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INSERVICE LEAK TESTING OF PRIMARY PRESSURE ISOLATION VALVES

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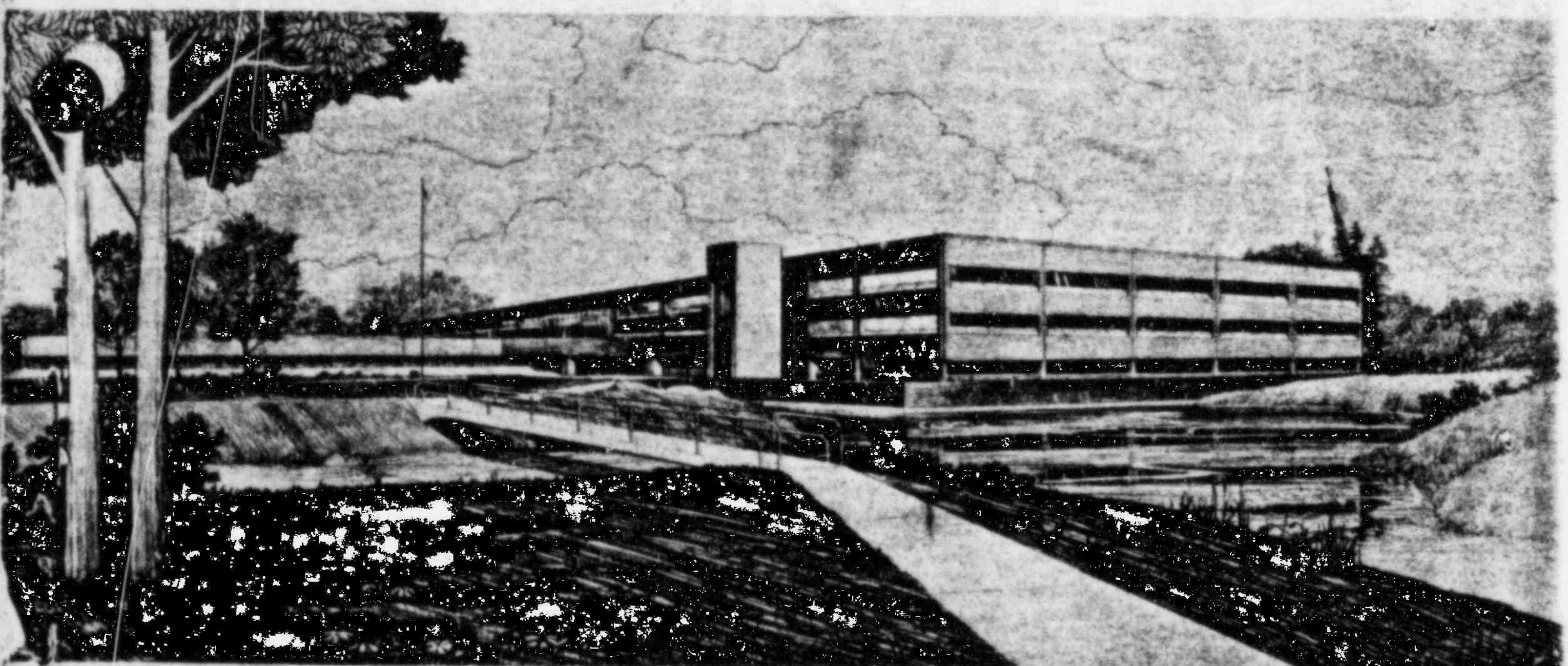

This is an informal report intended for use as a preliminary or wor\....g document

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EG&G Idaho

EG&G Idaho Inc.

P.O. BOX 1625, IDAHO FALLS, IDAHO 83415

January 20, 1984

Mr. Farrel L. Sims, Chief
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TRANSMITTAL OF TASK 13 FINAL REPORT ON A VALVE LEAKAGE TEST PROGRAM, SUPPORT OF NRC ON ASME BOILER AND PRESSURE VESSEL CODE, SECTION XI ACTIVITIES, (A6367) - LPL-30-84

Ref: G. E. Marx ltr to S. B. Milam, Marx-195-83, Transmittal of Revised NRC Form 189 for Section XI Support-Technical Assistance (A6367), May 1983

Dear Mr. Litteneker:

EG&G Idaho technical personnel are, under the provisions of the Referenced 189, providing assistance to the Nuclear Regulatory Commission, Office of Nuclear Regulatory Research relative to Section XI of the ASME Code where the NRC staff involved perceive a need for additional data or evaluation before establishing a staff position.

In fulfillment of Task 13, the attached final (Enclosure 1) report contains a description of a valve leakage and electric motor operator test program. The purpose of this test program is to validate the theoretical work performed earlier under task 4 and to resolve electric motor operator problems and related questions reported by the NRC Office For Analysis and Evaluation of Operational Data. The estimated cost to perform the program described is $771K plus the cost of valves. The duration of the program is 27 months with 10 man years of effort.

The scope of work has been reduced by negotiation with NRC personnel from that presented earlier in the informally submitted draft version of this same report. The earlier draft of this report included both valve

air leak tests and acoustic tests; the enclosed final version does not include these tests. All editorial and format changes requested by NRC personnel have been incorporated into the enclosure. This transmittal completes task 13 and EG&G Milestone Chart Node 24-02.

Very truly yours,

L. P. Leach, Manager
Reactor Evaluation Programs

BLB:acf

Enclosure:
As Stated

cc: J. Richardson, RES
J. O. Zane, EG&G Idaho (w/o Enclosure)

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INTERIM REPORT

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E. T. Baker/Technical Monitor, Office of Nuclear Regulatory Research, Divison of Engineering Technology

> This document was prepared primarily for preliminary or internal use. It has not received full review and approval. Since there may be substantive changes, this document should not be considered final.

EG&G Idaho, Inc
Idaho Falls, Idaho 83415

Prepared for the
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Washington, D.C.
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INTERIM REPORT

ABSTRACT

The inservice leak testing of primary pressure isolation valves in commercial power reactors was investigated to identify problems with current test procedures and requirements. Nine utilities were surveyed to gather information which is presented in this report. An analysis of the survey information was performed, resulting in recommended changes to improve valve leak testing requirements currently invoked by Section XI of the ASME Boiler and Pressure Vessel Code, Plant Technical Specifications, and Regulatory Guides addressing this subject.

FIN No. A6367 - EG&G Idaho Final Report
On Inservice Leak Testing of Primary Pressure
Isolation Valves

SUMMARY

This report presents an analysis of the results of a survey of nine commercial power reactor owners concerning in-service leak testing of primary pressure isolation valves. It is apparent that the extrapolation of leakage data from reduced test pressure to the function pressure is potentially in error. Another apparent problem is the non-uniform interpretation of regulations on which valves require inservice testing. Recommendations are offered for improving the effectiveness of inservice leak testing, and for changing the leak test acceptance criteria.

NOMENCLATURE

P	Pressure, psia (absolute)
V	Fluid velocity, ft/sec
A	Leakage flow area, $in.^2$
ΔH	Head difference, ft.
G	Mass flux, $lb/sec\text{-}ft^2$
K	Pressure loss coefficient, dimensionless $\Delta P = K \times \frac{\rho V^2}{2g \times 144}$
L	Weight flow rate, lb/min
Q	Volumetric flow rate, gal/min
D	Hydraulic diameter, in. = 4 x area/perimeter
g	Gravitational constant = 32.2 ft/s^2
k	Gas adiabatic exponent = 1.4 for air
R	Engineering gas constant = 53.3 ft/°R for air
T	Temperature, °R (= °F + 460)
ρ	Fluid density, lb/ft^3
ΔP	Pressure differential $P_1 - P_2$, psid
μ	Fluid viscosity, $lb\text{-}s/in.^2$
ℓ	Length of flow path, in.

Subscripts

1	Upstream of valve
2	Downstream of valve
f	Function as in plant operation
t	Test, as in valve leak test
a	Air
w	Water
sc	Subcooled
c	Critical

CONTENTS

ATTACHMENTS

INTRODUCTION

The owners of commercial nuclear power plants are required by the NRC to perform periodic tests on valves that isolate primary reactor cooling system (RCS) water from interfacing safety systems. These in-service tests are intended to demonstrate the operability of the valves, and to identify leakage due to valve degradation before it progresses to a hazardous level. The identification of valves to be tested, test methods, and acceptance criteria are specified in the Plant Technical Specifications, and in most cases invoke the requirements of Section XI, Subsection IWV of the ASME Boiler and Pressure Vessel Code. The date of Operating License issue controls the edition and addenda of the ASME Code that utilities apply to in-service testing.

This report presents the results of a survey of nine commercial power reactor owners concerning their experience and opinions on the effectiveness and problems associated with in-service leak testing of primary pressure isolation valves. A copy of the survey letter requesting the information is attached (Reference 1). The information received from the utilities was analyzed with the objective of identifying potential changes to testing procedures and allowable leak-rates that would improve the effectiveness of the tests, and alleviate where possible, hardships imposed on the utilities by the present requirements. The names of the nine commercial power reactor owners are not reported due to the limited information reported and the possibility of a misinterpretation of the reported information. The analysis and resulting recommendations were guided by the following restrictions and considerations:

1. Test procedures must yield unambiguous or conservative results (i.e., ambiguity and uncertainty are bounded)

2. Allowed valve leakage does not invalidate any Safety Analysis Report conclusions or compromise plant safety related design features

3. Flexibility in procedures is permitted to minimize impact of testing on utility operations

4. The valves tested, data analysis methods, and documentation are consistent from plant to plant

5. Test requirements are clear, concise, and practical to apply with minimized impact on plant operations and minimized exposure of personnel to radiation

6. Section XI of the ASME Boiler and Pressure Vessel Code should remain generic, with plant-specific testing requirements and criteria addressed by other means such as the Technical Specifications and Regulatory Guides.

SURVEY DATA

The information obtained in response to the survey (attached) addressing in-service leak testing of primary pressure isolation valves is summarized in the following tables. Copies of selected materials in the as-received form are attached.

TABLE 1. RESPONSE FROM UTILITIES ON CONTAINMENT ISOLATION VALVE LEAK TEST SURVEY

	Survey Questions						
	1	2	3	4	5	6	7
Utility	Edition of Section XI	List of Valves and History	Description of Test Methods	Problems	Practical Leak Rate	Original Documents	Manuals and Specifications
Utility A	1977 Ed. with S-78 Addenda	List of valves provided. 32 valves from 2-14" size	Meas. dn. Str. leak of water into Atm. standpipe. Pri. coolant inventory for UHI ck. valves	Tech. Spec. limit of 1 GPM @ 2235psi difficult to meet. Test during heatup a problem.	1 GPM at 2235 is the Tech. Spec. criteria.	Refer to flow diagram.	ISI program provided.
Utility B	1977 Ed. with S-78 Addenda	Valves listed by number	Procedure provided, air test at 43 psi		No response	Section XI not in effect then.	Refer to ISI Manual (not provided).
Utility C	1974 Ed. with S-75 Addenda	Data provided as requested.	Procedure provided. 1-5 GPM accep. 2235 Psi or less and cor. data.	Rad. during valve repair a problem. Test alignment also a problem. Also which valves.	Refer to Tech. Spec.	Sample provided	Sample procedure provided. Refer to Tech. Spec. (not provided).
Utility D	1974 Ed. S-75 Addenda. 1977 Ed. for Unit 2	Tables 1 and 2 provide size and leakage data.	Leak test with water, <1GPM acceptable.	Access a problem. Isolation of single valve a problem. Interpretation of Section XI to determine which valves.	<1 GPM may be too restrictive. 10 GPM may be more reasonable.	ASME Section III and XI not applied when plant was built.	--
Utility E	1974 Edition S-75 Addenda	Only 2 valves listed, 10 and 14" crane. Just Event V (WASH 1400) valves considered.	RCS water at 700 psi, 1-5 GPM acceptable. Procedure provided.	Some access problem. Vague wording in Tech. Spec. and Section XI	No Response	--	--
Utility F	1974 Ed. with S-75 Addenda	Table of valves, mfg., size, age, use, leakage	Leak test with water, meas. leakage flow dn. str.	Radiation exposure some time problem. T&P sets window during heatup. Leak test a critical path item on shutdown. Section XI allows test in normal flow dir. only.	1 and 5 GPM allowable leakage now used is a practical limit. ✓	Not available.	Procedure 2-PT-61.4 provided.

TABLE 1. (continued)

Utility	1 Version of Section XI	2 List of Valves and History	3 Description of Test Methods	4 Problems	5 Practical Leak Rate	6 Original Documents	7 Manuals and Specifications
	Survey Questions						
Utility G	1974 Ed with S-75 Addenda	12 valves listed.	Catch vol. and pressure decay methods.	--	5 GPM	Utility G	ISI procedure provided.
Utility H	No response.	No response.	Pump into test vol. meas. ΔQ/ΔT from reservoir. L. PR. core spray ck. and M.O. valves. 1 GPM at 1000 psi.	--	--	--	--
Utility I	1974 Edition with S-75 Addenda	Deny Cat. A valves. List 8 S.I. check valves.	Deny cat. A valves, so no Section XI procedure. 1-5 GPM limit on leak tests at 150 psid.	No problems.	Criteria based on NRC Order and Tech. Spec.	ASME B 31.7 Hydro Test	Excerpt from Tech. Spec. and leak test procedure provided.

TABLE 2. NUMBER, SIZE, AND TYPE OF VALVES LEAK TESTED

Utility	Number, Size, and Type of Valve
Utility A	2 ea. 14" GT[a], 2 ea. 12" CK[a], 8 ea. 10" CK, 6 ea. 6" CK, 9 ea. 2" CK, 27 total.
Utility B	Listed 41 containment Iso. valves (not limited to pri. press.), no size or type information.
Utility C	10 ea. 6" CK, 6 ea. 2" CK, 16 total.
Utility D	4 ea. 14" GT, 2 ea. 12" CK, 8 ea. 10" CK, 6 ea. 6" CK, 1 ea. 3" CK, 8 ea. 2" CK, 4 ea. 3" CK, 25 total.
Utility E	Just Wash 1400 Event V valves considered, 10" and 14" CK, 4 total.
Utility F	2 ea. 14" GT, 6 ea. 12" CK, 4 ea. 10" GT, 5 ea. 6" CK, 4 ea. 3" GT, 4 ea. 3" CK, 25 total.
Utility G	Cat. A, Event V valves listed, 3 ea. 14" CK, 6 ea. 10" CK, 3 ea. 8" GT, 12 total. 408 other valves listed, 3/4 - 30"
Utility H	Only 2 L.P. core spray Iso. valves listed. E21-F005 and 6, M.O. GT Valves, no size, 2 total.
Utility I	4 ea. 6" CK, 4 ea. 2" CK, 8 total.

a. GT = gate valve, CK = check valve.

TABLE 3. LEAK TEST METHODS AND PROCEDURES

Utility	
Utility A	Most pri, cont. Iso. valves tested by meas. downstream flow into Atm. standpipe at reduced pri, press. (385 psi typical). UHI Iso. valves tested by venting downstream to Atm and calc. pri. coolant Δ inventory at reduced press. (<1900 psi). Note: 4 GPM = 0.3%/hr. of 90,000 gal.
Utility B	F.W. Iso. valves tested with air at 43 psig.
Utility C	Leak test with hydro pump applying water press. = RCS-100 psi upstream. Drain leakage into grad. collection bottle. In some cases leakage from 2 valves is meas. simultaneously, but allowance for 1 valve applies.
Utility D	Leak test using RCS upstream press. and collect leakage from downstream drain in grad. vessel and time the volume change (RCS water).
Utility E	Leak test with RCS water at 700 psig, and 100 psig downstream controlled by manually throttling drain valve. $T \leq 195$°F required. Measure leakage flow in grad. vessel vs time.
Utility F	Leak test with RCS water at $\sim$ 350 psi and 0-100 psi downstream controlled by dr. valve. Meas. leakage intograd. container vs time.
Utility G	SI valves are leak tested by pressurizing upstream to 2475 psi with a pos. disp. pump. Pump strokes vs time use to measure make-up = leakage (water). Other valves tested at RCS press ≥ 2260 and meas. vol. vs time out downstream drain into calib. container.
Utility H	Leak test valves by applying water press. with a test pump and measure flow into pump suction by level vs time.
Utility I	Leak test SI valves with RCS water, valve $\Delta P \geq 150$ psid (150-250 typ.). Meas. leakage out of downstream drain point. Grad. vessel vs time (250 ml typical).

NOTE: upstream = RCS side of valve in above.

TABLE 4. PROBLEMS ASSOCIATED WITH PRIMARY PRESSURE ISOLATION VALVE LEAK TESTING PERFORMED BY UTILITIES

Utility	Problems Stated
Utility A	Leakage criteria (0.4 GPM at test press. = 350 psig) is difficult to meet with temperature and pressure fluctuations over long lengths of piping. Test and fix during plant heatup delays startup. Flashing of leakage due to temperature has been a problem.
Utility B	Documentation requirements are considered unnecessarily restrictive (no elaboration).
Utility C	Radiation exposure during valve repair a problem (8 Rem accum. in repair of six valves). System alignment for leak tests is difficult. Outages extended due to testing during startup. Problems determining which valves ASME Section XI, cat. A applies to.
Utility D	Vent valve accessibility a problem. Design of leak test system could be improved. Interpretation of Section XI regarding which valves require testing. <1 GPM leakage allowed may prove too restrictive in future, suggest <10 GPM.
Utility E	Component accessibility is a problem. Vague wording in Technical Specification and Section XI.
Utility F	Measures to prevent personnel exposure a problem. Overtime required to perform leak tests. In-service leak testing accounts for 1-2 days lost electricity generation per outage. Component accessibility. Documentation and procedures a problem due to lack of flexibility.
Utility G	Codes and standards not specific enough. Radiation exposure during repairs. Some system modifications were required for tests. Section XI does not provide explicit information needed to classify category A valves.
Utility H	No response.
Utility I	Detailed response, no problems.

TABLE 5. VALVE LEAK RATE LIMIT CONSIDERED PRACTICAL

Utility	Comments on Leak Rate Considered Practical
Utility A	Acceptable leakage based on Technical Specification 3.4.7.2.f (1 GPM at 2235 ± 20 psig). 0.4 GPM allowed at reduced pressure (Technical Specification requirement 350 psi)"difficult to meet with temperature and pressure fluctuations over long lengths of piping."
Utility B	Referred to containment isolation valve leak test procedure (not primary pressure isolation) with acceptance criteria per 10CFR50, Appendix J. No other information provided.
Utility C	"The current leakage rate limits (Technical Specification Table 4.4-3, 1 GPM - 5 GPM) are acceptable for all valves." Suggest leak testing at start of outage, re-test failed valves after repair. System alignment for leak testing is difficult to accomplish.
Utility D	Acceptance criteria for valve leakage is ≤1 GPM after correlating to 2250 psi. "This criteria may prove to be too restrictive in the future." "It is generally felt that a criteria of <10 GPM would not be unreasonable." (The <5 GPM/margin criteria is not used.) Access a problem.
Utility E	No comment. Currently using 1-5 GPM allowable leakage criteria. 5 GPM if 50% margin from last test exists.
Utility F	"The (allowable) leakage specified in N.A.2 Technical Specifications is practical from the standpoint of measurement and valve repair." (Limit is 1 and 5 GPM.) Would like to leak test m.o. gate valves in reverse direction. Consider $\sqrt{P}$ correlation too conservative.
Utility G	"The valves addressed should be able to maintain a leakage rate of less than 5 GPM." "Cumulative leakages in excess of 15 GPM can be handled by the LPSI relief system."
Utility H	No comment.
Utility I	"Leakage criteria based on the NRC Order and Technical Specification." (1-5 GPM criteria.)

ANALYSIS OF SURVEY DATA

Leakage vs. Valve Size and Type

The acceptance criteria for primary pressure isolation valve leak tests currently in the Plant Technical Specifications is most often 1 gpm, or 5 gpm if the margin since the last test has not been reduced in excess of 50%. This leakage allowance is independent of valve type and size. In order to determine the desirability of making the allowable leakage a function of valve size, a plot of measured leakage vs valve size was prepared (Figure 1). This figure shows that the measured leakage is not a strong function of valve size. This data does not show the expected trend of larger valves having greater leakage, which may be due to the following factors:

1. Except for the initial test data, the valves have been required to meet a leakage criteria (1-5 gpm) that is independant of valve size. The larger valves may therefore have had more frequent maintanence to reduce leakage.

2. The data is from a limited number of valves.

3. The data is based on tests by different people using different methods in different valve installations.

The leakage data for check valves covers the size range from 1-1/2 to 12 in. The only data on gate valves is for 14-in. valves, and indicates the leakage is comparable to the check valves.

Since leakage for only one size of gate valve was reported, the correlation of gate valve leakage with size was not pursued.

