inside containment, which is designed to withstand full containment design pressure, will prevent the escape of containment atmosphere. Should a leak occur inside containment, the diaphragm in the transmitter, which is designed to withstand full containment design pre e, will prevent any escape from containment. This arrangement provides automati double barrier isolation without operator action and without sacrificing any reliability with regard to its safeguards functions (i.e. no valves to be

APPENDIX B (Cont.)

inadvertantly closed or to close spuriously). Both the bellows and tubing inside containment and the transmitter and tubing outside containment are enclosed by protective shielding. This shielding (box, channel or guard pipe, etc.) prevents mechanical damage to the components from missiles, water jets, dropped tools, etc.

Because of this sealed fluid filled system, a postulated severance of the line during either normal operation or accident conditions will not result in any release from the containment.

If the fluid in the tubing is heated during the accident the flexible bellows will allow for expansion of the fluid without overpressurizing the system and without significant detriment to the accuracy of the transmitter.

APPENDIX C

REMOTE MANUAL OPERATION OF ISOLATION VALVES IN SAFEGUARDS LINES

There are several isolation valves in lines which penetrate containment and are required to perform a safeguards function following an accident. Since these valves must remain open or be opened, a trip signal obviously cannot be used. Instead each of these valves is capable of remote manual operation. Upon completion of the safeguards function of the line, the operator can close the isolation valve from the control room. Lines which fall into this category include the following: low head injection lines, high head injection lines, containment spray lines, and containment sump recirculation lines.

APPENDIX D

SEAL INJECTION LINES

The seal injection lines provide flow from the charging pumps to the main seals on the reactor coolant pumps. This seal flow provides cooling to the seals and the shafts. Part of the flow splits and goes into the RCS through the labyrinth seal while the remainder is recovered in the secondary seal leakoffs. A backup system is provided by the thermal barrier which is located lower down on the pump shaft. This is basically a coil carrying component cooling water. If seal flow is interrupted, the thermal barrier will cool the reactor coolant which will flow up through the seal. The component cooling water lines to and from the thermal barrier are isolated on a P signal.

If for any reason flow of cool water passing through the seals is interrupted for more than a minute or two - severe seal damage and/or shaft damage will occur. This is true whenever the RCS is above 160°F whether or not the RC pumps are in operation.

Due to the sensitive nature of the seals it is highly desirable to provide seal flow at all times. On plants where the charging pumps are used for safety injection, flow will be provided by the pumps through the seal injection lines following an accident. Because of this high pressure inflow there is no need to provide any sort of trip valves in these seal injection lines. Each line is equipped with a remote manual containment isolation valve which the operator can close when the charging pumps have completed their safeguards function.

On plants where the charging pumps are not used for safety injection the valves in the individual lines will be tripped closed on a T-signal. These valves will have the ability to be re-opened immediately from the control room without re-setting the T-signal in case of a spurious trip. A T-signal rather than a

APPENDIX D (Cont.)

P-signal is used so that a single spurious signal will not close both the seal injection lines and the component cooling lines to the thermal barrier at the same time.

APPENDIX E

RECIRCULATION SUMP LINES

The lines from the containment sump to the suctions of the low head SI recirculation (RHR) pumps are each provided with a single remote manual gate valve. This valve is enclosed in a compartment which is leaktight at containment design pressure. The piping from the sump to the valve is enclosed in concentric guard pipe which is also leaktight. A seal is provided so that neither the compartment nor the guard pipe is connected directly to the sump or to the containment atmosphere.

At the beginning of the SI recirculation phase the sump is full of water, the line from the RWST is closed, and the sump line valves are opened. Since the sump is always submerged and no containment atmosphere can impinge upon the valve, this valve is not a containment isolation valve as such.

The valve does provide a barrier outside containment to prevent loss of sump water should a leak develop in a recirculation loop. (The valve is closed remotely from control room to accomplish this). Should a leak develop in the valve body or in the pipe between the sump and the valve, the sump fluid will be contained by the leaktight compartment and/or by the guard pipe. Since the sump line connection to the sump is always submerged, there is no need for a valve inside containment to prevent the escape of containment atmosphere.

With this system no single failure of either an active or passive component will prevent the recirculation of core cooling water or adversely affect the integrity of the containment. The present arrangement meets all safety requirements and any additional valves are unnecessary for containment isolation.

APPENDIX F

RHR SUCTION LINES

The lines from the RCS hot legs to the RHR pump suctions each contain two remote manual (motor operated) valves, which are closed during normal plant power operation. The valves are interlocked such that they cannot be opened when the RCS pressure is greater than the design pressure of the RHR system. The valves closer to the RCS are interlocked with one pressure transmitter while the valves closer to containment are interlocked with a separate transmitter. The valve which is located closer to the RCS inside the missile barrier is not considered a containment isolation valve. The second valve defines the limit of the reactor coolant pressure boundary. This valve also provides the containment isolation barrier inside containment and is considered to be locked closed.

Since these lines connect to the SI recirculation loops which are filled with sump water and at least one of which is in operation post-accident, there is no need for any containment isolation valves in these lines outside containment. If a leak occurs in the line upstream (toward the RCS) of the valve inside containment, the closed valve isolates the line. If a leak occurs in the recirculation system outside containment, the sump valve is closed to prevent loss of sump water and the closed valve in the RHR suction line prevents any containment atmosphere from entering the system outside containment. If a leak should occur in the short length of pipe between the valve inside containment and the containment, any containment atmosphere will get only as far as the fluid-filled system. Since this system is filled with sump water and is most likely in operation, no gas could escape to the outside. The fluid in the RHR suction line would drop to approximately the level of fluid in the sump and any containment atmosphere which did leak into the line would be contained in this length of closed piping.

APPENDIX F (Cont.)

Another closed valve in the line would do nothing except somewhat decrease the length of pipe outside containment which could possibly be exposed to containment atmosphere following a leak. It is possible that a valve in this section of pipe would increase the probability of leakage of gas through the stem packing and could not be considered as tight as a clean length of pipe. No single failure of any active or passive component anywhere in the present system can cause any release of containment atmosphere to the outside. Any additional valves would complicate normal residual heat removal operation and are unnecessary for containment isolation.