Test Procedures

The most commonly employed test method is to apply reactor coolant system (RCS) water pressure on the RCS side of the isolation valve, then

MEASURED LEAKAGE VS. VALVE SIZE

Notes: Data corrected to function ΔP by $\sqrt{\Delta P}$ ratio
Some data for multiple tests on same valve
• = Check Valve, + = Gate Valve
IT = Initial Test

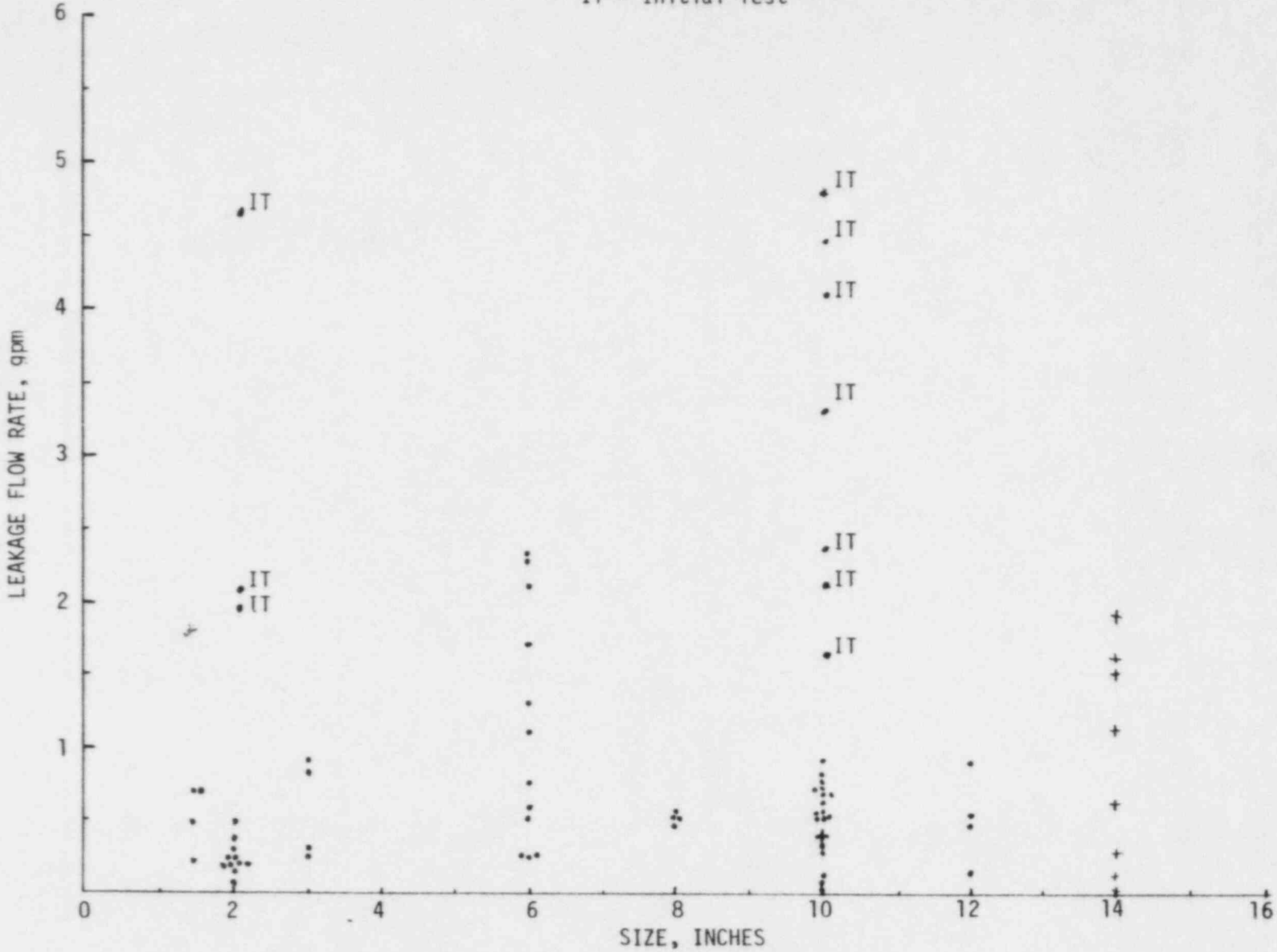

FIGURE 1

measure leakage out a vent or drain tap at atmospheric pressure on the downstream (for test) side of the valve. The RCS pressure maintained for leak testing is less than function pressure, with the test results correlated to function pressure by the $\sqrt{\Delta P}$ ratio as defined by the current version of the Code, Section XI. In several cases (Table 3), the downstream pressure is maintained above atmospheric.

Another test method used involves measuring the flow pumped into the piping upstream (for test) of the valve being tested. For either of these methods to be unambiguous, the drained leakage or supplied makeup must be the only source of flow out of or into the respective piping. This can be assured by controlling the pressure in interfacing systems such that all flow is into the piping downstream or out of the piping upstream of the valve being tested. This is not presently a stated requirement in the Code, Section XI or the Plant Technical Specifications (Reference 3). Another variable that has effected the accuracy of leakage flow measurements is the flashing or boiling away of part of the leakage flow. Test procedures that rely on draining the leakage flow into a graduated container at atmospheric pressure must be restricted to piping and fluid temperature below the boiling point (212°F at sea level). A nonconservative error in the measured leakage can also result due to local flashing at the valve seat, even though the downstream conditions are sufficiently subcooled to recondense the vapor. The phenomena of pressure recovery downstream from the minimum leakage area permits local flashing that reduces the flowrate due to two-phase losses occurring at the minimum area. In this case, the correlation of test leakage to function conditions by the $\sqrt{\Delta P}$ ratio results in an underprediction of function leakage, where the downstream pressure is higher and suppresses local flashing. This potential for error can be eliminated along with flashing and boil-off of the leakage flow by specifying that the liquid and component temperatures are subcooled by some margin relative to the downstream pressure. However, the margin required to suppress local flashing is a function of pressure recovery within the valve leak path and cannot be arbitrarily specified. An example of the reduction in water flowrate due to flashing is shown by comparing subcooled to saturated discharge rates.

For Subcooled Water

$$V_{sc} = \sqrt{2g\ \Delta H} = \sqrt{\frac{2g\Delta P \times 144}{\rho}}\ \text{ft/sec}$$

$$G_{sc} = \rho V_{sc} = \sqrt{2g\rho\ \Delta P \times 144}\ \text{lbm/sec-ft}^2$$

For example at ΔP = 285 psid, ρ = 62.4 lb/ft^3,

$$G_{sc} = 12{,}842\ \text{lb/sec-ft}^2$$

The discharge of water at saturated upstream conditions of 300 psia, h = 394 Btu/lb, T = 417°F is given by Figure 9-10a[a] (Reference 4), and is G_c = 4600 lb/sec-ft^2.

This flowrate is only 36% of the subcooled discharge calculated above. The assumed condition of saturation temperature upstream is an extreme example, but serves to show the potential for error exists when a leak test with flashing is correlated with function conditions where flashing is suppressed by higher downstream pressure.

Correlation of Test and Function Conditions

The 1980 edition of the Code, Section XI (Reference 2), Paragraph IWV-3423 allows leakage testing at reduced ΔP, with the function flow correlated to the measured flow by the $\sqrt{\Delta P}$ ratio. The calculations in Appendix A and Reference 5, of this report, show that the $\sqrt{\Delta P}$ correlation is correct with the following limitations:

1. Leakage flow area and K factor are constant
2. Flow is turbulent and subcooled
3. Fluid density is the same for test and function.

As shown by Equation (12) in Appendix A, when the flow is laminar (Reynolds No. <2000), the flowrate is proportional to ΔP/viscosity rather than $\sqrt{\Delta P}$. Since the leak path dimensions are generally unknown,

---

a. Moody model for maximum critical discharge.

the Reynolds number cannot be directly calculated to define which correlation is correct. The potential exists to underpredict the function leakage when the test leakage is laminar. This is because:

$$\frac{\Delta P_f}{\Delta P_t} > \left[\frac{\Delta P_f}{\Delta P_t}\right]^{1/2} \text{ when } \frac{\Delta P_f}{\Delta P_t} > 1$$

where the subscripts f and t denote function and test.

The flowrate and corresponding Reynolds number were calculated using turbulent and laminar theory to investigate the potential for under prediction of function leakage. Assuming a deep scratch across the valve seat as the leak path, the "scratch" cross-sectional diameter required for 1 gpm water leakage at 2250 psid is 0.029 in. based on turbulent flow theory.[a] The corresponding Reynolds number is 2×10^5, indicating that the flow is turbulent and proportional to $\sqrt{\Delta P}$. The flow would not become laminar unless the test ΔP was reduced to less than 1 psid, since the Reynolds number of 2000 corresponds to a flow of only 0.010 gpm. This calculation shows that for a discrete "scratch" type leak mechanism, the flow is turbulent and correctly correlated between test and function ΔP by the ratio of $\sqrt{\Delta P}$.

Assuming that the leakage is caused by a small annular gap distributed all around the circumference of the valve seat, the gap size[b] needed to produce 5 gpm leakage at 2250 psid in valves ranging from 2 to 14 in. nominal size is tabulated below, with the corresponding Reynolds number also shown:

---

a. Equation 3, Appendix A.

b. Through flow in Annuli, L. N. Tao and W. F. Donovan, Transactions of ASME, November 1955.

Valve Size (in.)	Assumed Seat Width[a] (in.)	Gap Size (in.)	Reynolds Number
2	0.062	0.00044	3435
6	0.11	0.00037	1150
10	0.18	0.00037	687
14	0.25	0.00037	490

The above tabulation shows that for leakage through a distributed gap, the flowrate is laminar for valves larger than 2 in. at the function ΔP. For laminar flow, the flowrate is proportional to ΔP rather than the $\sqrt{\Delta P}$ as for turbulent flow. Therefore, a valve leakage measured at reduced ΔP test conditions should be correlated to the function ΔP by the ratio of ΔP's. Correlating leakage by the $\sqrt{\Delta P}$ ratio now in the Code, Section XI, results in underprediction of the function leakage when laminar conditions exist. For example, a 10-in. valve with a distributed leak gap around the seat of 0.00046 in. would leak 2.2 gpm at a test pressure of 500 psid. The Reynolds number is 306 indicating laminar flow. Incorrect correlation of the leakage to the function ΔP of 2250 by the $\sqrt{\Delta P}$ ratio predicts 4.7 gpm. Laminar theory predicts the leakage at function ΔP to be 9.9 gpm, at which the Reynolds number is 1400, indicating the flow is still laminar. Incorrect application of the $\sqrt{\Delta P}$ correlation results in a 110% error, underpredicting the leakage at the function ΔP in the above example.

. . . .

The use of the $\sqrt{\Delta P}$ correlation is also incorrect when the test fluid is a compressible gas and the function fluid is incompressible or vice-versa. Using gas as the test fluid with the downstream pressure atmospheric, the upstream pressure need only be 28 psig or higher to produce sonic choking of the leakage flow. As shown by Equation (9) in Appendix A, the upstream volumetric gas flow is then proportional to the

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a. From conversations with manufacturers, the seating surface of 10 in. check valve is about 1/8 in. wide, the seating surface of 14 in. M.O. gate value is about 3/16 in. wide.

square root of the upstream temperature, and independent of upstream pressure. Critical gas flow therefore cannot be correlated with function water flow by the $\sqrt{\Delta P}$ factor given in the Code.

A calculation comparing critical with sub-critical compressible gas flow through an assumed leak path indicates that the error is small if sub-critical flow is extrapolated to critical flow conditions. For flow through a "scratch" geometry of 0.029 in. diameter, with 5 psig pressure upstream and atmospheric (14.7 psia) downstream, the pressure ratio is 0.746 which is subcritical. The subcritical flow equation[a] predicts an upstream flow of 1.23 gpm. The critical flow equation (Equation 5, Appendix A) incorrectly applied at this pressure ratio, predicts a flow of 1.4 gpm. It is apparent that the correlation of air flowrates can be made using Equations 5 through 10 in Appendix A without significant error even if the air flow is somewhat subcritical. At very low pressure drops, the error will be larger and a strict analysis of the actual flow condition would be in order.

The utility response to the questionnaire included two instances of test-to-function leakage correlation using other than the $\sqrt{\Delta P}$ correlation. Neither case applied to primary pressure isolation valve leak testing, but were used for other purposes. In one case, the water leakage data on containment isolation valves is correlated to function gas flow by the ratio of ΔP/viscosity. This is correct only for noncritical, subcooled laminar flow with negligible compressibility effects. These restrictions were not addressed.

A comparison of the air leak rate predicted by critical flow theory to the laminar flow correlation of air and water flow used by one of the utilities[b] for containment isolation valve leak testing (not primary pressure isolation valve) is shown below:

---

a. Vennard, Elementary Fluid Mechanisms.

b. Utility G, Procedure No. 3.17.4, Appendix A, Revision 6, page 6.

Assume for comparison:

P(air) = P(water) = 55 psig = 69.8 psia

T(air) = T(water) = 70F = 530R

Leakage flow area = 0.001 in.^{2} (D = 0.036 in. diameter)
K = form loss factor = 1.0

for turbulent water flow, [Appendix A, Equation (3)]

$$Q_w = 236\ D^2 \sqrt{\frac{\Delta P}{\rho K}} = 236 \times 0.036^2 \times \frac{55}{62.4} = 0.29 \text{ gpm}$$

$$= 1090 \text{ cc/min}$$

for critical airflow, [Appendix A, Equation (5)]

$$La = 3600 \sqrt{\frac{gk}{R}\left(\frac{2}{k+1}\right)^{k+1/k-1}} \times \frac{AP_1}{\sqrt{T_1}} = 3600 \sqrt{\frac{32.2 \times 1.4}{53.3}\left(\frac{2}{2.4}\right)^6} \times \frac{0.001 \times 55}{\sqrt{530}}$$

$$= 4.6 \text{ lb/hr} = 110 \text{ lb/day}$$

$$\text{ratio of } \frac{\text{air leak rate}}{\text{water leak rate}} = \frac{110 \text{ lb/day}}{1090 \text{ cc/min}} = 0.1 \frac{\text{lb/day (air)}}{\text{cc/min (water)}}$$

from the referenced utility correlation:

$$L.R. = \mu w\ L \frac{P_a}{P_w}$$

where:

L.R.	=	air leakage rate (function), lbm/day
μ_w	=	water viscosity = 1.0 Centipoise at 70°F
L	=	water leakage rate (test), cc/min
P_a	=	air pressure drop (function) = 55 psid
P_w	=	water pressure drop (test) = 55 psid.

This equation at the assumed conditions yields a leakage ratio of

$$\frac{\text{air leak rate}}{\text{water leak rate}} = \frac{L.R.}{L} = \mu w \frac{P_a}{P_w} = 1.0 \frac{55}{55} = 1.0.$$

Note that the laminar flow utility correlation overpredicts the air (function) leakage rate by a factor of 10 if turbulent water flow and choked airflow conditions exist. This is a conservative error which may result in more maintenance on valves than is actually required.

In the other case, valve repair is checked by leak testing with air, measuring the upstream volumetric flow at a critical pressure ratio of 0.43. The leakage allowance was 0.1 gpm. An interesting relationship, shown in Appendix A, is that for a function ΔP of 2250 psid and an air test temperature of 100°F, the ratio of upstream volumetric flowrates

$$\frac{Qw}{Qa} = 0.863,$$

hence the 0.1 gpm test air allowance is very conservative relative to a 1 gpm function allowance for these specific conditions.

Allowable Leakage Criteria

Excessive leakage of RCS water into lower pressure interfacing systems such as the HPSI, LPSI, RHR, and accumulator systems is a safety concern because of the following:

1. Leakage from the RCS, together with other sources may exceed the flow capacity of the pressure relief system, causing overpressurization of a lower pressure system

2. A large allowance of identified leakage through primary pressure isolation valves may make it more difficult for leakage detection systems to identify small but important increases in unidentified leakage (Reference 7)

3. Leakage of radiologically contaminated RCS water may exceed the processing capacity of waste water cleanup systems

4. This allowed breach of containment may increase the probability of uncontrolled fission product release under certain accident conditions.

While the scope of this study is limited to the first of the three safety concerns listed above, a brief examination of the radiological transport associated with current leakage limits is presented for information. The Standard Technical Specification (Reference 3) permits unlimited reactor operation with a RCS water specific activity of 1.0 μC/gm[a], and limited operation with up to 275 μC/gm. At the maximum allowed primary pressure isolation valve leakage rate of 5 gpm, the leakage of activity is:

$$C = 5 \text{ gpm} \times 3785 \text{ gm/gal} \times 60 \frac{\text{min}}{\text{hr}} \times 275 \times 10^{-6} \text{ C/gm}$$

$$= 312 \text{ C/hr per valve leaking 5 gpm.}$$

An assessment of the potential radiological releases associated with this allowed activity leak-rate would require an analysis of plant processes and the probability of failures in containing mechanisms.

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a. Dose Equivalent I-131.

EFFECTS OF LEAKAGE ON OVERPRESSURIZATION

Overpressure protection is provided by relief valves or other devices having a flow capacity based on the predicted sources of flow and energy input into the protected system, and the design pressure rating. Leakage through valves separating high pressure from lower pressure systems is a potential source of overpressurization. Leak testing is therefore essential for identifying valve degradation before the leakage increases to a value that may exceed the relief capacity of the interfacing system.

The 1980 edition of the ASME Code, Section XI, Subsection IWV-3426 provides that the permissible leakage rate of specific valves may be specified by the Owner (utility). If not specified by the Owner, the leakage rate permitted by the Code is:

1. For water, at function ΔP, 30D ml/hr (0.00013 gpm/in. nominal valve size)

2. For air, at function ΔP, 7.5D Std. ft^3/day where D is the nominal valve size, inches.

Section XI of the Code does not address the potential for valve leakage to cause overpressurization of the leaked-into system. However, the permitted leakage (1 and 2 above) is so small that it is very unlikely to effect the pressure in a system having overpressure protection from other sources. It is therefore the responsibility of the owner, in specifying the allowable leakage for specific valves, to assure that:

1. The maximum allowable leakage specified should not exceed the value allowed for that valve in the analysis of overpressure protection system requirements on which the pressure relief design is based

2. If the leakage source was not included in the overpressure protection analysis, the allowed leakage must be a negligible contribution to avoid exceeding the capacity of the pressure relief valves.

The previously quoted leakage permitted by Section XI of the Code (0.00013 gpm per inch valve size) surely meets Criterion 2 above. The 1 gpm allowance specified in the Standard Technical Specifications for Westinghouse PWRs (Reference 3, Paragraph 3.4.6.2 f) probably also meets Criterion 2, although this question was not addressed in the utility survey. For example, literature on commercial pressure relief valves shows a one-inch relief valve with the smallest available orifice (0.11 in.^{2}) has a flow capacity of 22 gpm at 150 psi with 10% accumulation. A system protected by this small relief valve would experience very little pressure increase due to an extra flow source of 1 gpm. Of greater concern is potential leakage into a system which could be isolated from overpressure relief systems.

For plants constructed in accordance with the ASME Code, Section III, the requirements of Subsections NB-7000 and NC-7000 (Class 1 and 2 systems) include an Overpressure Protection Report containing "an analysis of conditions that give rise to the maximum pressure relieving requirements."[a] For plant systems of lower design pressure than the RCS that interface with the RCS via isolation valves, the owner could specify allowed leakage in excess of the 1-5 gpm currently allowed as long as the Overpressure Protection Report documents that the allowed leakage was specifically included in the analysis and design of the pressure relief system.

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a. NB/NC-7220.

MAINTENANCE REQUIRED TO LIMIT LEAKAGE

Two manufacturers of valves of the type used for primary pressure isolation were contacted for information pertaining to valve leakage, with the following response:

1. Question: What is the configuration of the valve seat sealing surface?

   Response: For a 10-in. check or gate valve, the seat is a lapped flat surface about 1/8-in. wide adjacent to a shallow tapered surface.

2. Question: What leakage criteria is recommended for valves in high pressure water service?

   Response: Most valve procurements specify Manufacturers Standardization Society Standard Practice SP-61, which allows a maximum of 10 cc/hr/in. valve size at 3100 psig for 1500-lb class valves. They have not been called upon to supply or maintain valves with 1 gpm leakage allowance, and don't appreciate why such a large allowance is needed.

3. Question: What is the estimated cost of maintaining a 1 gpm leakage allowance for valves in the 10-in. 1500-lb class size?

   Response: Their only experience is the work required to meet the criteria of SP-61 quoted above, which requires about 2 hr to lap the seats from the as-machined condition.

4. Question: What mechanisms have been identified for leakage increasing with service time for valves installed in high pressure water systems?

Response: The most common cause of gate valve deterioration is cycling the valve dry prior to operation in service with water. They could offer no explanation or experience with check valve deterioration or leakage increase as a function of time.

As may be seen from the above response, these valve manufacturers have not had to consider the cost and radiation exposure associated with meeting a leakage criteria for valves installed in a commercial nuclear power plant. The small leakage allowance in MSS SP-61, 0.0004 gpm for a 10-in. valve, is relatively inexpensive to achieve in new valves at the factory.

REDUNDANT ISOLATION VALVES IN SERIES

A conclusion of the Reactor Safety Study (WASH 1400) is that an Interfacing Systems LOCA due to failure of the redundant LPIS check (isolation) valves is a potential event of relatively high probability (4×10^{-6}/yr). Since one of the bases for the valve leakage limit is to prevent overpressurization of the interfacing system, it follows that for redundancy, both of the isolation valves must comply with the leakage limit that precludes overpressurization of the interfacing system. While an isolation valve leak of a few gpm is unlikely to exceed the pressure relief capacity of a large system such as the LPIS, the allowance of a higher leakage rate for the valves of a redundant set should not be made without that allowance being specifically addressed in the overpressure protection analysis for the interfacing system.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations concerning leakage through primary pressure isolation valves are based on the survey responses and analysis work presented in this report.

Valve Identification

A problem identified by plant operaters is inadequate guidance in selecting specific valves that should be included in their inservice testing program. The Draft Regulatory Guide "Identification of Valves for Inclusion in Inservice Testing Programs", dated October, 1982 describes criteria that will help plant operators identify the safety-related valves that should be included in an inservice testing program. Interpretation of this Guide would ideally result in the owners of similar plants presenting similar lists of valves for their required inservice testing programs. To achieve consistancy of interpretation, it may be desirable to supplement the guide with a more definitive methodology whereby plant operating personnel would be lead through a valve selection process. Recognizing that the Guide must remain nonplant-specific, the development of a useful methodology appropriate for all plants may not be feasable. If this is found to be the case, uniform and consistant valve testing among the many plant owners could be achieved by having their testing requirements coordinated by a technical support firm competant in this field.

Leakage Allowance Criteria

1. The allowance of 1-5 gpm leakage currently invoked in plant Technical Specifications is generally considered practical to achieve, and was not reported to be challenging the pressure relief capacity of interfacing systems. The Section XI alternative to owner specified leakage allowance is essentially zero, and should so remain to prevent this allowance from affecting the requirements of Section III of the Code which defines overpressure protection requirements.

2. The current Technical Specification allowances of up to 5 gpm leakage for older plants, and 1 gpm for newer plants should be changed to make the leakage allowance proportional to valve size, and the same for all

plants. It is recommended that the leakage allowance be 1/2 gpm/in. nominal valve size at function ΔP, with a maximum of 5 gpm allowed regardless of valve size. This recommendation is based on the following factors:

a. As shown by the survey responses, new valves, supplied from the factory with nearly zero leakage, can leak in excess of 1 gpm after installation in the plant due to such factors as dry-cycling, distortion due to body welds, and contamination during construction. The rework required to reachieve less than 1 gpm leakage should be comparable for new and old valves. The seat lapping process used in the factory requires about two hours of labor after the valve is disassembled.

b. The leakage allowance should be proportional to valve size because the sealing surface circumference, or potential for leakage is so proportioned. This is recognized in the valve Manufacturers Standard MSS SP-61, which allows 10 cc/hr/in. valve size.

c. A maximum leakage allowance of 5 gpm should be routinely achievable by plant maintenance personnel using lapping equipment designed specifically for valve rework.

d. Allowance of more than 5 gpm leakage is not recommended because:

(1) If not accounted for in the Over Pressure Protection[a] analysis, the pressure relief valve in a small system may not be able to accommodate more flow without exceeding system pressure limts.

(2) Larger leakage allowances would tend to mask the detection of unidentified leakage from the primary system, which is currently limited by the Standard Technical Specification to 10 gpm (see References 3 and 7).

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a. ASME B&PV Code, Section III, Div. 1, SS NB/NC-7000.

(3) This leakage should be limited to limit fission product distribution from the primary coolant to plant systems outside the containment that are relatively free of contamination.

e. The criteria that the margin between measured leakage and the maximum allowed leakage shall not have decreased by more than 50% since the last scheduled leak test should be retained. This will reduce the chance that a deteriorating valve will substantially exceed its leakage limit between scheduled ISI leak tests.

3. The owner should be allowed the option of a higher allowance of leakage for specific valves only if justified by a documented analysis of overpressure protection and radiological processing capability showing that Code Section III and FSAR conclusions are not violated by the higher leakage allowance.

4. The question of radiological hazards associated with primary pressure isolation valve leakage should be addressed by a preliminary scoping analysis of the potential for release to the environment from this source. Under accident conditions, the specific activity of the RCS water may considerably exceed the Technical Specification limits. The specific activity of TMI RCS water measured one month after the accident was 1876 μC/mL (Reference 6). Five gpm leakage of this specific activity results in an activity leakage of 2130 C/hr.

Testing Methods and Documentation

1. The flexibility currently allowed in testing methods should be retained to accommodate the variety of individual plant design features and operating practices. However, the test condition constraints needed to assure valid results should be identified either in the Code or the Plant Technical Specifications. The following constraints have been identified in this report.

a. System pressures must be controlled to assure the measured leakage is no less than the leakage through the valve being tested (i.e., alternate paths are not accepting some of the leakage). Since this involves plant-specific design features, this requirements should be invoked in the Plant Technical Specifications.

b. The temperature of the test fluid and piping must be sufficiently subcooled relative to the downstream pressure to assure no leakage is vaporized and local internal flashing is suppressed. This should be a general requirement invoked in the Code.

c. The correlation of function leakage to test leakage must account for the actual fluid conditions. The $\sqrt{\Delta P}$ correlation currently in the Code is only valid for turbulent, subcooled, incompressible flow. The Code should include the restrictions that apply to the $\sqrt{\Delta P}$ correlation and include other correlations as appropriate.

2. A test program should be performed to document the accuracy and limitations of leak-rate correlations as affected by flow media, thermal effects, and pressure drop. The tests would involve leak testing several representative valves over a range of fluid conditions to validate existing or new correlations specified in the Code.

3. To the extent feasible, a standard format should be used by all utilities to document test conditions, methods, data, calculations, and correlated function leakage. The resulting consistency would help identify and correct errors in the testing process, and ease the burden of interpretation by plant operations personnel.

4. Valve leak testing required during plant startup rather than during shutdown places testing and repair activities on the schedule critical path. This has extended scheduled outages by 1-2 days. Since most valves are designed for repeatable seat leakage performance, the NRC should consider allowing leak testing during the plant cooldown phase to permit operators to repair failed valves during the scheduled outage. Tests on the repeatability of valve seating leak-tightness would be useful in supporting a decision on this matter.

REFERENCES

1. Transmittal of Valve Survey Sheet, letter from B. F. Saffel, Jr. to R. E. Tiller (DOE-ID), August 20, 1981.

2. ASME Boiler and Pressure Vessel Code, Section XI, Subsection IWV, 1980 edition.

3. Standard Technical Specifications for Westinghouse Pressurized Water Reactors, NUREG-0452, Revision 4.

4. The Thermal Hydraulics of a Boiling Water Reactor, R. T. Lahey and F. J. Moody.

5. Calculations by A. G. Ware, letter from B. F. Saffel to R. E. Tiller, November 30, 1981.

6. Letter from J. T. Collins, USNRC to C. W. Sill, May 22, 1980.

7. Regulatory Guide 1.45, Reactor Coolant Pressure Boundary Leakage Detection Systems.

APPENDIX A

ANALYSIS OF LIQUID AND GAS FLOW FOR VALVE LEAK TESTING

Introduction

The ASME Boiler and Pressure Vessel Code, Section XI, Subsection IWV, 1980 edition, allows ISI leak testing of certain valves at lower than functional pressure differential [IWV-3423 (e)] with test medium the option of the Owner (IWV-3425). The measured leakage rates for tests performed at less than the functional pressure differential "shall be adjusted to the function maximum pressure differential value. This adjustment shall be made by calculation appropriate to the test media and the ratio between test and function pressure differential, assuming leakage to be directly proportional to the pressure differential to the one-half power" [Reference IWV-3423 (e)]. The acceptance criteria is the option of an owner specified maximum leakage rate, or the values specified in the code (IWV-3426) which are:

1. For water, at function pressure differential, 30D mL/hr which is 0.00013 gpm/in. valve size

2. For air, at function pressure differential, 7.5D Std. ft^3/day which is 0.039 gpm/in. valve size

D in the above formulas is the nominal valve size, in.

This appendix contains an analysis of the adjustment needed to correlate measured valve leakage at reduced pressure differential with both air and water as the test media, with the function media and pressure differential. The simplifying assumptions needed to perform this analysis consistent with the rules in the Code are:

1. Valve leakage flow area and pressure loss form factor (K) are constant and independent of pressure differential and test media.

2. Valve leakage flow area and pressure loss form factor (K) in the reverse flow direction are equal or less than exist in the function flow direction in valves where reverse flow leak testing is allowed by the Code (IWV-3423).

3. In valve leak testing with air, the flow is assumed to be adiabatic. In reality, the flow will be somewhere between adiabatic and isothermal as influenced by heat transfer between the flow boundaries and the air. A refined analysis, including a heat transfer model of the flow path is beyond the scope of this study, and would preclude any generalized formulation.

4. In valve leak testing with liquid, the downstream pressure must be sufficiently above saturation pressure at the prevailing temperature to assure that flashing is suppressed. The vapor generated if flashing were allowed would be detrimental due to two-phase flow losses giving a nonrepresentative leakage rate, and inaccurate measurement of downstream leakage flow due to vapor escape. It is recognized that local flashing will occur at the minimum area if the leakage path provides pressure recovery. It is assumed that this flashing has a negligible effect on the leakage flowrate.

Nomenclature

P	=	Pressure, psia (absolute)
V	=	Fluid velocity, ft/sec
A	=	Leakage flow area, $in.^2$
K	=	Pressure loss coefficient, dimensionless $\left(\Delta P = K \times \frac{\rho V^2}{2g \times 144}\right)$
L	=	Weight flowrate, lb/hr
Q	=	Volumetric flowrate, gal/min
D	=	Leak path diameter, in.
g	=	Gravitational constant = 32.2 ft/s^2
k	=	Gas adiabatic exponent = 1.4 for air
R	=	Engineering gas constant = 53.3 ft/°R for air
T	=	Temperature, °R (= °F + 460)
ρ	=	Fluid density, lb/ft^3
ΔP	=	Pressure differential $P_1 - P_2$, psid
ℓ	=	Flow path length, in.
μ	=	Fluid viscosity, $lb\text{-}s/in.^2$
c	=	Valve seat leakage gap, in.
γ	=	Valve seat radius, in.
ℓ	=	Valve seat width, in.

Subscripts

1	=	Upstream of valve
2	=	Downstream of valve
f	=	Function, as in plant operation
t	=	Test, as in valve leak test
a	=	Air
w	=	Water

Leak Testing with Water

The expression for water flow through a small restriction is derived below:

Flow area $A = \frac{\pi D^2}{4}$ in.^{2}

Flow velocity $V = \sqrt{\frac{2g\Delta P \times 144}{K\rho_w}}$ ft/s

Flowrate $L_w = \rho AV = \frac{\rho_w \pi D^2 \times 3600}{4 \times 144} \sqrt{\frac{2g\Delta P \times 144}{K\rho_w}}$

$$= \frac{\pi \times 3600 \sqrt{2g \times 144}}{4 \times 144} D^2 \sqrt{\frac{\Delta P \rho_w}{K}}$$

(1) $L_w = 1891\ D^2 \sqrt{\frac{\Delta P \rho_w}{K}}$ lb/hr

Assuming, as previously noted that the leak path characteristics remain constant, D and K in equation (1) are the same for function and test conditions. The correlation of valve leakage at function conditions with measured leakage at test conditions is given by the expression:

(2) $L_f = L_t \sqrt{\frac{\Delta P_f \rho_{w-f}}{\Delta P_t \rho_{w-t}}}$

on a volumetric water flow basis:

$$Q_w = \frac{L}{\rho_w} \text{ ft}^3/\text{hr} \times \frac{1}{60} \frac{\text{hr}}{\text{min}} \times 7.48 \frac{\text{gal}}{\text{ft}^3} =$$

$$(3)\quad Q_w = 236\ D^2\sqrt{\frac{\Delta P}{\rho_w K}}\quad \text{gpm}$$

Assuming constant values of D and K, the correlation of valve leakage at function conditions with measured leakage at test conditions is given by:

$$(4)\quad Q_{w-f} = Q_{w-t}\sqrt{\frac{\Delta P_f \rho_{w-t}}{\Delta P_t \rho_{w-f}}}$$

Note, that the volumetric flow correlation (4) has a fluid density factor that is the reciprocal of that factor in the weight flow correlation (2).

Leak Testing with Air

The equations in this section are based on critical air flow which occurs when the ratio of downstream to upstream pressure, P_2/P_1 is less than 0.53. This restriction simplifies both the equations for flow correlation, and the test procedure since downstream pressure need not be controlled or accurately measured. The equations are derived on the basis of measuring the upstream volumetric flowrate. This allows the use of a single set of air pressure and temperature measurements. Flow measurement upstream of the valve also precludes the nonconservative error that would occur if the flow was measured downstream, and unknown parallel leakage paths existed out of the downstream volume. The expression for the critical flow of a gas through a restricted flow area A is:

$$(5)\quad L_a = 3600\sqrt{\frac{gk}{R}\left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}\ \times \frac{A \times P_1}{\sqrt{T_1}}\quad \text{lb/hr}\quad \text{a)}$$

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a) Ref: Vennard, Elementary Fluid Mechanics, 3rd Edition.

using ideal gas theory to convert equation (5) to volumetric gas flowrate:

$$\rho_{a-1} = \frac{144\ P_1}{R\ T_1}\ \text{lb/ft}^3 \times \frac{1}{7.48}\ \text{ft}^3\text{/gal} = \frac{19.25\ P_1}{RT_1}\ \text{lb/gal}$$

$$Q = \frac{L\ \text{lb/hr}}{60\ \frac{\text{min}}{\text{hr.}} \times \frac{19.25\ P_1}{RT_1}\ \text{lb/gal}}\ \text{gpm}$$

$$Q = \frac{3600\ RT_1}{60 \times 19.25\ P_1} \sqrt{\frac{gk}{R} \left(\frac{2}{k+1}\right)^{\frac{k+1}{K-1}}} \times \frac{A\ P_1}{\sqrt{T_1}}$$

(6) $$Q = 3.117 \sqrt{gkR \left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}\ X\ A\sqrt{T_1}\ \text{gpm}$$

noting that: g = 32.2, and for air k = 1.4, R = 53.3 ft/°R,

$$Q_a = 3.117\sqrt{32.2 \times 1.4 \times 53.3 \left(\frac{2}{2.4}\right)^6} \times A\ \ T_1$$

(7) $$Q_a = 88.4\ A\sqrt{T_1}\ \ \text{gpm}$$

since $A = \frac{\pi}{4} D^2$,

(8) $$Q_a = 69.4\ D^2\ \sqrt{T_1}$$

Introducing the loss factor K is only partially justified since frictional effects downstream of the minimum flow area cannot influence the flowrate when the pressure ratio is significantly less than the critical value of

0.53. Ignoring this discrepancy, and introducing K in the same relationship to the flow area as exists in the case of liquid flow (Equation 3)

$$(9)\quad Q_a = 69.4\, D^2 \sqrt{\frac{T_1}{K}} \quad \text{gpm}$$

For leak-path geometries where K ≈ 1, the error introduced by different K values for liquid and gas flow are not large since $\sqrt{K}$ applies.

The correlation of function water leakage flowrate with air flowrate leak test data is given by the following expression: (Eqns. 3 and 9)

$$\frac{Q_{f-w}}{Q_{t-a}} = \frac{236\, D^2 \sqrt{\frac{\Delta P_f}{\rho_w K}}}{69.4\, D^2 \sqrt{\frac{T_{1-a}}{K}}}$$

canceling terms and dividing yields:

$$\frac{Q_{f-w}}{Q_{t-a}} = 3.4 \sqrt{\frac{\Delta P_f}{\rho_w T_{1-a}}}$$

$$(10)\quad Q_{f-w} = Q_{t-a} \times 3.4 \sqrt{\frac{\Delta P_f}{\rho_w T_{1-a}}}$$

Example Calculation

For typical function and test conditions, assume:

ΔP_f = 2250 psid, ρ_w (100°F, 1125 psia) = 62.4 lb/ft^3

T_{1a} = 560°R (100°F)

from Eqn. (10) $\quad Q_{f-w} = Q_{t-a} \times 3.4 \sqrt{\frac{2250}{62.4 \times 560}}$

$$= Q_{t-a} \times 0.863$$

For the assumed conditions, critical air flow leakage data closely represents the volumetric water leakage at function conditions.

Laminar Flow

Assuming that the leakage path approximates a circular duct of diameter D, length ℓ, the expression for the laminar flowrate is:

$$(11) \quad f = \frac{64}{Re} = \frac{64\mu}{\rho DV} = \frac{4A}{S} \times \frac{\Delta P}{\rho} \times \frac{2}{V^2} \quad \text{(a)}$$

for the units in the nomenclature:

$$f = \frac{64\mu \times 12g}{\frac{\rho}{1728} \times D \times 12V} = \frac{4A}{S} \times \frac{\Delta P}{\frac{\rho}{1728}} \times \frac{2}{144V^2} \times 12g$$

$$A = \frac{\pi}{4} D^2, \; S = \text{surface area} = \pi D\ell$$

$$Q = A \times V \times \frac{60}{231} \; \text{(gpm)}$$

$$(12) \quad Q = 5.31 \times 10^{-4} \; \frac{D^4 \Delta P}{\mu \ell} \; \text{gpm}$$

(a) Through Flow in Annuli, L. N. Tao and W. F. Donovan, Trans. of ASME. November 1955.

Assuming that the leakage path approximates an annular gap distributed around the valve seat circumference:

for: c = valve seat leakage gap, in

r = valve seat radius, in

ℓ = valve seat width, in

$$Q = \frac{\pi r c^3 \Delta P}{6 \mu \ell} \ \frac{in^3}{sec} \times \frac{60}{231} \ \frac{gpm\text{-}sec}{in.^3} \quad (a)$$

$$(13) \quad Q = \frac{0.136 r c^3 \Delta P}{\mu \ell} \ gpm$$

ATTACHMENT 1

INSERVICE TESTING OF VALVES IN NUCLEAR POWER PLANTS SURVEY SHEET

NRC TASK #
6367-4

Please provide the following information:

1. What version, year and addenda, of the ASME Boiler and Pressure Vessel Code, Section XI is implemented for "in-service testing requirements" for your facility?

2. List all "Category A" primary pressure isolation valves in your facility for which the applicable edition and addenda of the ASME Boiler and Pressure Vessel Code, Section XI; Technical Specifications; or NRC orders, require periodic leak testing. Provide valve name, manufacturer, identification number, age, type, and size.

   a. Of the valves listed above, provide a history of the in-service leak testing they have received. Provide test medium, test pressure, and leak rates observed. List those valves found to be deficient during testing. Include the number of deficiencies observed for each valve over its service life to date. Describe each deficiency, and the corrective action taken.

   b. Of the valves listed in 2. above, list those which at some time during their in-service life to date have missed a required in-service leak test. For each omission, describe the circumstances which caused the leak test to be omitted.

IN-SERVICE TESTING OF VALVES IN NUCLEAR POWER PLANTS

SURVEY SHEET - PAGE 2

3. Provide a list and description of the various testing methods utilized to comply with ASME Section XI, as it applies to leak testing of "Category A" valves at your facility. Include sketches of equipment used, together with test piping diagrams, and instrumentation types and locations. Also, include copies of operating procedures used for leak testing, together with examples of logs, records, or other documentation utilized to record the testing data for each valve type.

4. What problems have been encountered in your facility with applicable in-service leak testing requirements and procedures?

   a. To what extent has personnel exposure to radiation presented problems in meeting in-service leak testing requirements?

   b. Has the availability of personnel qualified to perform in-service leak testing, presented problems or caused in-service leak testing to be delayed?

   c. Has component accessibility presented problems in performing in-service leak testing?

   d. Has the original design of the facility, in regard to the availability and location of test taps or orifices, been adequate to allow performance of in-service leak testing?

   e. Have documentation requirements been restrictive to an extent you consider unnecessary? Explain.

   f. Has in-service leak testing been hindered by the availability of test equipment or procedures?

   g. Has interpretation of ASME Section XI presented problems in establishing your in-service leak testing program?

IN-SERVICE TESTING OF VALVES IN NUCLEAR POWER PLANTS

SURVEY SHEET - PAGE 3

List and describe any additional problems encountered.

5. List--as a function of valve type, service, size, age, and manufacturer--the allowable leak rate you consider practical from the standpoint of measurement and valve repair.

6. Provide examples of design reports or comparable documentation which delineates the manner in which ASME Sections III and XI code requirements for valves were met at the time of the original installation.

7. Provide examples of applicable portions of Plant Operating Manuals, In-service Inspection Manuals, Technical Specifications, or comparable documentation which outlines in-service leak testing of "Category A" valves in your facility.

RESPONSE FROM UTILITIES;
PRIMARY PRESSURE ISOLATION
VALVE LEAK TEST SURVEY

A. McGuire 1
B. Millstone
C. Farley 1
D: Sequoyah.
E. Crystal River #3
F. North Anna 2
G: Maine Yankee
H. LaSalle 1
I. Ft. Calhoun.

Note: The attached material was selected from the Utility submittals. Some of the procedures and forms have been omitted to condense this material. The most appropriate information is included.

Utility A

INSERVICE TESTING OF VALVES IN
NUCLEAR POWER PLANTS
SURVEY SHEET

Please provide the following information:

1. What version, year and addenda of the ASME Boiler and Pressure Vessel Code, Section XI is implemented for "in service testing requirements" for your facility?

   ANSWER: 1977 - Summer 1978 Addendum

2. List all "Category A" primary pressure isolation valves in your facility for which your applicable edition and addenda of the ASME Boiler and Pressure Vessel Code, Section XI, requires periodic leak testing. Provide valve name, manufacturer, identification number, age, type, and size.

   ANSWER: See attached sheet (Attachment l)

   a. Of the valves listed above, provide a history of the in-service leak testing they have received. Provide test medium, test pressure, and leak rates observed. List those valves found to be deficient during testing. Include the number of deficiencies observed for each valve over its service life to date. Describe each deficiency, and the corrective action taken.

      ANSWER: See attached sheets (Attachment II)

   b. Of the valves listed in 2., above, list those which at some time during their in-service life to date have missed a required in-service leak tesc. For each omission, describe the circumstances which caused the leak test to be omitted.

      ANSWER: As of 9/25/81 no valve listed has missed a required in-service leak test.

3. Provide a list and description of the various testing methods utilized to comply with ASME Section XI, as it applies to leak testing of "Category A" valves at your facility. Include sketches of equipment used, together with test piping diagrams, and instrumentation types and location. Also, include copies of operating procedures used for leak testing, together with examples of logs, records, or other documentation utilized to record the testing data for each valve type.

   ANSWER: See attached sheets (Attachment III)

4. What problems have been encountered in your facility with applicable in-service leak testing requirements and procedures?

ANSWER: According to Utility A Technical Specification 3.4.7.2.f each Reactor Coolant System Pressure Isolation Valve has a leakage limit of 1 GPM at a Reactor Coolant System pressure of 2235 ± 20 psig. And since other Tech. Specs. require us to test valves at pressures as low as 350 psig, our acceptance criteria becomes .4 GPM (according to IWV-3423: Differential Test Pressure Leak Testing). This criteria is difficult to meet with temperature and pressure fluctuations over long lengths of piping.

a. To what extent has personnel exposure to radiation presented problems in meeting in-service leak testing requirements?

   ANSWER: Under present start-up conditions, exposure has not been a problem yet.

b. Has the availability of personnel qualified to perform in-service leak testing presented problems or caused in-service leak testing to be delayed?

   ANSWER: Due to varying Tech. Specs. this test will always be critical path during heatup, and under present staffing conditions only one person is in charge of this test which makes lengthy testing, especially testing involving repairs to valves, very difficult.

c. Has component accessibility presented problems in performing in-service leak testing?

   ANSWER: Since testing is done from a centralized location, this has not been a problem.

d. Has the original design of the facility, in regard to the availability and location of test taps or orifices, been adequate to allow performance of in-service leak testing?

   ANSWER: Due to extensive modifications during construction of the plant and some modifications to better meet Tech. Spec. 4.4.7.2.2.d, we have changed a large portion of the plant's original design to accommodate this test.

e. Has time been available to allow the plant to cool down sufficiently to permit in-service leak testing to be performed?

   ANSWER: Due to Tech. Spec. 4.4.7.2.2.d, most testing is done during plant heat-up which means temperature (i.e., water flashing to steam) has been a problem.

f. Have documentation requirements been restrictive to an extent you consider unnecessary? Explain.

ANSWER: Documentation has been no more restrictive on this test than any other testing done at the plant.

g. Has in-service leak testing been hindered by the availability of test equipment or procedures?

ANSWER: No more so than any other testing.

h. Has interpretation of ASME Section XI presented problems in establishing your in-service leak testing program?

ANSWER: No

List and describe any additional problems encountered.

5. List -- as a function of valve type, service, size, age, and manufacturer-- the allowable leak rate you consider practical from the standpoint of measurement and valve repair.

ANSWER: We base our acceptable leakage rate on Tech. Spec. 3.4.7.2.f (1 GPM at 2235 $\pm$20 psig)

6. Provide examples of design reports or comparable documentation which delineates the manner in which ASME Sections III and XI code requirements for valves were met at the time of the original installation.

ANSWER: See attached sheets (Attachment IV)

7. Provide examples of applicable portions of Plant Operating Manuals, Inservice Inspection Manuals, or comparable documentation which outlines in-service leak testing of "Category A" valves in your facility.

ANSWER: See attached sheets (Attachment V)

Attachment 1

Category A Primary Pressure Isolation Valves

Name	Manufacturer	I.D. #	Type	Size (inches)
Accumulator Discharge	Walworth	1NI059	CK	10
Accumulator Discharge	Walworth	1NI060	CK	10
Accumulator Discharge	Walworth	1NI070	CK	10
Accumulator Discharge	Walworth	1NI071	CK	10
Accumulator Discharge	Walworth	1NI081	CK	10
Accumulator Discharge	Walworth	1NI082	CK	10
Accumulator Discharge	Walworth	1NI093	CK	10
Accumulator Discharge	Walworth	1NI094	CK	10
Safety Injection (Hot Leg)	Kerotest	1NI124	CK	2
Safety Injection (Hot Leg)	Walworth	1NI126	CK	6
Safety Injection (Hot Leg)	Kerotest	1NI128	CK	2
Safety Injection (Hot Leg)	Walworth	1NI134	CK	6
Safety Injection (Hot Leg)	Kerotest	1NI156	CK	2
Safety Injection (Hot Leg)	Walworth	1NI157	CK	6
Safety Injection (Hot Leg)	Kerotest	1NI159	CK	2
Safety Injection (Hot Leg)	Walworth	1NI160	CK	2
Safety Injection/RHR (Cold Leg)	Kerotest	1NI165	CK	2
Safety Injection/RHR (Cold Leg)	Kerotest	1NI167	CK	2
Safety Injection/RHR (Cold Leg)	Kerotest	1NI169	CK	2
Safety Injection/RHR (Cold Leg)	Kerotest	1NI171	CK	2
Safety Injection/RHR (Cold Leg)	Walworth	1NI175	CK	6
Safety Injection/RHR (Cold Leg)	Walworth	1NI176	CK	6
Safety Injection/RHR (Cold Leg)	Walworth	1NI180	CK	6
Safety Injection/RHR (Cold Leg)	Walworth	1NI181	CK	6
Upper Head Injection	Westinghouse	1NI248	CK	12
Upper Head Injection	Westinghouse	1NI249	CK	12
Upper Head Injection	Westinghouse	1NI250	CK	8
Upper Head Injection	Westinghouse	1NI251	CK	8
Upper Head Injection	Westinghouse	1NI252	CK	8
Upper Head Injection	Westinghouse	1NI253	CK	8
RHR	Walworth	1ND001B	GT	14
RHR	Walworth	1ND002A	GT	14

Attachment II

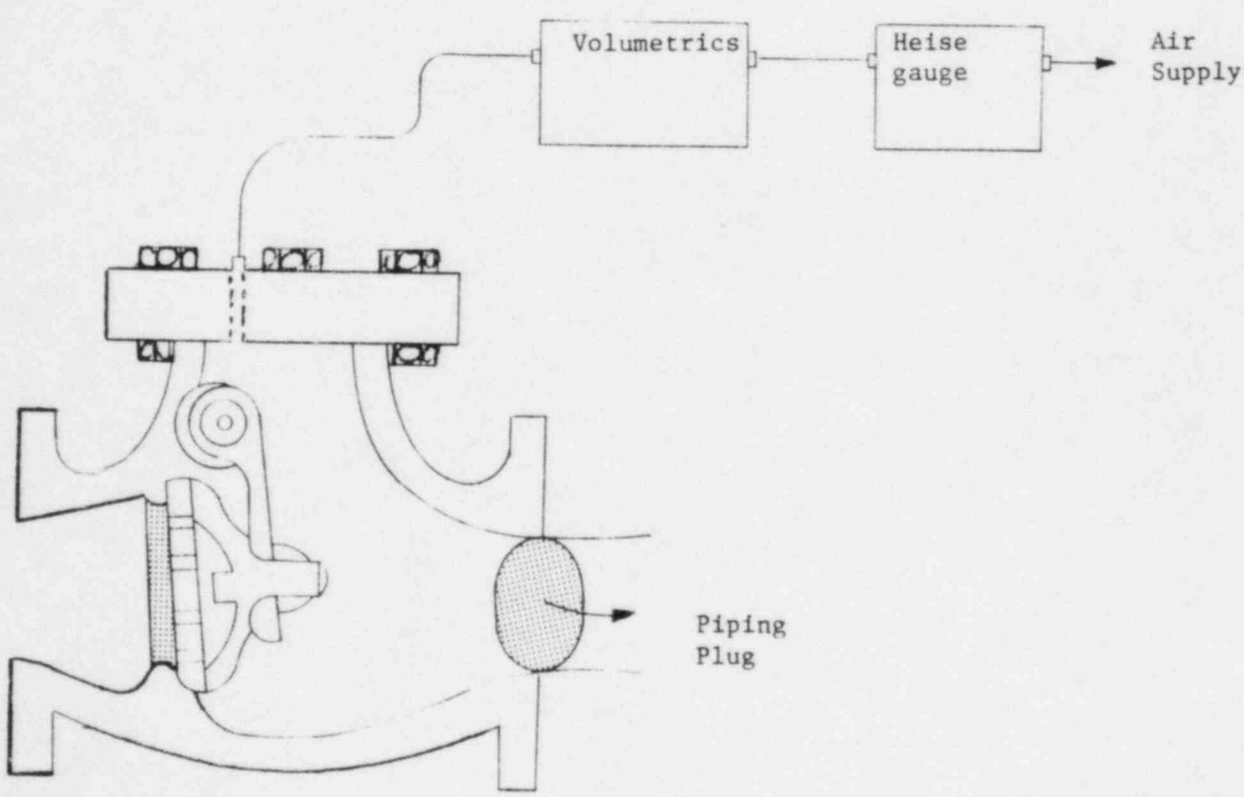
1) During all pressure testing of primary pressure isolation valves, water is used as a test medium.

2) The test pressure used for each valve is listed in the test procedure (Attachment III).

3) When we tested all the primary pressure isolation valves for the first time, there were many failures. These failures continued until maintenance and Walworth representatives perfected lapping and bluing procedures to the point that the valves would pass the leak test. Some of the leakages found prior to maintenance were:

Valve #	Leakage	Valve #	Leakage
1NI60	2.4 GPM	1NI71	4.8 GPM
1NI59	1.5 GPM	1NI70	4.5 GPM
1NI82	5.4 GPM	1NI81	>10 GPM
1NI93	2.1 GPM	1NI159	9.4 GPM
1NI156	8.6 GPM	1NI160	2 GPM
1NI157	1.1 GPM	1NI248	>10 GPM
1NI124	4.7 GPM	1NI169	2.1 GPM

After the initial leak testing and subsequent maintenance which caused about 1/3 of the failed valves to pass, it was decided that all failed valves would be worked on using the new lapping techniques and a local leak testing arrangement (shown below).



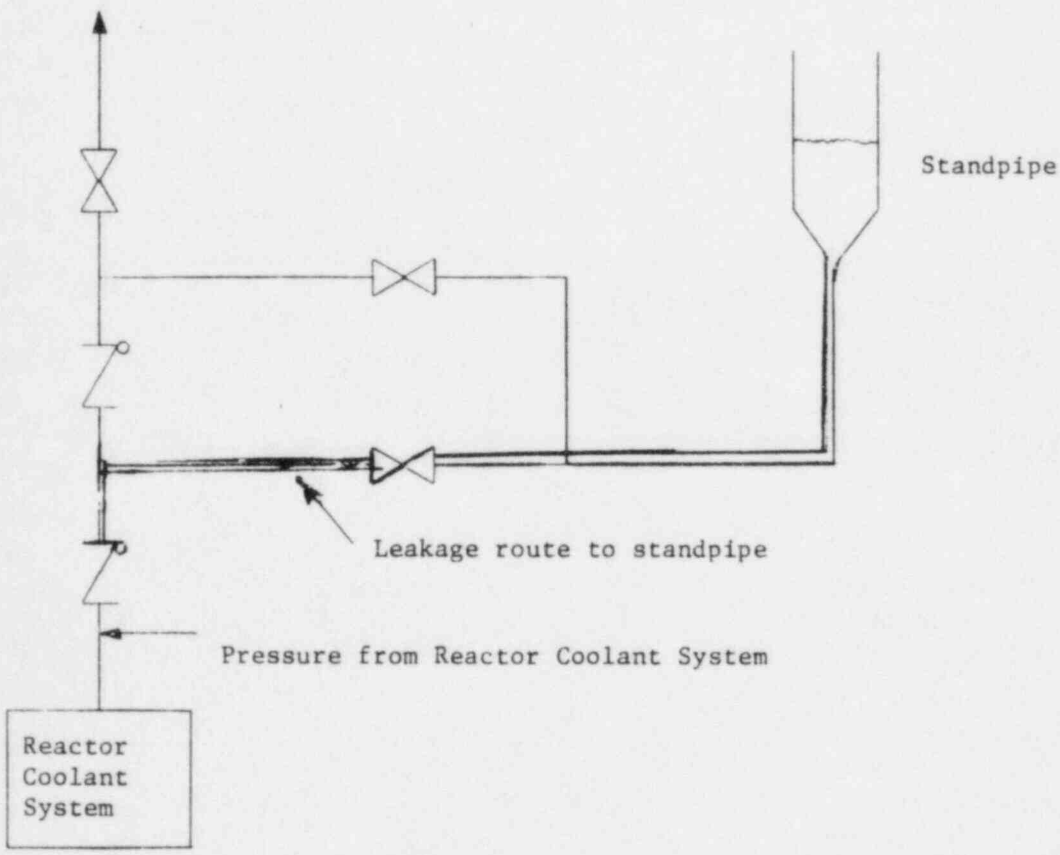
The volumetric and Heise gauge assembly measure the amount of make up air it takes to maintain a certain pressure (i.e., the leakage). We set an acceptance of .1 GPM at 20 psig of air. The work done on the valves required an unscheduled outage of approximately 3 weeks. Since this work was only done 4 months ago (approximately 6/1/81) we have not been able to determine how time and use will affect the leak rate.

Attachment III

Currently at Utility A we are using two methods to test primary pressure isolation valves.

Method 1:

For most valves we have installed a "test header" which routes any leakage to a standpipe. The leakage is measured by a rise in level in the standpipe.



The level of the standpipe is determined by a differential pressure indication between the top and bottom of the pipe.

Method 2:

For the 4 primary Upper Head Injection check valves we measure leakage by:

1) Vent downstream side of check valves to atmospheric pressure.
2) Run Reactor Coolant System Inventory Calc. to find total leakage from Reactor Coolant System.
3) Attribute all leakage to the check valves being tested.

Utility B

October 26, 1981

John G. Collett
EG&G Idaho Inc.
Idaho National Engineering Laboratory
Idaho Falls, ID 83401

Dear John,

Enclosed is a copy of our Containment Isolation Valve Leak Rate Test procedure that you requested.

The following information is in response to your survey sheet and is numbered accordingly.

1. ASME Section XI 1977 S-78 addenda.

2. Valves that are leak rate tested are listed in enclosed procedure. Time does not permit me to obtain the information required by parts (a) and (b) of this question. This information is available on LER's submitted to the NRC.

3. Methods used are in accordance with 10 CFR 50, Appendix J and the enclosed procedures.

4. (a) None.

   (b) No.

   (c) See exemptions.

   (d) See exemptions for FWCI, RBCCW and Fuel Pool.

   (e) Yes.

   (f) No.

   (g) No.

   (h) Definition of "ALERT" and "REQUIRED ACTION" ranges for pump vibration signature analysis.

5. Time does not permit me to fully answer this question. See acceptance criteria in procedure.

6. Section XI was not issued at time of original construction.

7. See plant ISI manual and applicable procedures.

Sincerely yours,

Utility C

INSERVICE TESTING OF VALVES IN NUCLEAR POWER PLANTS

SURVEY SHEET NRC TASK # 6367-4

The following information is provided in response to the survey questions.

1. Question:

What version, year and addenda, of the ASME Boiler and Pressure Vessel Code, Section XI is implemented for "in service testing requirements" for your facility?

Response:

Utility C Nuclear Plant Unit 1 Pump and Valve Program is in accordance with the requirements of Subsections IWP and IWV of the ASME Boiler and Pressure Vessel Code, Section XI, 1974 Edition through the Summer 1975 Addenda.

2. Question:

List all "Category A" primary pressure isolation valves in your facility for which the applicable edition and addenda of the ASME Boiler and Pressure Vessel Code, Section XI; Technical Specifications; or NRC orders, require periodic leak testing. Provide valve name, manufacturer, identification number, age, type and size.

Response:

See Table 1.

Question:

a. Of the valves listed above, provide a history of the in-service leak testing they have received. Provide test medium, test pressure, and leak rates observed. List those valves found to be deficient during testing. Include the number of deficiencies observed for each valve over its service life to date. Describe each deficiency, and the corrective action taken.

Response:

See Table 2.

Question:

b. Of the valves listed in 2., above, list those which at some time during their in-service life to date have missed a required in-service leak test. For each omission, describe the circumstances which caused the leak test to be omitted.

Response:

None of the valves listed in Table 1 have missed a required inservice leak test.

3. Question:

Provide a list and description of the various testing methods utilized to comply with ASME Section XI, as it applies to leak testing of "Category A" valves at your facility. Include sketches of equipment used, together with test piping diagrams, and instrumentation types and locations. Also, include copies of operating procedures used for leak testing, together with examples of logs, records, or other documentation utilized to record the testing data for each valve type.

Response:

See the attached Plant Procedure, FNP-1-STP-158, Reactor Coolant System Pressure Isolation Valve Leak Test, and piping diagrams D-175037 sheet 1, D-175038 sheet 1, D-175038 sheet 2.

4. Question:

What problems have been encountered in your facility with applicable in-service leak testing requirements and procedures?

a. To what extent has personnel exposure to radiation presented problems in meeting in-service leak testing requirements?

Response:

Personnel exposure to radiation does not present any unusual problems during performance of the leak testing. However, significant radiation exposure to personnel has been a problem during valve repair. A radiation dose of approximately 8 REM was accumulated by personnel during repair of only six valves (≅ 1.3 REM/Valve). This high dose was a result of exposing the valve internals which are highly contaminated. The surface exposure of the valve internals and valve bodies averaged between 20 to 30 REM/hr. The total dose for the testing and repair was 9 REM.

Question:

b. Has the availability of personnel qualified to perform in-service leak testing, presented problems or caused in-service leak testing to be delayed?

Response:

No.

Question:

c. Has component accessibility presented problems in performing in-service leak testing?

Response:

Yes, the system alignment necessary to perform the leak testing is difficult to accomplish when considering operational constraints because, the test alignment deviates significantly from the normal operational alignment.

Question:

d. Has the original design of the facility, in regard to the availability and location of test taps or orifices, been adequate to allow performance of in-service leak testing?

Response:

Yes, the availability of test vents and drains have been adequate when performing leak tests per the plant procedure.

Question:

e. Have documentation requirements been restrictive to an extent you consider unnecessary? Explain.

Response:

No, the documentation requirements are per plant procedure.

Question:

f. Has in-service leak testing been hindered by the availability of test equipment or procedures?

Response:

No.

Question:

g. Has interpretation of ASME Section XI presented problems in establishing your in-service leak testing program?

Response:

There have been no problems with interpreting ASME Section XI when establishing the inservice leak testing program.

However, there are problems determining which valves the Section XI Category A requirements apply to when establishing the pressure isolation valves. Section XI does not provide sufficient guidance for these valves. This information has been derived from the NRC staff position stated in NUREG-0677 and Appendix A to the Proposed Revision Standard Review Plan PSRP-3.9.6 (Rev. 2).

Question:

List and describe any additional problems encountered.

Response:

Additional problems have been encountered when performing the leak testing just prior to resuming power operation as the plant is pressurized. If a valve fails, the plant has to depressurize and drain the Reactor Coolant System to mid-plane to perform valve repair. As a result, the plant has been subjected to unnecessary transients and has an unscheduled extension of the outage.

It would be more practical to perform the leak testing when the plant is being depressurized at the start of the outage. Then the valves that fail could be scheduled to be repaired during the outage and retested at the end of the outage. The valve integrity and leak-tightness will be verified whether it has been tested at the beginning or end of the outage.

5. Question:

List -- as a function of valve type, service, size, age and manufacturer -- the allowable leak rate you consider practical from the standpoint of measurement and valve repair.

Response:

The current leakage rate limits as shown in the attached Technical Specifications, Table 4.4-3, are acceptable for all valves.

6. Question:

Provide examples of design reports or comparable documentation which delineates the manner in which ASME Sections III and XI code requirements for valves were met at the time of the original installation.

Response:

See the attached example of Form N-5 Data Report for Field Installation of Nuclear Power Plant Components, Component Supports and Appurtenances and Form NIS-1 Owner's Data Report for Inservice Inspection for ASME Section III and XI requirements, respectively.

7. Question:

Provide examples of applicable portions of Plant Operating Manuals, Inservice Inspection Manuals, Technical Specifications, or comparable documentation which outlines in-service leak testing of "Category A" valves in your facility.

Response:

See the plant procedure FNP-1-STP-158 (response to Question 3), the attached Technical Specification and the example page from the FNP Unit 1 Pump and Valve Program.

TABLE 1
GENERAL INFORMATION

VALVE ID NUMBER	VALVE FUNCTION	MANUFACTURER	SIZE & TYPE	AGE*
Q1E11V021A	RHR Pump Discharge to SICL	Velan	6" Check Valve	4 Yrs
Q1E11V021B	RHR Pump Discharge to SICL	Velan	6" Check Valve	4 Yrs
Q1E11V021C	RHR Pump Discharge to SICL	Velan	6" Check Valve	4 Yrs
Q1E11V051A	SI/BIT to RCS (CL)	Velan	6" 1500 lb Check Valve	4 Yrs
Q1E11V051B	SI/BIT to RCS (CL)	Velan	6" 1500 lb Check Valve	4 Yrs
Q1E11V051C	SI/BIT to RCS (CL)	Velan	6" 1500 lb Check Valve	4 Yrs
Q1E21V062A	SIS/BIT to RCS (CL)	Kerotest	2" Check Valve	4 Yrs
Q1E21V062B	SIS/BIT to RCS (CL)	Kerotest	2" Check Valve	4 Yrs
Q1E21V062C	SIS/BIT to RCS (CL)	Kerotest	2" Check Valve	4 Yrs
Q1E21V066A	CHG (HHSI) Pumps Disch to RCS (CL)	Kerotest	2" Check Valve	4 Yrs
Q1E21V066B	CHG (HHSI) Pumps Disch to RCS (CL)	Kerotest	2" Check Valve	4 Yrs
Q1E21V066C	CHG (HHSI) Pumps Disch to RCS (CL)	Kerotest	2" Check Valve	4 Yrs
Q1E21V076A	Water from Residual Hx to SI to RCS HL Loops 1 & 2	Velan	6" Check Valve	4 Yrs
Q1E21V076B	Water from Residual Hx to SI to RCS HL Loops 1 & 2	Velan	6" Check Valve	4 Yrs
Q1E21V077A	HHSI/LHSI and RHR to RCS HL Loops 1 & 2	Velan	6" Check Valve	4 Yrs
Q1E21V077B	HHSI/LHSI and RHR to RCS HL Loops 1 & 2	Velan	6" Check Valve	4 Yrs

*Age Based on commercial operation date of December 1, 1977

TABLE 2

TESTING HISTORY†

VALVE ID NUMBER	FIRST TEST 11/7/80-11/10/80		SECOND TEST 2/27/81-2/28/81		THIRD TEST 3/20/81	
	TEST PRESSURE	LEAKAGE	TEST PRESSURE	LEAKAGE	TEST PRESSURE	LEAKAGE
Q1E11V021A	400 PSIG	0.1 GPM				
Q1E11V021B	325 PSIG	6 GPM*	340 PSIG	None		
Q1E11V021C	400 PSIG	0.1 GPM				
Q1E11V051A	400 PSIG	8.9 GPM*	390 PSIG	9.1 PSIG*	1025 PSIG	0.9 GPM
Q1E11V051B	400 PSIG	None				
Q1E11V051C	400 PSIG	3.3 GPM*	390 PSIG	2.9 GPM		
Q1E21V062A	400 PSIG	0.1 GPM				
Q1E21V062B	400 PSIG	0.1 GPM				
Q1E21V062C	400 PSIG	0.1 GPM				
Q1E21V066A	400 PSIG	0.1 GPM				
Q1E21V066B	400 PSIG	0.1 GPM				
Q1E21V066C	[illegible]0 PSIG	0.1 GPM				
Q1E21V076A	900 PSIG	None	340 PSIG	None		
Q1E21V076B	900 PSIG	None	340 PSIG	None		
Q1E21V077A	1054 PSIG	6 GPM*	375 PSIG	None		
Q1E21V077B	1054 PSIG	3 GPM*	375 PSIG	None		

†Test Medium - Water

*Indicates tests which failed due to excessive leakage. Valves were repaired by lapping the disks.

UTILITY C
SURVEILLANCE TEST PROCEDURE
STP-158

REACTOR COOLANT SYSTEM PRESSURE
ISOLATION VALVE LEAK TEST

1.0 Objective

To verify that the backleakage for the following check valves meet the Acceptance Criteria listed below:

Q1E21V077A and B - Hot Leg Injection Check Valves

Q1E21V076A and B - Hot Leg Injection Check Valves

Q1E11V051A, B and C - Cold Leg Injection Check Valves

Q1E11V021A, B and C - Cold Leg Injection Check Valves

Q1E21V062A, B and C - Cold Leg Injection Check Valves

Q1E21V066A, B and C - Cold Leg Injection Check Valves

REV. 3

1.1 Leakage rates less than or equal to 1.0 gpm are considered acceptable. However, for initial testing and testing following repair, leakage rates of less than or equal to 5 gpm are considered acceptable.

1.2 Leakage rates greater than 1.0 gpm but less than or equal to 5.0 gpm are considered acceptable if the latest measured rate has not exceeded the rate determined by the previous test by an amount that reduces the margin between the measured leakage rate and the maximum permissible rate of 5.0 gpm by 50% or greater.

1.3 Leakage rates greater than 1.0 gpm but less than or equal to 5.0 gpm are considered unacceptable if the latest measured rate exceeded the rate determined by the previous test by an amount that reduces the margin between measured leakage rate and the maximum permissible rate of 5.0 gpm by 50% or greater.

1.4 Leakage rates greater than 5.0 gpm a[illegible] considered unacceptable.

2.0 References

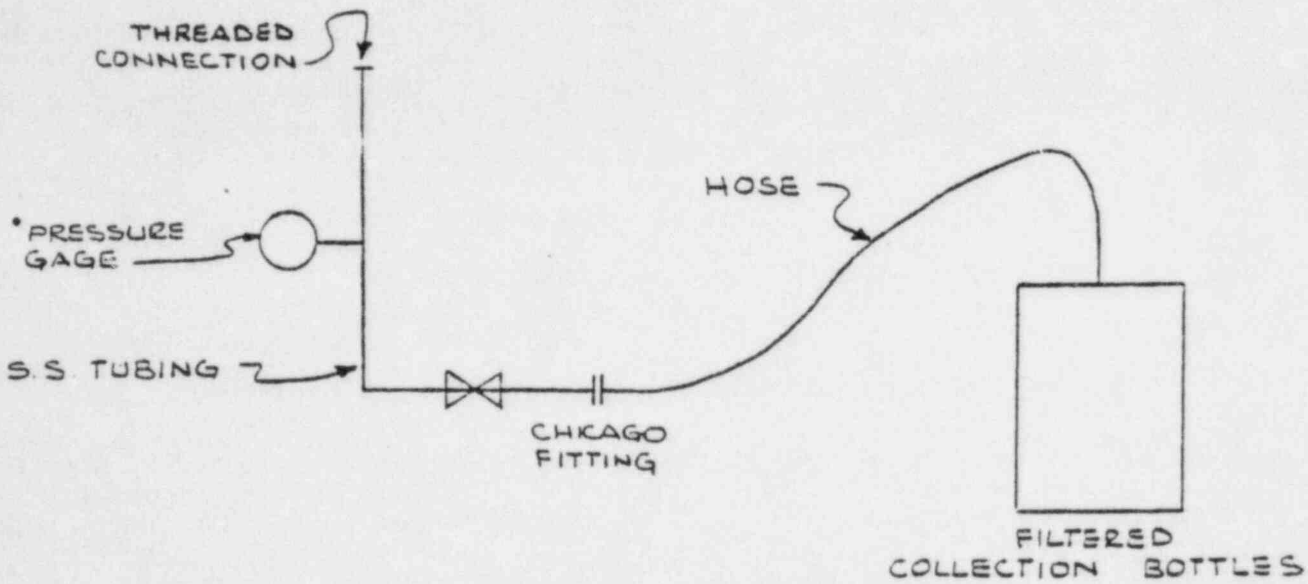
2.1 Standard Review Plan (Proposed Revision) PSRP-3.9.6.

2.2 D-175037, sheet 1 of 3 - Reactor Coolant System.

2.3 D-175038, sheets 1 and 2 of 3 - Safety Injection System.

3.0 Test Equipment

3.1 Test rig as shown below or comparable.



3.2 Portable Hydro Pump.

3.3 Large graduated filtered collection bottles from Health Physics. REV. 3

3.4 Stopwatch.

4.0 Required Data & Documentation

4.1 An Official Test Copy of the completed test procedure, along with data collected, will be retained by Document Control as part of the plant historical record.

5.0 Prerequisites & Initial Conditions

5.1 Obtain Health Physics approval to enter required test areas.

5.2 One or both trains of RHR shall be out of service for testing check valves V051A, B, C, V062A, B, C, V066A, B, C & V021A, B, C.

6.0 Precautions and Notes

6.1 When making connections to vent and drain valves or operating vent and drain valves, all reasonable care should be exercised to prevent personnel injury from an accidental discharge of steam or hot water.

6.2 When a tygon hose is run to a bucket or beaker to collect back leakage through a check valve, label the container with th number of the check valve for which the leakage is bein collected, if the container is not in the immediate vicinity of the check valve.

6.3 Use only demineralized water as a source of water to the hydro pump in this procedure.

6.4 Leak tests may be performed at pressures less than 2235 psi, but data obtained will be adjusted in accordance with ASME Section XI, IWV-3420 Section C-5.

6.5 Before engaging hydro pumps, obtain the Reactor Coolant System Pressure from the Control Room, and ensure hydro pump pressure is at least 100 psi below it at all times.

6.6 When plant is solid maintain constant communication with Control Room during testing to monitor for loss of RCS pressure due to leakage collection and/or increase in RCS pressure due to overpressurization from hydro pump.

6.7 Valve leak tests may be worked out of procedural order at the discretion of the Test Director.

7.0 Detailed Test Procedure

7.1 Determine check valve back leakage of the hot leg injection line check valves Q1E21V077A & Q1E21V077B using Reactor Coolant System Pressure.

7.1.1 Verify closed or close valves Q1E11V044(8889), Q1E21V068(8886) and Q1E21V072(8884). Install test rig (described in Section 3.0) to test connection valve QV422C, QV412D or QV411D for QV077A and valve QV422D, QV412E or QV411E for QV077B. Test connection valve will be selected in field by test director or his designated alternate. REV. 2

7.1.2 Connect high pressure tubing to test rig and run to filtered collection bottle provided by HP & located at a convenient point above the highest point in the line containing subject check valve(s).

7.1.3 Fill high pressure tubing with demin. water.

7.1.4 With all valves in the test rig closed, slowly open test connection valve. Observe test gauge.

7.1.4.1 If no pressure is indicated, continue observing gauge for several more minutes. If still no pressure is indicated, check valve can be assumed functioning satisfactorily. Close test connection valve and restore system. REV. 2

7.1.4.2 If pressure is indicated, it is quite possibly residual pressure in the line, and not pressure due to a leaking valve.

a. Carefully attempt to bleed off pressure.

b. After bleed off, if no appreciable pressure build up is noted, go to step 7.1.4.1.

c. If pressure remains unchanged or builds back up after bleed off, check valve leak test shall be performed to determine valve acceptability.

NOTE: If after the bleed off attempt a high pressure is indicated, the check valve may be assumed to be functioning unsatisfactorily. At the discretion of the test director,

the check valve leak test may then be waived and the the valve tagged for repair.

7.1.5 Check valve leak rate test.

7.1.5.1 Slowly open test connection valve.

7.1.5.2 When flow of water into collection bottle stabilizes, begin measuring the leak rate.

7.1.5.3 Record the time duration and amount of leakage collected. REV. 3

7.1.5.4 Shut test connection valve.

7.1.5.5 Drain & remove high pressure hose and test rig.

7.1.5.6 Restore system.

7.2 Determine check valve back leakage of hot leg injection line check valves Q1E21V076A and Q1E21V076B.

7.2.1 Verify close or close valves Q1E11V044(8889), Q1E21V068(8886) and Q1E21V072(8884).

7.2.2 Install test rig to test connection valve Q1E11V048E.

7.2.3 Connect high pressure tubing to test rig and run to filtered collectoin bottle provided by HP and located at a convenient point <u>above</u> the hot leg injection line.

7.2.4 Connect hydro pump(s) to vent or drain valves used as test connections in 7.1.1. Hydro pump pressure shall be maintained at a minimum of 100 psi less than Reactor Coolant System pressure for the test duration. Hydro pump pressure shall be noted on leak test data sheet.

7.2.5 Perform leak tests per Sections 7.1.3 through 7.1.5.

<u>NOTE</u>: Collection of leakage for both valves will be taken simultaneously

from the same point. Although leakage is being collected from two valves, the maximum allowable leakage rate at this point is still 1 GPM.

7.2.6 Disconnect hydro pumps.

7.3 Determine check valve back leakage of the cold leg injection line check valves Q1E11V051A & B using Reactor Coolant System Pressure. REV 2

7.3.1 Verify closed or close valves Q1E21V063(8885), Q1E21V004A & B (8801A & B), Q1E11V023B(8888B) and Q1E11V043A(8972A). Before closing V023B(8888A), verify Q1E11V024A & B (8887A & B) open, then turn off RHR A Train pump.

7.3.2 Install test rigs (described in Section 3.0) to test connection valve QV061B or QV415D for QV051A, QV0548 or QV415E for QV051B. Test connection valve will be selected in field by Test Director or his designated alternate.

7.3.3 Perform leak tests per Sections 7.1.2 through 7.1.5.

7.4 Determine check valve back leakage of the cold leg injection line check valves Q1E11V021A & B, Q1E21V062A & B & Q1E21V066A & B.

7.4.1 Verify closed or close valves Q1E21V063(8885), Q1E21V004A & B (8801A & B) Q1E11V023B(8888A), and Q1E11V043A(8972A). Before closing V023B (8888A), verify Q1E11V024A & B (8887A & B) open, then turn off RHR A Train pump.

7.4.2 Install test rigs (described in Section 3.0) to test connection valve Q1E11V049D, V07713, V060B or V072B for QV021A & B, QV558B or QV416B for QV062A & B and QV418B for QV066A & B. Test connection valves will be selected in field by Test Director or his designated alternate.

7.4.3 Connect hydro pump(s) to vent and/or drain valves used as test connections in section 7.3.2.

Hydro pump pressure shall be maintained a minimum of 100 ± 50 psi less than Reactor System Pressure for the test duration.

7.4.4 Perform leak tests per sections 7.1.2 through 7.1.5.

NOTE: The cold leg injection lines (to RCS Loops 2 & 3) may be pressurized independently or simultaneously at the Test Director's discretion. Because of common leakage collection points, if the 2 injection lines are pressurized simultaneously any leakage coming from their respective check valves will be indistinguishable as to origin. Therefore maximum allowable leakage for this condition remains 1 GPM, even though leakage collection is from two independent check valves.

7.4.5 Disconnect hydro pumps.

7.5 Determine check valve back leakage of the cold leg injection line check valves Q1E11V051C using Reactor Coolant Pressure.

7.5.1 Verify closed or close Q1E11V063(8885), Q1E21V004A & B (8801A & B), Q1E11V023A (8888B) and Q1E11V043A (8972A). Before closing V023A(8888B), verify Q1E11V024A & B (8887A & B) open, then turn off RHR B Train pump.

7.5.2 Install test rig (described in section 3.0) to test connection QV415F, QV074B or QV559B. Test connection valve will be selected in field by Test Director or his designated alternate.

7.5.3 Perform leak test per sections 7.1.2 through 7.1.5.

7.6 Determine check valve back leakage of the cold leg injection line check valves Q1E11V021C(8973C), Q1E21V062C(8997C) and Q1E21V066C(8995C).

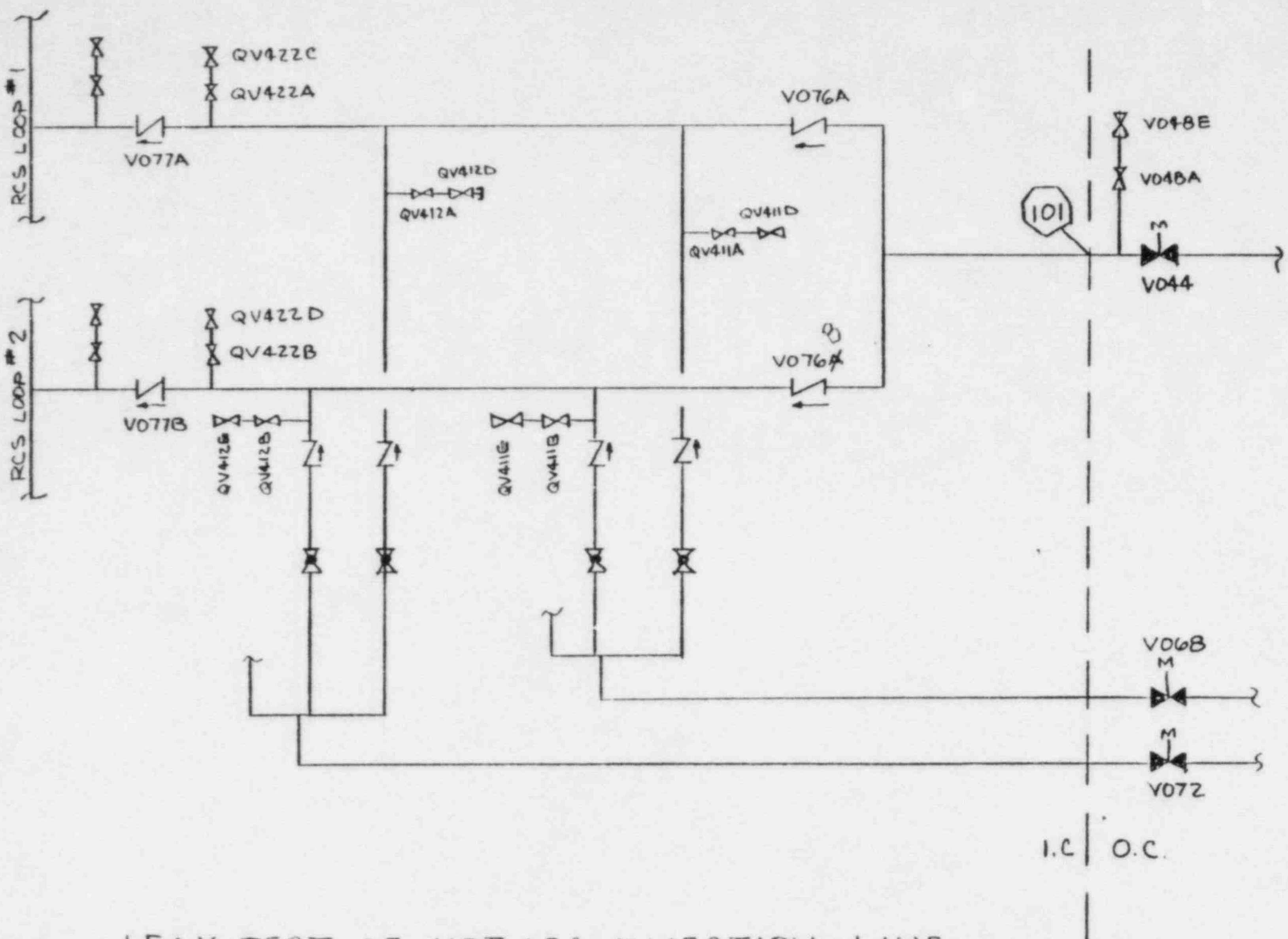
7.6.1 Verify closed or close valves Q1E11V063(8885), Q1E21V004A & B (8801A & B), Q1E11V023A(8888B) and Q1E11V043A(8972). Before closing QV023A (8888B), verify Q1E11V024A & B (8887A & B) open, then turn off RHR B Train pump.

7.6.2 Install test rigs (described in Section 3.0) to test connection valves QV049C for QV021C, QV562B or QV416B for QV062C and QV418B for V066C. Test connection valve will be selected in field by Test Director or his designated alternate.

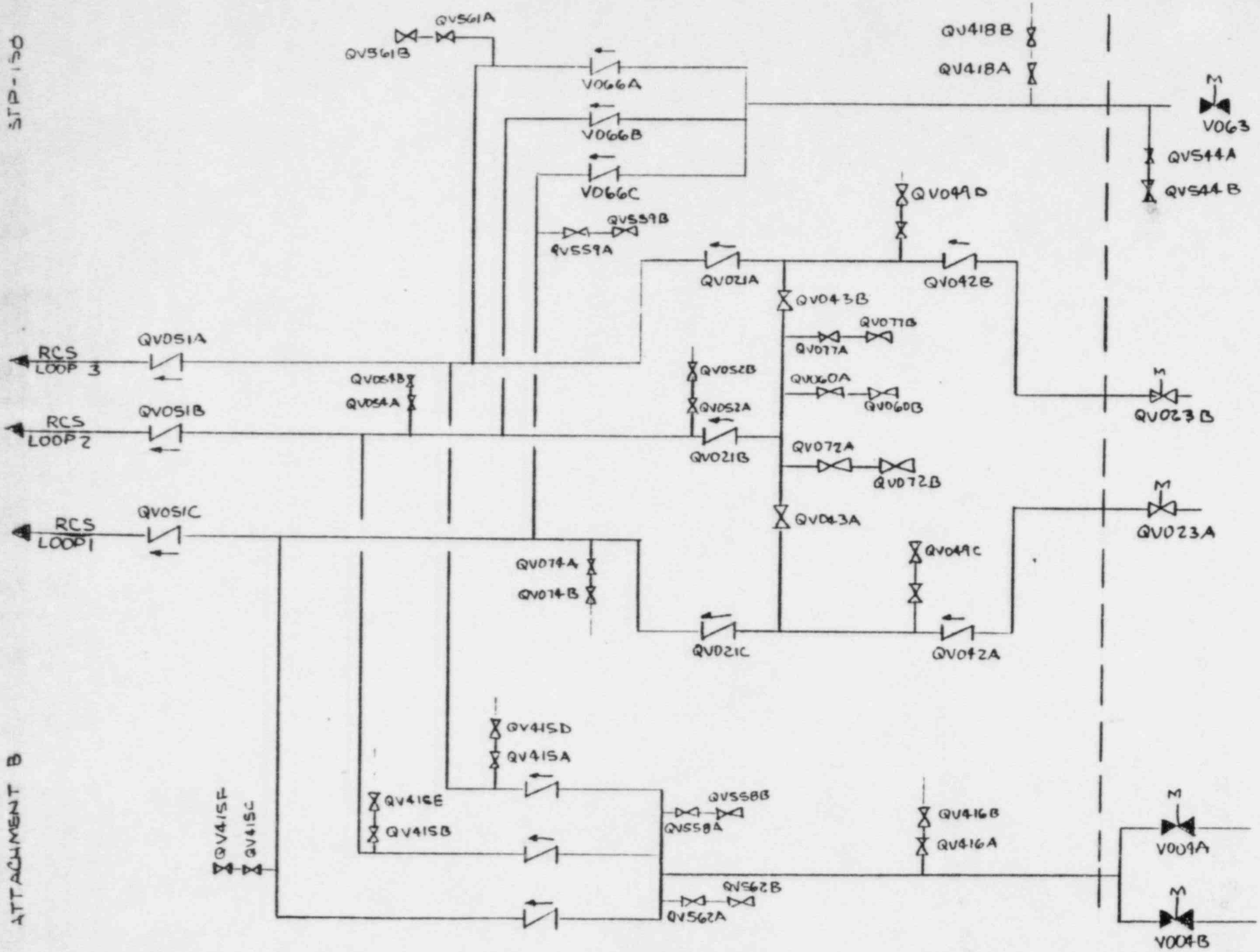
7.6.3 Connect hydro pump to vent and/or drain valves used as test connections in Section 7.5.2. Hydro pump pressure shall be maintained a minimum of 100 ± 50 psi less than reactor system pressure for the test duration.

7.6.4 Perform leak tests per section 7.1.2 through 7.1.5.

7.6.5 Disconnect hydro pumps.



LEAK TEST OF HOT LEG INJECTION LINE
CHECK VALVES



ATTACHMENT B

ATTACHMENT C

DATA SUMMARY SHEET

TEST DATE	VALVE #	TEST GAGE PRESSURE	MEASURED LEAKAGE	RCS PRESSURE	ADJUSTED LEAKAGE

Utility D

Sequoyah

NOTE: The numbers on this Attachment refer to the questions in your letter.

1. The 1974 Edition, Summer 1975 Addenda of the ASME Boiler and Pressure Vessel Code, Section XI is implemented for in-service leak testing requirements for Unit 1 and 1977 Edition, Summer 1978 Addenda is used for Unit 2.

2. See Table 1

   a. See Table 2

   b. No valve has missed a required in-service leak test.

3. The Surveillance Instruction (SI) is the basic operational procedure used for leak testing. This package includes the procedure (Testing Method and Instructions) and the data sheet (Record of Test Results). Attached are SI-166.10, 166.11, and 166.18 which makeup the category "A" Testing Program. Also attached are the corresponding flow diagrams for these SI's: SI-166.10 47W 811-1
   SI-166.11 47W 811-2
   SI-166.18 47W 810-1

4. a. Thus far, personnel exposure to radiation has presented no problems in meeting leak testing requirements. However, as plant radiation levels increase, personnel exposure may become a greater problem in the future.

   b. The availability of qualified personnel has presented no problems in meeting in-service leak testing requirements.

   c.&d. Yes, component accessibility has presented problems. Vent valve test connections, due to their high locations, present a safety hazard to test personnel. However, we can perform the leak test as designed.

   Also, the design of the leak test system is such that a leakage may be indicated without the system being lined up to a specific check valve. This is caused by system leakage which is not constant. Since the system leak rate varies, it is not possible to predict when a valve will exceed its maximum allowable leak rate. This is clearly shown by the leak rates on Table 2.

   e. Documentation requirements have not been found unnecessarily restrictive.

   f. In-plant rotometers have been found to be unreliable and have caused delays. These delays, however, have not affected plant startup.

g. Interpretation of ASME Section XI has presented some problems in determining exactly which valves require in-service testing.

5. Acceptance criteria for each valve may be found in its respective SI. This criteria is usually a leak rate of <1 gpm. This criteria may prove to be restrictive in the future. It is generally felt that criteria of <10 gpm would not be unreasonable.

6. At time of design, this plant was not under ASME Section III and XI requirements.

7. Attachment 1 is the applicable portion of Plant Technical Specifications which outlines in-service leak testing of Category "A" Valves.

Table
pg 1 of 1

VALVES TESTED PER SI-166.10

VALVE(S) / DATES TESTED	5-1[illegible]-80	9-21-80	10-11-80	10-17-80	10-29-80	11-2-80	11-16-80	11-23-80	11-27-80	12-13-80	1-24-81	2-7-81	3-2-81	3-7-81	3-19-81	4-24-81	4-27-81	5-2-81	5-17-81	6-25-81	8-17-81
63-543/545	0 (1)											0									
63-547/549	0											0									
63-551	.51	.16										0	0								
63-553	.30	0										0	0								
63-555	.40	0										0	0								
63-557	.23	.07										0	0								
63-558	.78											.56									
63-559	.26											.56									
63-560	0	.75	0	.69	.59	0				0				.91					.56	.61	.56
63-561	.51	.76	0		0	0	0		.42	0	0			.90	.75		.64		.55	.58	.59
63-562	.44	.68	0		0	0	0		.46	0	0			.91	.93		.69		.73	.69	.55
63-563	.38	.76	.01	.62	.67	0				0				.89					.49	.64	.56
63-581	.81	.84						0				0				0		0			
63-586/587	0	0						0				.70				.49		.21			
63-588/589	0	0						0				.70				.49		.21			

(1) All leak rates measured in gpm and extrapolated to 2250 PSIA

Table 2
pg 2 of 4

VALVES TESTED PER SI-166.10

VALVE(S) / DATES TESTED	5-10-80	9-21-80	10-11-80	10-17-80	10-24-80	11-2-80	11-16-80	11-23-80	11-27-80	12-13-80	1-24-81	2-7-81	3-2-81	3-7-81	3-19-81	4-24-81	4-27-81	5-2-81	5-17-81	6-25-81	8-17-81
63-622	.49	.08										.35									
63-623	.49	.08										.67									
63-624	.49	.08										.67									
63-625	.51	0										.81									
63-632/634	.51	.02	0		0	.14	0		0	0	0			0	0		0		0	0	0
63-633/635	.61	0 (1)	0	0	0	0				0				0					0	0	0
63-640/643	.99	0										0									
63-641	.47											.57									
63-644	.48											.54									

(1) 63-635 was tested on 9/21/80 and found [illegible] have a leak rate of 710.0 gpm due [illegible] discover lockwire tackweld interfering [illegible]h valve seating. Repaired 9/27/81 and [illegible]ested [redacted] 9-27-80 with .02 leak rate found.

Table 2
Pg 3 of 4

VALUES
TESTED
PER
SI-166.11

VALVE(S) / DATE TESTED	5-10-80	5-16-80	2-8-81
87-558/559	2.28	0	0
87-560/561	2.30	0	0
87-562 10cc	3.34	.10	.42
87-563	4.12	.29	.56

Table 2
pg. 4 of 4

VALVES TESTED PER SI-166.18

VALVE \ DATE TESTED	9-26-80	10-11-80	10-17-80	10-27-80	11-7-80	11-16-80	11-27-80	12-13-80	1-24-81	3-7-81	3-19-81	4-27-81	5-17-81	6-26-81	8-17-81	8-23-81
1-FCV-74-1	.06	0	0	0	0	0	0	0	0	0	0	.09	0	.27	0	
1-FCV-74-2	0	0	0	0	0	0	0	0	0	0	0	.07	0	0	0	
2-FCV-74-1																0
2-FCV-74-2																0

TABLE
pg 1 of 7

I.D. NUMBER	VALVE NAME	MANUFACTURER	SIZE
① 1-FCV-63-543	SIS PUMP HOT LEGS 1 & 3 SECONDARY CHECK VALVE	ROCKWELL	2"
1-FCV-63-545	SIS PUMP HOT LEGS 1 & 3 SECONDARY CHECK VALVE	ROCKWELL	2"
1-FCV-63-547	SIS PUMP HOT LEGS 2 & 4 SECONDARY CHECK VALVE	ROCKWELL	2"
1-FCV-63-549	SIS PUMP HOT LEGS 2 & 4 SECONDARY CHECK VALVE	ROCKWELL	2"
1-FCV-63-551	SIS PUMP COLD LEG #1 SECONDARY CHECK VALVE	ROCKWELL	2"
1-FCV-63-553	SIS PUMP COLD LEG #2 SECONDARY CHECK VALVE	ROCKWELL	2"
1-FCV-63-555	SIS PUMP COLD LEG #3 SECONDARY CHECK VALVE	ROCKWELL	2"
1-FCV-63-557	SIS PUMP COLD LEG #4 SECONDARY CHECK VALVE	ROCKWELL	2"
1-FCV-63-558	SIS/RHR HOT LEG #4 PRIMARY CHECK VALVE	VELAN	6"
1-FCV-63-559	SIS/RHR HOT LEG #2 PRIMARY CHECK VALVE	VELAN	6"
1-FCV-63-560	SIS/RHR COLD LEG #1 PRIMARY CHECK VALVE	DARLING	10"
1-FCV-63-561	SIS/RHR COLD LEG #2 PRIMARY CHECK VALVE	DARLING	10"
1-FCV-63-562	SIS/RHR COLD LEG #3 PRIMARY CHECK VALVE	DARLING	10"

① SI-166.10

TABLE
pg 2 of 4

ID NUMBER	VALVE NAME	MANUFACTURER	SIZE
1-FCV-63-563	SIS/RHR COLD LEG #4 PRIMARY CHECK VALVE	DARLING	10"
1-FCV-63-581	BORON INJECTION SECONDARY CHECK VALVE	VELAN	3"
1-FCV-63-586	BORON INJECTION COLD LEG #1 PRIMARY CHECK VALVE	ROCKWELL	1 1/2"
1-FCV-63-587	BORON INJECTION COLD LEG #2 PRIMARY CHECK VALVE	ROCKWELL	1 1/2"
1-FCV-63-588	BORON INJECTION COLD LEG #3 PRIMARY CHECK VALVE	ROCKWELL	1 1/2"
1-FCV-63-589	BORON INJECTION COLD LEG #4 PRIMARY CHECK VALVE	ROCKWELL	1 1/2"
1-FCV-63-622	SIS ACCUMULATOR #1 SECONDARY CHECK VALVE	DARLING	10"
1-FCV-63-623	SIS ACCUMULATOR #2 SECONDARY CHECK VALVE	DARLING	10"
1-FCV-63-624	SIS ACCUMULATOR #3 SECONDARY CHECK VALVE	DARLING	10"
1-FCV-63-625	SIS ACCUMULATOR #4 SECONDARY CHECK VALVE	DARLING	10"
1-FCV-63-632	RHR PUMP COLD LEG #2 SECONDARY CHECK VALVE	VELAN	6"
1-FCV-63-633	RHR PUMP COLD LEG #1 SECONDARY CHECK VALVE	VELAN	6"
1-FCV-63-634	RHR PUMP COLD LEG #3 SECONDARY CHECK VALVE	VELAN	6"

TABLE I
pg 3 of 4

I.D NUMBER	VALVE NAME	MANUFACTURER	SIZE
1-FCV-63-635	RHR PUMP COLD LEG #4 SECONDARY CHECK VALVE	VELAN	6"
1-FCV-63-640	RHR PUMP HOT LEG #1 SECONDARY CHECK VALVE	DARLING	8"
1-FCV-63-641	SIS/RHR HOT LEG #1 PRIMARY CHECK VALVE	VELAN	8"
1-FCV-63-643	RHR PUMP HOT LEG #3 SECONDARY CHECK VALVE	DARLING	8"
1-FCV-63-644	SIS/RHR HOT LEG #3 PRIMARY CHECK VALVE	VELAN	8"
(2) 1-FCV-74-001	RHR SUCTION ISOLATION VALVE	COPES-VULCAN	14"
1-FCV-74-002	RHR SUCTION ISOLATION VALVE	COPES-VULCAN	14"
2-FCV-74-001	RHR SUCTION ISOLATION VALVE	COPES-VULCAN	14"
2-FCV-74-002	RHR SUCTION ISOLATION VALVE	COPES-VULCAN	14"
(3) 1-FCV-87-558	UPPER HEAD INJECTION PRIMARY CHECK VALVE	COPES-VULCAN	8"
1-FCV-87-559	UPPER HEAD INJECTION PRIMARY CHECK VALVE	COPES-VULCAN	8"
1-FCV-87-560	UPPER HEAD INJECTION PRIMARY CHECK VALVE	COPES-VULCAN	8"
(2) SI-166.18 (3) SI-166.11			

TABLE 1
Pg. 4 of 4

I.D. NUMBER	VALVE NAME	MANUFACTURER	SIZE
1-FCV-87-561	UPPER HEAD INJECTION PRIMARY CHECK VALVE	COPES-VULCAN	8"
1-FCV-87-562	UPPER HEAD INJECTION SECONDARY CHECK VALVE	COPES-VULCAN	12"
1-FCV-87-563	UPPER HEAD INJECTION SECONDARY CHECK VALVE	COPES-VULCAN	12"

Attachment 1

REACTOR COOLANT SYSTEM

OPERATIONAL LEAKAGE

LIMITING CONDITION FOR OPERATION

3.4.6.2 Reactor Coolant System leakage shall be limited to:

a. No PRESSURE BOUNDARY LEAKAGE,

b. 1 GPM UNIDENTIFIED LEAKAGE,

c. 1 GPM total primary-to-secondary leakage through all steam generators and 500 gallons per day through any one steam generator,

d. 10 GPM IDENTIFIED LEAKAGE from the Reactor Coolant System,

e. 40 GPM CONTROLLED LEAKAGE at a Reactor Coolant System pressure of 2235 + 20 psig.

FP f. 1 GPM leakage from any Reactor Coolant System Pressure Isolation Valve specified in Table 3.4-1.*

APPLICABILITY: MODES 1, 2, 3 and 4

ACTION:

a. With any PRESSURE BOUNDARY LEAKAGE, be in at least HOT STANDBY within 6 hours and in COLD SHUTDOWN within the following 30 hours.

b. With any Reactor Coolant System leakage greater than any one of the above limits, excluding PRESSURE BOUNDARY LEAKAGE, and leakage from Reactor Coolant System Pressure Isolation Valves, reduce the leakage rate to within limits within 4 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

FP

c. With any Reactor Coolant System Pressure Isolation Valve leakage greater than the above limit, isolate the high pressure portion of the affected system from the low pressure portion within 4 hours by use of at least two closed manual or deactivated automatic valves, or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.4.6.1 Reactor Coolant System leakages shall be demonstrated to be within each of the above limits by:

R5 *Specific exceptions to the 1 GPM leakage limit and the MODE 3 and 4 applicability are listed on Table 3.4-1.

SURVEILLANCE REQUIREMENTS (Continued)

a. Monitoring the lower containment atmosphere particulate radioactivity monitor at least once per 12 hours.

b. Monitoring the containment pocket sump inventory and discharge at least once per 12 hours.

c. Measurement of the CONTROLLED LEAKAGE to the reactor coolant pump seals when the Reactor Coolant System pressure is 2235 ± 20 psig at least once per 31 days with the modulating valve fully open. The provisions of Specification 4.0.4 are not applicable for entry into Mode 4.

d. Performance of a Reactor Coolant System water inventory balance at least once per 72 hours.

e. Monitoring the reactor head flange leakoff system at least once per 24 hours.

4.4.6.2.2 Each Reactor Coolant System Pressure Isolation Valve specified in Table 3.4-1 shall be demonstrated OPERABLE pursuant to Specification 4.0.5, except that in lieu of any leakage testing requirements required by Specification 4.0.5, each valve shall be demonstrated OPERABLE by verifying leakage to be within its limit:

a. At least once per 18 months.

b. Prior to entering MODE 4 whenever the plant has been in COLD SHUTDOWN for 72 hours or more and if leakage testing has not been performed in the previous 9 months.

c. Prior to returning the valve to service following maintenance, repair or replacement work on the valve.

d. Within 24 hours following valve actuation due to automatic or manual action or flow through the valve.

SEP 17 1980

REVISION 8 1/15/81

TABLE 3.4-1

REACTOR COOLANT SYSTEM PRESSURE ISOLATION VALVES

	VALVE NUMBER	FUNCTION
	63-586	Boron Injection
	63-587	Boron Injection
	63-588	Boron Injection
	63-589	Boron Injection
	63-581	Boron Injection
	63-560	Accumulator Discharge (1)
R5	63-561	Accumulator Discharge (1)
	63-562	Accumulator Discharge (1)
	63-563	Accumulator Discharge (1)
	63-622	Accumulator Discharge
	63-623	Accumulator Discharge
	63-624	Accumulator Discharge
	63-625	Accumulator Discharge
	63-551	Safety Injection (Cold Leg)
	63-553	Safety Injection (Cold Leg)
	63-557	Safety Injection (Cold Leg)
	63-555	Safety Injection (Cold Leg)
	63-632	Residual Heat Removal (Cold Leg) (1)
	63-633	Residual Heat Removal (Cold Leg) (1)
R5	63-634	Residual Heat Removal (Cold Leg) (1)
	63-635	Residual Heat Removal (Cold Leg) (1)
	63-641	Residual Heat Removal/Safety Injection (Hot Leg)
	63-644	Residual Heat Removal/Safety Injection (Hot Leg)
	63-558	Safety Injection (Hot Leg)
	63-559	Safety Injection (Hot Leg)
FP	63-543	Safety Injection (Hot Leg)
	63-545	Safety Injection (Hot Leg)
	63-547	Safety Injection (Hot Leg)
	63-549	Safety Injection (Hot Leg)
	63-640	Residual Heat Removal (Hot Leg)
	63-643	Residual Heat Removal (Hot Leg)
	87-558	Upper Head Injection
	87-599	Upper Head Injection
	87-560	Upper Head Injection
	87-561	Upper Head Injection
	87-562	Upper Head Injection
	87-563	Upper Head Injection
R5	~~FCV-74-1~~	~~Residual Heat Removal~~ (1)(2)
	~~FCV-74-2~~	~~Residual Heat Removal~~ (1)(2)

R5
(1) ~~The valves must be tested prior to entering MODE 2.~~
(2) The leakage limit for these valves is 3 GPM. This value will be finalized within 30 days of issuance of this amendment.

12/22/80

REVISION 8 1/15/81

1.0 SCOPE

1.1 Test Description

Measure the leak rate of the accumulator/injection primary and secondary check valves. This is performed by pressurizing the down stream side of the check valve and measuring the leakage on the upstream side.

1.2 Objective

Verify that the leakage through each check valve when tested and extra-polated to full RCS pressure is less than or equal to 1 gpm.

1.3 Requirements

1.3.1. The Category A ASME Section XI valves are required to be leak tested per SR 4.0.5.

1.3.2 Fulfill SR 4.4.6.2.2.a - each valve shall be demonstrated OPERABLE by verifying leakage to be within its limits at least once per 18 months.

1.3.3 Fulfill SR 4.4.6.2.2.b - each valve shall be demonstrated OPERABLE by verifying leakage to be within its limits prior to entering the required mode[1] whenever the plant has been in Cold Shutdown for 72 hours or more and if leakage testing has not been performed in the previous 9 months.

1.3.4 Fulfill SR 4.4.6.2.2.c - each valve shall be demonstrated OPERABLE by verifying leakage to be within its limits prior to returning the valve to service following maintenance, repair or replacement work on the valve.

1.3.5 Fulfill SR 4.4.6.2.2.d - each valve shall be demonstrated OPERABLE by verifying leakage to be within its limits within 24 hours following valve actuation due to automatic or manual action or flow through the valve.

* [1]NOTE: Required Modes

* Unit 1

* Parts A and B shall be in required frequency and performed prior to entry into Mode 4 and Part C shall be in required frequency and performed prior to entry into Mode 2.

* Unit 2

* Parts A and C shall be in required frequency and performed prior to entry into Mode 2. Part B does not apply to Unit 2.

* NOTE: SI-166.10 and 166.11 satisfy category "A" for the SIS/accumulator check valves. The category "C" portion is performed in SI-166.12.

2.0 REFERENCE

2.1 Utility D preoperational test W-6.1A3.

2.2 ASME Boiler and Pressure Code, Section XI. 1974 Edition through summer 1975 addenda.

3.0 PREREQUISITES

3.1 Obtain permission from shift engineer to perform test.

3.2 Open or verify open 63-666, 63-601 and 62-953 to create a leakage path from test system to CVCS holdup tank.

3.3 When the instruction calls for installation of test flanges in place of blind flanges, the following items apply:

3.3.1 Need/Actions - The blind flanges must be removed and replaced with test flanges to allow the required leak tests to be performed.

3.3.2 Effects of Test Flange Installation - None

3.3.3 Limitations - The test flanges must be removed and the blind flanges re-installed prior to Mode 2.

NOTE: No TACF is required for removal of blind flanges and replacement with test flanges.

4.0 PRECAUTIONS

4.1 Ensure that the pressure-temperature of the RCS is maintained within the acceptable limits per STS 4.9.1.

4.2 Ensure that the required ECCS is maintained while performing this instruction per STS 3/4.5.3.

4.3 Operations should not operate any valves in system 63 during this test except at direction of test engineer or in an accident situation.

5.0 INSTRUCTIONS FOR PART A (This section applies to Units 1 and 2)

NOTE: Part A shall be performed prior to entry into Mode 4 if required for Unit 1 and prior to entry into Mode 2 for Unit 2.

NOTE: Ensure RCS pressure is greater than accumulator pressure before performing Part A instructions if an accumulator fill valve is to be opened.

5.1 Leak test of check valves 63-551, 63-553, 63-555, and 63-557 (SIS CL Secondary Check Valves) using RHR pump.

5.1.1 Verify both RHR pumps are in service. If both RHR pumps are not in service, open FCV-63-111 and FCV-63-112 and verify one RHR pump is in service and either FCV-63-93 or -94 is open.

5.1.2 Install a test flange in place of blind flange on vent valve 63-654. Attach hose as necessary to be able to collect leakage from vent valves into a calibrated vessel. Verify on data sheet when flange is installed. Obtain second person verification.
NOTE: No TACF is required.

5.1.3 Close FCV-63-22.

5.1.4 Crack open vent valve 63-654 and allow pressure to bleed off system.

5.1.5 Fully open vent valve 63-654 and allow flow to stabilize for several minutes.

5.1.6 Record RCS pressure on data sheet.

5.1.7 Collect any leakage into a calibrated vessel over a period of time. Calculate the leak rate by dividing the volume collected by the period of time.

5.1.8 Complete a leak rate for valves 63-551, 63-553, 63-555 and 63-557 at an RCS pressure of 2250 psia by multiplying the flow rate from 5.1.6 above by $\sqrt{\frac{2250}{14.7 + \text{rcs pressure}}}$ and record this leak rate on data sheet.
NOTE: If the calculated leak rate obtained above is > 1 GPM retest valves individually by performing step 5.9.

5.1.9 Perform the following valve lineup:

5.1.9.1 Close vent valve 63-654
5.1.9.2 Open FCV-63-22 if required.

5.1.10 Close or verify closed FCV-63-111 and FCV-63-112.

5.1.11 If valves passed leak rate of < 1 GPM remove test flange and reinstall blind flange on vent valve 63-654. Verify blind flange installed on data sheet. Obtain second person verification on data sheet.

5.2 Leak test of check valves 63-543, 63-545 (SIS Pump Hot Leg 1 & 3 Secondary Check valves) and 63-640, 63-643 (RHRP HL 1 & 3 secondary check valves).

5.2.1 Install test flanges in place of blind flanges on vent valves 63-657 and 63-639. Attach hose as necessary to be able to collect leakage from vent valves into a calibrated vessel. Verify flanges installed on data sheet. Obtain second person verification.
NOTE: No TACF is required.

5.2.2 Perform the following valve lineup: REPEATS FOR OTHER VALVES

5.2.2.1 Close or verify closed FCV-63-172, [illegible] valve.

Utility E

INSERVICE TESTING OF VALVES IN

NUCLEAR POWER PLANTS

SURVEY SHEET

NRC TASK #

6367-4

Please provide the following information: J. I. Pox event V valves

1. What version, year and addenda, of the ASME Boiler and Pressure Vessel Code, Section XI is implemented for "in service testing requirements" for your facility? 1974 Thru Summer 75 & Standard tech Spec requirements.

2. List all "Category A" primary pressure isolation valves in your facility for which the applicable edition and addenda of the ASME Boiler and Pressure Vessel Code, Section XI; Technical Specifications; or NRC orders, require periodic leak testing. Provide valve name, manufacturer, identification number, age, type, and size. Crane, 10" & 14" dwg # H-30365

   a. Of the valves listed above, provide a history of the in-service leak testing they have received. Provide test medium, test pressure, and leak rates observed. List those valves found to be deficient during testing. Include the number of deficiencies observed for each valve over its service life to date. Describe each deficiency, and the corrective action taken. See Attached Procedures

   b. Of the valves listed in 2., above, list those which at some time during their in-service life to date have missed a required in-service leak test. For each omission, describe the circumstances which caused the leak test to be omitted. see Attached Procedures

3. Provide a list and description of the various testing methods utilized to comply with ASME Section XI, as it applies to leak testing of "Category A" valves at your facility. Include sketches of equipment used, together with test piping diagrams, and instrumentation types and locations. Also, include copies of operating procedures used for leak testing, together with examples of logs, records, or other documentation utilized to record the testing data for each valve type. see Attached Procedures

IN-SERVICE TESTING OF VALVES IN NUCLEAR POWER PLANTS

SURVEY SHEET - PAGE 2

4. What problems have been encountered in your facility with applicable in-service leak testing requirements and procedures?

   a. To what extent has personnel exposure to radiation presented problems in meeting in-service leak testing requirements?
   No major problems

   b. Has the availability of personnel qualified to perform in-service leak testing, presented problems or caused in-service leak testing to be delayed? No.

   c. Has component accessibility presented problems in performing in-service leak testing? yes

   d. Has the original design of the facility, in regard to the availability and location of test taps or orifices, been adequate to allow performance of in-service leak testing? no

   e. Have documentation requirements been restrictive to an extent you consider unnecessary? Explain. no

   f. Has in-service leak testing been hindered by the availability of test equipment or procedures? no

   g. Has interpretation of ASME Section XI presented problems in establishing your in-service leak testing program? Some with vague wording in tech spec and Sec. XI

List and describe any additional problems encountered.

5. List -- as a function of valve type, service, size, age, and manufacturer-- the allowable leak rate you consider practical from the standpoint of measurement and valve repair.

6. Provide examples of design reports or comparable documentation which delineates the manner in which ASME Sections III and XI code requirements for valves were met at the time of the original installation.

IN-SERVICE TESTING OF VALVES IN NUCLEAR POWER PLANTS

SURVEY SHEET - PAGE 3

7. Provide examples of applicable portions of Plant Operating Manuals, Inservice Inspection Manuals, Technical Specifications, or comparable documentation which outlines in-service leak testing of "Category A" valves in your facility.

8109-4

SURVEILLANCE PROCEDURE

SP-405

Utility E

CORE FLOODING SYSTEM CHECK VALVE OPERATION
DEMONSTRATION AND LEAK TESTING

1.0 SURVEILLANCE REQUIREMENTS

1.1 Core flood system (CFS) check valve operation and leak testing shall be demonstrated during the modes and at the frequencies indicated below.

1.2 TECHNICAL SPECIFICATION REFERENCES

Tech. Spec. Waiver	Surv. Perf. During Modes	LCO/FPC Requirement During Modes	Surv. Freq.	Freq. Notes	Mode Notes
3.5.1	3	1,2,3,4	R	30	70
4.4.6.2.2	3 or 4	1,2,3,4	R	27,30, 41	70

SURVEILLANCE FREQUENCY:

R - Refueling (18 Months)

MODE NOTES:

70 - With reactor coolant system (RCS) pressure

> ~~250~~ psig.
700 ± 20 psig

FREQUENCY NOTES:

27 - Prior to criticality.

30 - Prior to shutdown for refueling.

41 - Whenever the plant has been in cold shutdown for 72 hrs. or more and leakage test has not been performed in the previous 9 months.

2.0 ACCEPTANCE CRITERIA

2.1 PART "A", CHECK VALVE OPERATION

2.1.1 A CF tank (CFT) level decrease with corresponding pressurizer level increase does occur when RCS pres-

sure decreases to below CFT pressure, adequately demonstrating that the CFS check valves open.

NOTE: If the Acceptance Criteria of Section 2.1 above cannot be met, refer immediately to the "Action Statement" of Technical Specification (TS) 3.5.1.

2.1.2 Following the check valves opening, no steady CFT level change occurs with RCS pressure increased to greater than CFT pressure. This demonstrates that the check valve(s) have reseated.

NOTE: If the check valve(s) fail to reseat, initiate and complete a Work Request per CP-113, Procedure for Handling and Controlling Work Requests, to correct the check valve operation.

2.2 PART "B", CHECK VALVE LEAKAGE TEST

~~2.2.1 Leakage through CFV-1 and 2 is less than 5 gpm.~~

See Attached new page.

3.0 REFERENCES NEEDED TO DO PROCEDURE

3.1 OP-202, Plant Heatup

3.2 OP-203, Plant Startup

3.3 OP-209, Plant Cooldown

3.4 OP-401, Core Flooding System

3.5 CP-107, Test Equipment, Standards and Calibration Control

3.6 CP-102, Inservice Inspection Pump and Valve Data Review and Corrective Action

3.7 FPC Drawing #FS-302-702

2.0 ACCEPTANCE CRITERIA

2.1 Leakage rates less than or equal to 1.0 gpm are considered acceptable.

2.2 Leakage rates greater than 1.0 gpm but less than or equal to 5.0 gpm are considered acceptable if the latest measured rate has not exceeded the rate determined by the previous test by an amount that reduces the margin between measured leakage rate and the maximum permissible rate of 5.0 gpm by 50% or greater.

2.3 Leakage rates greater than 1.0 gpm but less than or equal to 5.0 gpm are considered unacceptable if the latest measured rate exceeded the rate determined by the previous test by an amount that reduces the margin between measured leakage rate and the maximum permissible rate of 5.0 gpm by 50% or greater.

2.4 Leakage rates greater than 5.0 gpm are considered unacceptable.

CONTINUED

Utility F

RESPONSE TO IST SURVEY SHEET

NRC Task # 6367-4

1. Utility F Units 1 and 2 are tested to ASME Boiler and Pressurizer Vessel Code, Section XI 1974 through summer of 1975 Addenda.

2. Attached is a table which is a list of all "Category A" primary pressure isolation valves for Utility F. The list includes the valve mark number, function description, manufacturer, type, size, age and testing history. All of these valves are required to be tested pursuant to the Technical Specifications.

   a. For all valves listed in the table, the test medium used was water. The test pressure used was dependent on plant and system conditions at the time of the test. The high side and low side test pressures are listed for each individual valve test. No valves tested to date have been found deficient.

   b. None of the valves listed in the table have missed a required inservice leakage test.

3. Attached is a copy of 2-PT-61.4, RCS Pressure Isolation Valves Leakage Test. This periodic test delineates the specific test procedure for each valve or pair of valves. Reference drawings 12050-FM-94A, 96A, B are attached, which provide valve operating numbers for the residual heat removal system and the safety injection system, sheet 1 and 2, respectively.

4. a. All of the valves that are required to be tested are either inside the containment building or in a pipe penetration area directly adjacent to the containment. All of the testing requires test personnel to dress out in full protective clothing and many cases a full face respirator. The radiation exposure levels are not extremely high, although personnel contamination has been a problem. In most cases, the leak rate is determined by maintaining a pressure differential across a valve by bleeding water from the low pressure side. The water is reactor coolant water and can be fairly hot, radiologically.

   b. The test procedure is written such that any experienced operator should be able to conduct the in-service leak surveillance. The availability problem occurs due to the total number of operators required to perform leak testing in addition to the normal required shift complement. Shift personnel are required to work overtime during the in-service leak testing.

   The valve testing can only be performed with the reactor coolant system in a narrow temperature and pressure window. At these conditions, the heat up must be terminated and the primary maintained at these conditions for the duration of the leak testing. This forces the testing into a critical path position for outage planning. The outage down time is increased by the time

b. (Continued)

required to conduct all the leak testing. Prior experience at Utility F indicates that the in-service leak testing accounts for 1-2 days of lost electrical generation per outage.

c. Component accessibility has presented problems that increase the time required to perform in-service leak testing. A majority of the valves that are tested are located near the containment wall adjacent to many other pipe penetrations. The drain and vent valves are difficult to access due to the congestion in the pipe penetration vicinity. In order to install the test apparatus to a drain valve, close physical contact with adjacent piping increases the possiblity of personnel contamination.

d. Westinghouse nuclear steam supply systems are designed to have fail safe redundancy by providing two or more parallel flow paths. Each flow path has its own valve with no other isolation valves provided for maintenance or testing. This type of configuration requires two or more valves to be tested concurrently while contributing the entire leakage to each valve. This testing technique has been adequate to date.

e. Documentation requirement, or more precisely, administrative requirements, place an unnecessary burden on the test personnel. The testing procedure must be written to provide an unambiguous sequence of steps, and in so doing, disallow the flexibility that is required by the plant status. For example, depending on the availability of the accumulators to serve as pressure sources, the procedures may have to be deviated to allow a different pressure source. The additional deviations and subsequent Station Nuclear Safety and Operating Committee approval increase the amount of documentation and personnel time.

f. The test equipment required is relatively simple and consists of a pressure gauge, valve and a length of high pressure flexible hose. The availability of test equipment or procedures has not hindered in-service leak testing appreciably.

g. Interpretation of ASME Section XI has not presented problems in leak testing.

5. The leakage specified in the Utility F Unit 2 Technical Specifications is practical from the standpoint of measurement and valve repair. The allowable leakage is 1 GPM except for any RHR system isolation valve. The RHR valves have an allowable leakage of 5 GPM.

The problem with testing of all the valves is the requirements of ASME XI Section XI (IWV-3420) with regard to the direction of pressurization and the use of pressure differentials lower than function pressure differentials. The Code does not allow testing a valve in either direction unless the function differential pressure is less than 15 psi. No RCS boundary isolation valves fall into this category. Several of the motor operated gate valves would be easier to test in the direction opposite to the function direction.

ASME Section XI specifies the relationship to be used when adjusting a test leakage to the leakage that would be expected at the function differential pressure. The leakage is calculated to be proportional to the square root of the pressure differential. This relationship assumes that the leak path cross-sectional area remains constant at any differential pressure. This assumption is extremely conservative when it is applied to check valves, since increasing the differential pressure tends to reduce the leakage. The test differential pressure is generally limited by the low side saturation pressure and the temperature vs. pressure condition of the reactor coolant system. To keep the water temperature below 200°F, the RCS pressure must be maintained below 450 psi. All of the valves that are being tested are designed for a differential pressure of about 2200 psi. At the lower differential pressure used for testing, the check valves may not seat properly.

6. The original testing documentation is not available at Utility F.

7. The in-service leak testing of the subject "Category A" valves is delineated in 2-PT-61.4, RCS Pressure Isolation Valves Leakage Test.

VALVE MARK NUMBER	DESCRIPTION	VALVE MANUFACTURER (WESTINGHOUSE #)	VALVE TYPE	VALVE SIZE	AGE (INSTALLED)	TEST DATE	TEST PRESSURE HIGH SIDE	TEST PRESSURE LOW SIDE	LEAK RATE GPM AT 2235 PSID
2-SI-85	High Head Safety Injection to the Cold Legs	Velan (3"-C58)	Swing Check	3"	1975	5/18/81 11/23/81	354 575	20 100	0.0 0.0
2-SI-93	High Head Safety Injection to the Cold Legs	Velan (3"-C58)	Swing Check	3"	1975	7/9/81 5/18/81 8/8/81 8/10/81 10/3/81 11/23/81	317 353 635 625 618 575	98 20 80 70 90 100	.93 .23 .274 0.0 .23 0.0
2-SI-107	High Head Safety Injection to the Hot Legs	Velan (3"-C58)	Swing Check	3"	1975	5/18/81 11/23/81	346 570	0 100	0.0 0.0
2-SI-119	High Head Safety Injection to the Hot Legs	Velan (3"-C58)	Swing Check	3"	1975	5/18/81 11/23/80	345 575	0.0 100	0.0 0.0
MOV-2836	High Head Safety Injection From Charging Header To Cold Legs	Velan (3"-GM58FN)	Gate	3"	1975	5/18/81 11/23/81	353 580	30 100	0.0 0.0
MOV-2869A	High Head Safety Injection From Charging Header To Hot Legs	Velan (3"-GM58FN)	Gate	3"	1975	5/18/81 11/23/81	354 585	80 100	0.0 0.0
MOV-2869B	High Head Safety Injection From Charging Header To Hot Legs	Velan (3"-GM58FN)	Gate	3"	1975	5/18/81 11/23/81	350 580	80 100	0.0 0.0

VALVE MARK NUMBER	DESCRIPTION	VALVE MAN-UFACTURER (WESTING-HOUSE #)	VALVE TYPE	VALVE SIZE	AGE (INSTAL-LED)	TEST DATE	TEST PRESSURE HIGH SIDE	LOW SIDE	LEAK RATE GPM AT 2235 PSID
2-SI-91	Low Head Safety Injection to Cold Leg Loop 1	Velan (6"-C58)	Swing Check	6"	1975	7/9/81 5/18/81 8/8/81 11/24/81	314 346 0.0 300	0.0 90 1500 100	0.0 0.0 0.0 0.0
2-SI-99	Low Head Safety Injection to Cold Leg Loop 2	Velan (6"-C58)	Swing Check	6"	1975	7/9/81 5/18/81 8/8/81 11/24/81	314 346 0.0 310	0.0 90 1500 100	0.0 0.0 0.0 0.0
2-SI-105	Low Head Safety Injection to Cold Leg Loop 3	Velan (6"-C58)	Swing Check	6"	1975	7/9/81 5/18/81 8/8/81 11/24/81	314 346 1500 310	0.0 90 0.0 100	0.0 0.0 0.0 0.0
MOV-2867C, D	Boron Injection Tank Outlet Valves	Velan (3"-GM58FN)	Gate	3"	1975	7/9/81 5/18/81 8/8/81 8/10/81 10/3/81 11/23/81	318 353 3 1505 2220 550	90 95 1500 88 80 100	0.0 0.0 0.0122 0.0 0.0 0.0
2-SI-126	Low Head Safety Injection to the Hot Legs	Velan (6"-C58)	Swing Check	6"	1975	5/18/81 11/24/80	353 300	75 100	0.0 0.0
2-SI-128	Low Head Safety Injection To the Hot Legs	Velan (6"-C58)	Swing Check	6"	1975	5/18/81 11/24/80	353 310	25 100	0.0 0.0
2-SI-151	Accumulator Tank No. 1 Discharge Check Valve	Darling (12"-C48Z)	Swing Check	12"	1975	5/18/81 11/25/80	360 380	60 50	.007 .51

VALVE MARK NUMBER	DESCRIPTION	VALVE MANUFACTURER (WESTINGHOUSE #)	VALVE TYPE	VALVE SIZE	AGE (INSTALLED)	TEST DATE	TEST PRESSURE HIGH SIDE	TEST PRESSURE LOW SIDE	LEAK RATE GPM AT 2235 PSID
2-SI-153	Accumulator Tank No. 1 Discharge Check Valve	Darling (12"-C48Z)	Swing Check	12"	1975	5/18/81	350	0.0	.0354
2-SI-168	Accumulator Tank No. 2 Discharge Check Valve	Darling (12"-C48Z)	Swing Check	12"	1975	5/18/81 11/25/80	345 360	0.0 80	.0071 .878
2-SI-170	Accumulator Tank No. 2 Discharge Check Valve	Darling (12"-C48Z)	Swing Check	12"	1975	7/1/81 7/17/81 5/18/81 8/7/81	409 399 409 425	114 46 50 92	.03 0.0 0.0 .01
2-SI-185	Accumulator Tank No. 3 Discharge Check Valve	Darling (12"-C48Z)	Swing Check	12"	1975	5/18/81 11/25/80	360 380	60 150	0.0 .467
2-SI-187	Accumulator Tank No. 3 Discharge Check Valve	Darling (12"-C48Z)	Swing Check	12"	1975	5/18/81 11/25/80 w/2720B	409 380	20 170	0.0 .14
MOV-2700	RHR System Inlet Isolation Valve	Copes-Vulcan (14"-GM48SER)	Double Disk Gate	14"	1975	7/1/81 7/17/81 5/18/81 8/7/81 8/19/81 11/25/80	373 400 380 397 380 380	100 89 35 90 0.0 225	.07 0.0 .59 .01 1.613 1.12
MOV-2701	RHR System Inlet Isolation Valve	Copes-Vulcan (14"-GM48SER)	Double Disk Gate	14"	1975	7/1/81 7/17/81 5/18/81 8/7/81 8/19/81 11/25/80	364 399 385 397 380 402	110 46 45 90 0.0 200	.01 0.0 .412 .01 1.93968 1.48

VALVE MARK NUMBER	DESCRIPTION	VALVE MANUFACTURER (WESTINGHOUSE #)	VALVE TYPE	VALVE SIZE	AGE (INSTALLED)	TEST DATE	TEST PRESSURE HIGH SIDE	TEST PRESSURE LOW SIDE	LEAK RATE GPM AT 2235 PSID
MOV-2720A, B	RHR System Outlet Isolation Valves	Darling (10"-VM58-FM)	Venturi Gate	10"	1975	7/1/81 5/18/81	642 620	350 45	0.0 .37
MOV-2890A	Low Head Safety Injection to the Hot Legs	Darling (10"-VM58FJ)	Venturi Gate	10"	1975	5/18/81 11/23/80	352 355	30 100	0.0 0.0
MOV-2890B	Low Head Safety Injection to the Hot Legs	Darling (10"-VM58FJ)	Venturi Gate	10"	1975	5/18/81 11/24/80	349 355	25 100	0.0 0.0
MOV-2890C,D	Low Head Safety Injection to the Cold Legs	Darling (10"-VM58FJ)	Venturi Gate	10"	1975	6/30/81 7/9/81 5/18/81 8/8/81 8/19/81 11/24/80	100 351 340 21 113 305	47 81 15 140 0.0 100	0.0 0.0 0.0 0.0 0.02 0.0

TITLE: RCS PRESSURE ISOLATION VALVES - LEAKAGE TEST

REFERENCES:

1. ASME Section XI, Subsection IWV
2. T.S. 4.4.6.2.2
3. 12050-FM-94A, 96A, 96B

REVISION RECORD:

REV. NO.	PAGE(S)	DATE	APPROVED (CHAIRMAN, SNS&OC)
1	ENTIRE	10-30-80	UMC

RECOMMEND APPROVAL:

APPROVED BY:

DATE: 10-30-80

Initials

1.0 Purpose

1.1 To verify that each reactor coolant system pressure isolation valve is within its limit:

a. At least once per 18 months.

b. Prior to entering Mode 4 whenever the plant has been in cold shutdown for 72 hours or more and if leakage testing has not been performed in the previous 9 months.

c. Prior to returning the valve to service following maintenance repair or replacement work on the valve.

d. Within 24 hours following valve actuation due to automatic or manual action or flow through the valve.

2.0 Initial Conditions

2.1 Values to be tested have been identified and unaffected appendices are m N/A.

2.2 The test apparatus shown in attachment 6.1 is available and ready for use.

2.3 Two NQC pressure gauges will be required (one for the test ~~RIG~~ rig and an additional gauge) with a range of about 0-3000 psi. NOTE: A LOWER RANGE MAY BE USED IF SYSTEM PRESSURE IS LOWER THAN 2235 psi.

2.4 A bucket and hose may be required to collect the water from the test ~~RIG.~~ rig.

2.5 A calibrated container is available to measure the amount of water bled off.

2.6 A stopwatch is available.

2.7 Obtain or note any RWP that may be required for each valve being tested.

2.8 Notify the shift supervisor of the inpending test and coordinate its performance through him.

Initials

3.0 Precautions

3.1 Insure that the valve line up required for testing each valve does not create a problem for the plant conditions during testing.

3.2 Health Physics must be present to survey the area whenever a primary boundary is broken.

3.3 When testing ~~a~~ check valves and MOV(S) in series, always test the MOV first. This can be accomplished by always using the appendices in alphabetical order.

3.4 WHEN REMOVING THE HOSE JUMPER, DEPRESSURIZE THE HOSE PRIOR TO ~~[illegible]~~ UNCOUPLING EITHER END.

4.0 Instructions

NOTE: ONE or more valves may be tested as required.

4.1 Individual instructions are provided for each valve or set of valves to be tested. (Attachment 6.3) Reference operating procedures and flow diagrams for the systems concerned are indicated on Attachment 6.2. Review the applicable OP to insure that the operation of the system concerned is maintained as required.

4.2 Record the initial position of each valve during the performance of Step 1 on the individual instructions (record beside each valve on the diagram). After testing, return the valves to their original positions.

4.3 On each individual instruction sheet, record the following:

4.3.1 Signature and date.

4.3.2 Equipment Q.A. number(s).

4.3.3 Any remarks which may be helpful in the evaluation of test results.

4.3.4 The boundary leakage for each valve tested.

Initials

4.0 Instructions (cont.)

4.4 The low side pressure should be maintained below 100 psi during the entire test.

4.5 Only the applicable appendixes need to be attached to this completed procedure. Reference the purpose section to determine which valves need to be tested.

5.0 Acceptance Criteria

5.1 All valves tested (except MOV-2700, MOV-2701, MOV-2720A, and MOV-2720B) had a corrected leakage rate of less than 1 gpm.

NOTE: If only the RHR isolation valves were tested, "N/A" Step 5.1.

5.2 MOV-2700, MOV-2701, MOV-2720A and MOV-2720B had a corrected leakage rate of less than 5 gpm.

NOTE: If none of the RHR isolation valves were tested, mark Step 5.2 "N/A".

6.0 Attachments

6.1 Test RIG diagram

6.2 Reference OPs and FMs

6.3 Valve testing procedures

Utility G

Utility G
INSERVICE TESTING OF VALVES IN
NUCLEAR POWER PLANTS
SURVEY SHEET

NRC TASK #
6367-4

Please provide the following information:

1. Question:

What version, year, and addenda, of the ASME Boiler and Pressure Vessel Code, Section XI is implemented for "in service testing requirements" for your facility?

Reply:

Utility G is committed the 1974 eddition of Section XI, as addended to the summer of 1975.

2. Question:

List all "Category A" primary pressure isolation valves, (Event "V" Valves) in your facility for which the applicable edition and addenda of the ASME Boiler and Pressure Vessel Code, Section XI; Technical Specifications; or NRC orders, require periodic leak testing. Provide valve name, manufacturer, identification number, age, type, and size.

Reply:

Category "A", Event V Interfacing Systems LOCA, pressure isolation valves:

HPSI Header Check Valves, (HPSI-17, HSI-27, HSI-37) 14 IN., 1500# Atwood & Morrill, 10 years old.

LPSI Header Check Valves (LSI-12, LSI-22, LSI-32) 10 IN., 1500#, Velan, 10 years old, Velan No. P-346-93.

LPSI Header Stop Valve (LSI-M-11, LSI-M-21, LSI-M-31) 8 IN., 1500#, Velan/Limitorque, 10 years old, Velan No. P-34576.

HPSI Header Check Valves (HSI-61, HSI-62, HSI-63) 10 IN., 1500#, Westinghouse, Model # 10000 ICS 990000 (DO/ZO), new valves in 1981.

2a. Question:

Of the valves listed above, provide a history of the in-service leak testing they have received. Provide test medium, test pressure, and leak rates observed. List those valves found to be deficient during testing. Include the number of deficiencies observed for each valve over its service life to date. Describe each deficiency, and the corrective action taken.

Reply:

These valves are required to open for emergency core cooling and the system is maintained at a pressure higher than the containment design pressure, the systems are seismic class 1 and are protected from high energy line brakes and missels. In addition, these lines are designed to circulate contaminated coolant through a closed system outside of containment. Regulatory guide 1.141 addresses the exemption of this type of system from leak testing. Section IWV-3421 of the ASME Code (S1978), also states that "Valves which function in the course of plant operation in a manner that demonstrates functional adequate seat tightness need not be leak tested". Significant leakage into the ECCS System shows up as a loss of RCS inventory and it may be confirmed by ECCS pressure or flow instrumentation. Leakage paths may also be determined by checking line temperatures during reactor operation and by venting the RCS to containment during the class "A" leak test.

In 1975, valves, LSI-12, 22, 32 were suspected of leaking and the seats were blue checked and found to be satisfactory. In 1981, valves LSI-22 and LSI-32 were opened, the seats were blue checked, and they were both found to be satisfactory.

The safety injection system was modified in 1981 to assure an intersystem leakage rate of less than 15 gpm; assuming the failure of a single check valve. A new check valve was added to each safety injection system train. Prior to start up each train was tested to quantify valve leakage. All systems were found to be satisfactory. These valves will be leak tested each refueling outage and the systems are checked for pressure build up prior to the monthly functional test of the motor operated isolation valves. Additional specific information is included in this package.

2b. Question:

Of the valves listed in 2., above, list those which at some time during their in-service life to date have missed a required in-service leak test. For each omission, describe the circumstances which caused the leak test to be omitted.

Reply:

Not applicable

3. Question:

Provide a list and description of the various testing methods utilized to comply with ASME Section XI, as it applies to leak testing of "Category A" valves at your facility. Include sketches of equipment used, together with test piping diagrams, and instrumentation types and locations. Also, include copies of operating procedures used for leak testing, together with examples of logs, records, or other documentation utilized to record the testing data for each valve type.

Reply:

The following procedures are attached for information on Utility G leak testing methods.

Valve Testing Program (currently under revision)

Class B & C Leak Testing Procedure

Component Cooling System Leak Test Procedure

4. Question:

What problems have been encountered in your facility with applicable in-service leak testing requirements and procedures?

Reply:

We have found that the Codes and Standards lack specific information necessary to justify the exemption of ECCS containment isolation valves from class "C" testing. Leak testing requirements are not delineated in a direct, concise fashion. Section XI does not have the explicit information needed to classify category "A" valves.

4a. Question:

To what extent has personnel exposure to radiation presented problems in meeting in-service leak testing requirements?

Reply:

Radiation exposure is a problem when repairs have to be made to meet strict leakage rates in systems that circulate reactor coolant.

4b. Question:

Has the availability of personnel qualified to perform in-service leak testing, presented problems or caused in-service leak testing to be delayed?

Reply:

Utility G has not had a problem with the availability of personnel necessary to perform in-service leak testing.

4c. Question:

Has component accessibility presented problems in performing in-service leak testing?

Reply:

Component accessibility has not been a major problem in leak testing.

4d. Question:

Has the original design of the facility, in regard to the availability and location of test taps or orifices, been adequate to allow performance of in-service leak testing?

Reply:

Original plant designs offered limited test taps and vents. Systems have been modified and a few should be modified in the future.

4e. Question:

Have documentation requirements been restrictive to an extent you consider unnecessary? Explain.

Reply:

Documentation requirements have not been extremely restrictive or excessive.

4f. Question:

Has in-service leak testing been hindered by the availability of test equipment or procedures?

Reply:

Leak testing procedures and equipment have been updated as necessary.

4g. Question:

Has interpretation of ASME Section XI presented problems in establishing your in-service leak testing program?

Reply:

Our leak testing program was developed in accordance with appendix "J" of the Code of Federal regulations. Variations between our original program and ASME requirements are being addressed in revision to the ISI program. These revisions will clarify the desc[illegible]ies between the codes and the existing valve testing program.

List and describe any additional problems encountered. (See question 4).

5. Question:

List -- as a function of valve type, service, size, age, and manufacturer -- the allowable leak rate you consider practical from the standpoint of measurement and valve repair.

Reply:

The valves addressed in question two should be able to maintain a leakage rate of less than 5 gpm. Valves HSI-17, 27, 37 were exempted from this rate following the installation of HSI-61, 62, 63. Their leakage rates are not stated and they are maintained as a thermal barrier only. Cumulative leakages in excess of 15 gpm can be handled by the LPSI relief system.

6. Question:

Provide examples of design reports or comparble documentation which delineates the manner in which ASME Sections III and XI code requirements for valves were met at the time of the original installation.

Reply:

Utility G was not constructed to ASME Section III or to Section XI requirements. See the inclosed copy of Valve Specification YA-GEN-3.

7. Questions:

Provide examples of applicable portions of Plant Operating Manuals, Inservice Inspection Manuals, Technical Specifications, or comparable documentation which outlines in-service leak of "Category A" valves in your facility.

Reply:

The last revision to our valve testing program is inclosed.

The preceding information in submitted to John G. Collett, to aid in his analysis of valve testing programs and related problem at nuclear power stations, (NRC Task #6367-4). All responses were based on the interperatations of the plant I.S.I. cooridnater and they do not express the opinion of Utility G's management. The information if supplied in good faith, soley for the use of Mr. Callett, and the information should be handled accordingly.

December 11. 1981

Plant ISI Coordinator

EDCR TITLE: Safety Injection System Modifications

COGNIZANT ENGINEER:

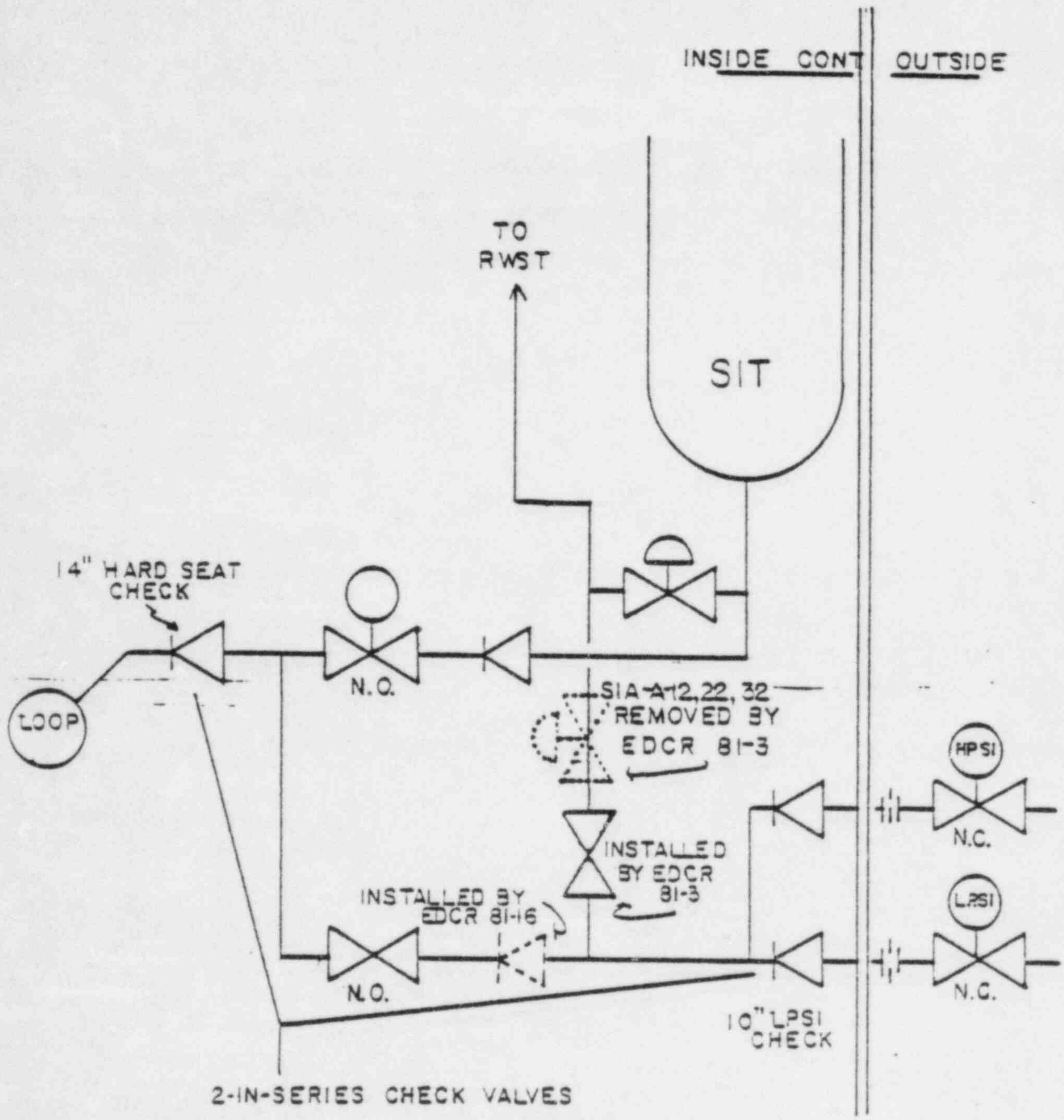
SUMMARY: This EDCR installs a new 10" check valve in the safety injection lines to each loop.

REASON FOR CHANGE: USNRC letter to all LWR Licensees, dated 2/23/80 identified a potential intersystem loss-of-coolant accident which could result in a LOCA outside containment. The situation postulated is the failure (as pressure isolation boundaries) of two in-series check valves. This situation, as it applies to Utility G, involves the LPSI/HPSI headers.

Additional verbal correspondence with the NRC, has required a commitment for periodic inspection and leak testing of these check valves with stringent leak rate requirements (< 5 gpm). The 14" hard-seat check valves close to the loop were not designed to be leak tight, but mainly a thermal barrier. It may be difficult to meet the new leak rate requirements on these valves. Because these valves are in a relatively high radiation area, valve maintenance would involve considerable personnel exposure.

The addition of the new check valves will preclude the testing requirements of the 14" hard-seat valves. The new valves will have provisions for leak testing and will be located in relatively low radiation areas. Additionally, provisions will be made for leak testing the upstream 10" LPSI check valves as these valves will also have to be inspected and tested.

DESCRIPTION OF CHANGE: This change will involve the installation of three (3) new 10" swing check valves. Each valve will be located in the 10" safety injection line between the manual header isolation valve (HSI-16, 26 or 36) and the penetration for the new 2" safety injection recirculation line (see EDCR 81-3). The valves will be located in relatively low radiation areas to facilitate installation, periodic leak testing and future maintenance. The valves for Loops 1 and 3 will be located just inside the crane wall dependent upon accessibility and radiation levels. In Loop 2, the 10" header runs adjacent to a concrete wall making installation extremely difficult. For this reason, the Loop 2 check valve will be located in the annulus.


INSIDE CONT
OUTSIDE
TO RWST
SIT
14" HARD SEAT CHECK
LOOP
N.O.
SIA-A12, 22, 32 REMOVED BY EDCR 81-3
HPSI
N.C.
INSTALLED BY EDCR 81-3
INSTALLED BY EDCR 81-16
LPSI
N.O.
N.C.
10" LPSI CHECK
2-IN-SERIES CHECK VALVES

MEMORANDUM

TO ______________ Company or Location ______________ LEAK TEST L I-12,22,32

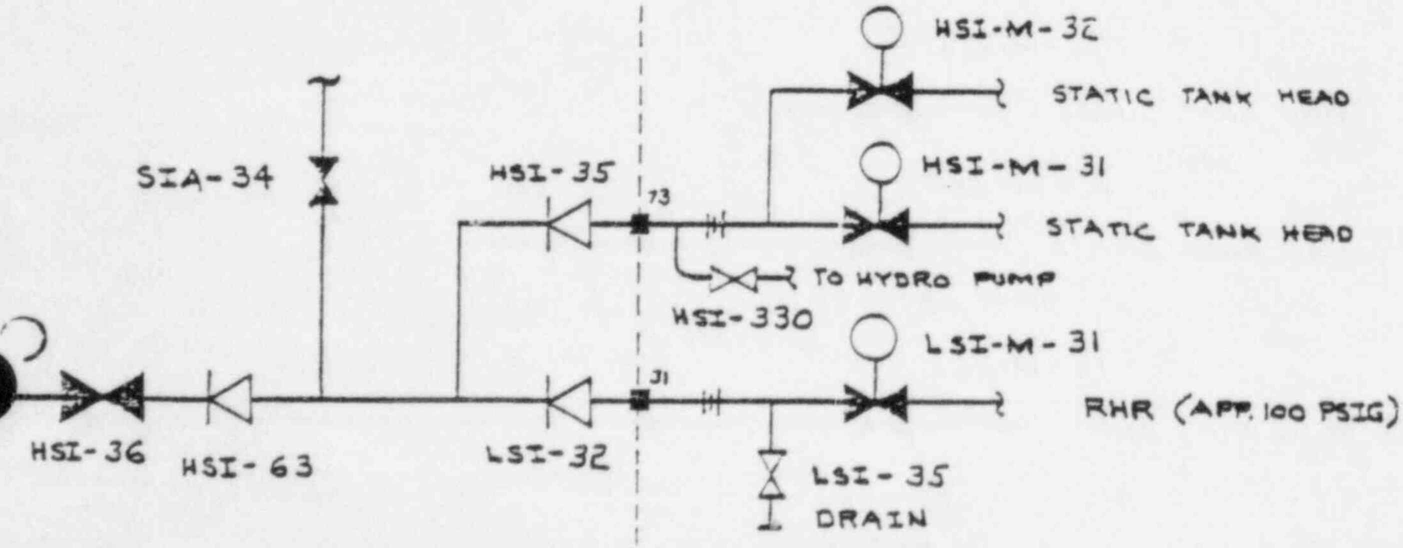
FROM ______________ Company or Location ______________ FILE ______________

SUBJECT ______________

The following leak tests were performed while hydro testing the safety injection system for EDCR 81-16 modifications. A positive displacement pump was used to pressurize the system to 2,475 psig. The pump displacement was verified to be 1/33 gal. liquid per stroke. Each complete cycle of the pump is two strokes.

Loop 3

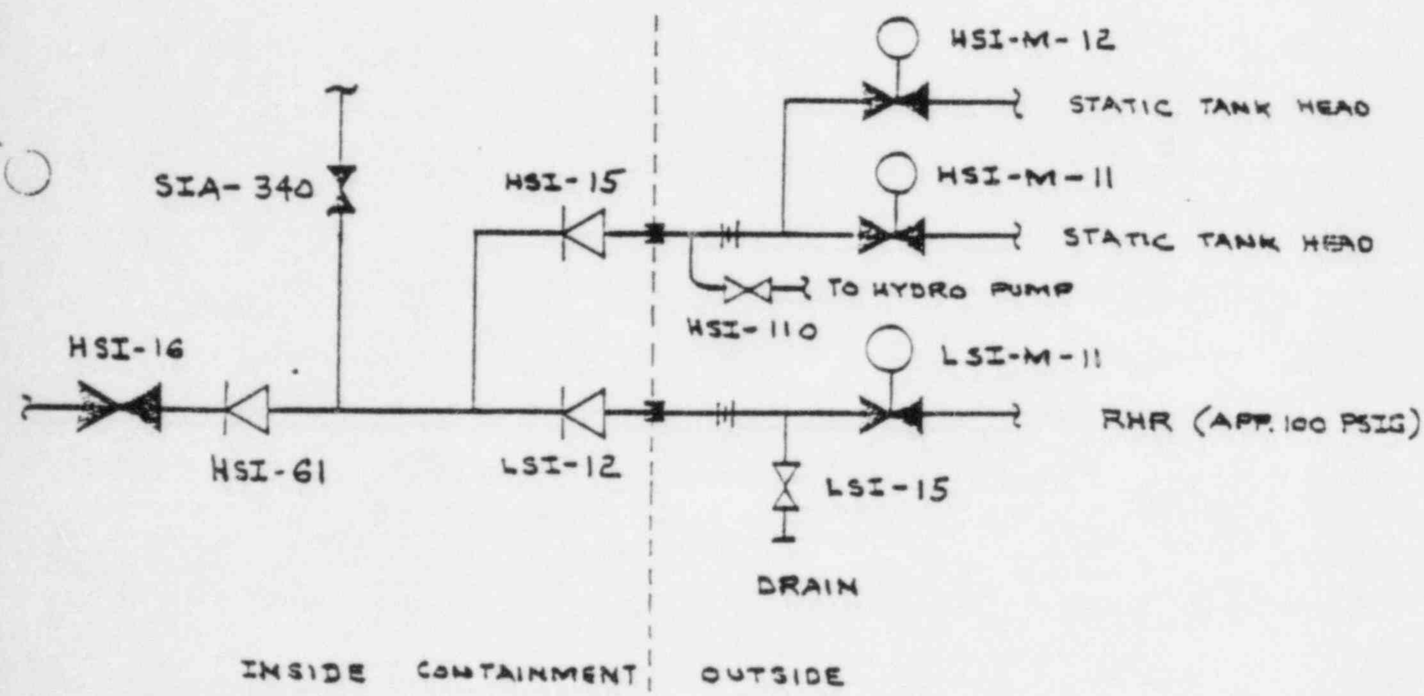
Make-up during the hydro test was .07 gal/min.. The darkened valves on the sketch indicate the hydro boundries. Drain valve LSI-35 was closed during the hydro and opened at the end of the hydro test, to check for leakage across check valve LSI-32. On opening LSI-35, the flow did not increase at the pump, and only a slow drip was released from the drain valve as air moved into the pipe and displaced liquid.



LOOP 1

Make-up during the hydro was .58 gpm. On opening the drain, LSI-15, the make-up was reduced to .18 gpm. No significant flow was noted from the drain, and the decrease in flow was do to the check valve seating. This indicates that LSI-M-11 was leaking at .4 gpm with a 2375 psi differential pressure across the valve.

TEST BOUNDARY



MEMORANDUM

TO ____________ Company or Location ____________ LEAK TEST 1 I-12,22,32

FROM ____________ Company or Location ____________ FILE ____________

SUBJECT ____________

The following leak tests were performed while hydro testing the safety injection system for EDCR 81-16 modifications. A positive displacement pump was used to pressurize the system to 2,475 psig. The pump displacement was verified to be 1/33 gal. liquid per stroke. Each complete cycle of the pump is two strokes.

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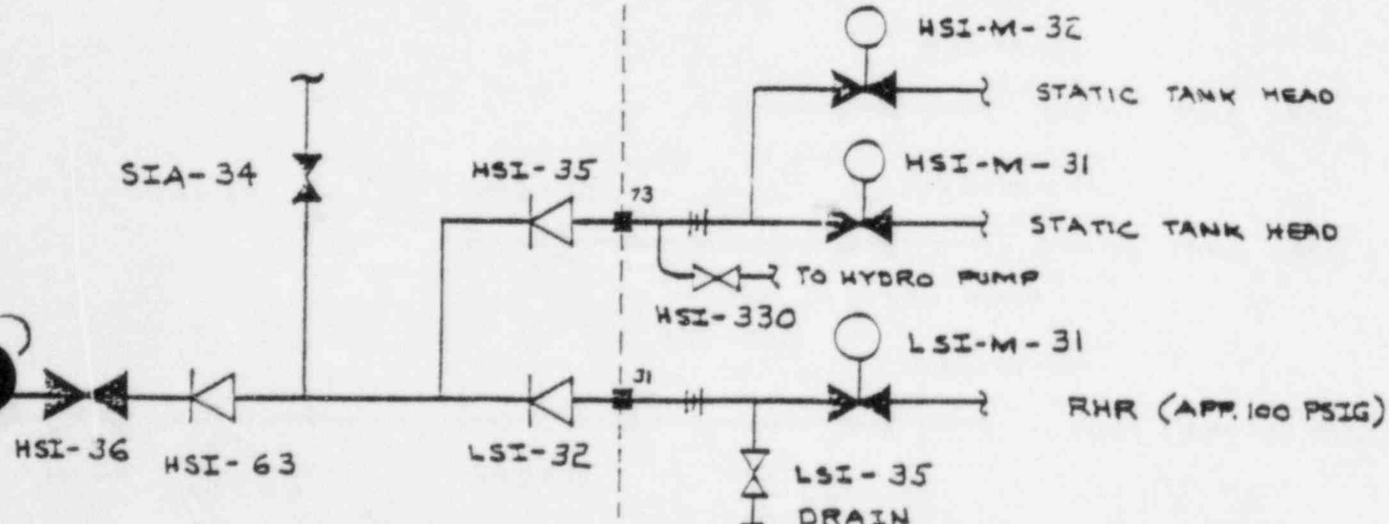


M.Y.

COMPLETED ______	Dept. Head ______
DATE/TIME 7/6/81 2133	Plt. Mgr. ______
PSS REVIEW ______	PORC ______

Proc. No. 4-121
Class. B
Rev. No. 0
Issue Date 7/6/81
Review Date 7/6/82

4-121 TEMPORARY LEAK TEST FOR HSI-61, 62 & 63

1.0 OBJECTIVE

1.1 To determine if the valves meet the criteria of passing less than 5 gpm each.

2.0 PRECAUTIONS

2.1 Avoid exceeding 700 psi in the SIATk recirc. header (approx. lift pressure for SIA-S-43).

2.2 Do not open LSI-M-11, 21 or 31 to avoid overpressurizing the RHR piping while this test is being conducted.

2.3 If SIA-S-43 lifts open up a flow path to relieve SIATk recirc. header pressure.

3.0 INITIAL CONDITIONS

3.1 RCS system pressure equal to or greater than 2260 psi. ______

3.2 Suitable flow measuring device has been installed for the test on SIA-34_. (see sketch) ______

3.3 Personnel are available to inspect for piping leakage. ______

3.4 Record initial tank levels

1 SIATk #1	45	NR
2 SIATk #2	54	NR
3 SIATk #3	40	NR
4 Quench Tank	49	Inches

3.5 Stopwatch available to time flow rate. ______

3.6 Calibrated container makeup to measure flow. ______

4.0 PROCEDURE

4.1 Verify the following valve lineup:

SIA-A-13	#1 SIATk fill	Closed	______
SIA-344	#1 SIATk fill isol.	Closed	______
SIA-341	#1 SIATk hdr drain	Closed	______
SIA-340	#1 SIATk recirc. isol.	Closed	______

SIA-A-23	#2 SIATk fill	Closed	JW
SIA-346	#2 SIATk fill isol.	Closed	JN
SIA-342	#2 SIATk hdr drain	Closed	JN
SIA-345	#2 SIATk recirc. isol.	Closed	JN
SIA-A-33	#3 SIATk fill	Closed	JW
SIA-348	#3 SIATk fill isol.	Closed	JN
SIA-343	#3 SIATk hdr drain	Closed	JN
SIA-347	#3 SIATk recirc. isol.	Closed	JN
LSI-M-11	RHR to loop 1	Closed	JW
LSI-M-21	RHR to loop 2	Closed	JW
LSI-M-31	RHR to loop 3	Closed	JW
SIA-M-40	SIATk recirc. hdr. stop	Closed	JW

4.2 To determine the leakage past HSI-61:

4.2.1 Open SIA-340 #1 SIATk recirc. isol. JN
Open valve #1 on test gage JN
Slowly open SIA-342 to full open JN

4.2.2 Using the calibrated container and a stopwatch determine the leakage past HSI-61. JN

Leak Rate .0526 gpm

4.2.3 Close SIA-340 #1 SIATk recirc. valve JN

4.2.4 Close SIA-342 #2 SIATk hdr. drain JN

4.3 To determine the leakage past HSI-62:

4.3.1 Open SIA-345 #2 SIATk recirc. isol. JN
Open valve #1 on test gage JN
Slowly open SIA-342 to full open JN

4.3.2 Using the calibrated container and a stopwatch determine the leakage past HSI-62. JN

Leak Rate .0277 gpm

4.3.3 Close SIA-345 #2 SIATk recirc. valve JN

4.3.4 Close SIA-342 #2 SIATk hdr. drain JN

4.4 To determine the leakage past HSI-63:

4.4.1 Open S... #3 SIATk recirc. isol. — JN
Open valve #1 on test gage — JN
Slowly open SIA-342 to full open — JN

4.4.2 Using the calibrated container and a stopwatch determine the leakage past HSI-63. — JN

Leak Rate .0166 gpm

4.4.3 Close SIA-347 #3 SIATk recirc. valve — JN

4.4.4 Close SIA-342 #2 SIATk hdr. drain — JN

5.0 FINAL CONDITIONS

5.1 Remove flow measuring device from SIA-342 and store in I&C shop in PAB. — JN

5.2 Lock closed SIA-342. — JN

5.3 Record final levels of

1 SIATk #1	45	NR
2 SIATk #2	54	NR
3 SIATk #3	40	NR
4 Quench Tank	49	Inches

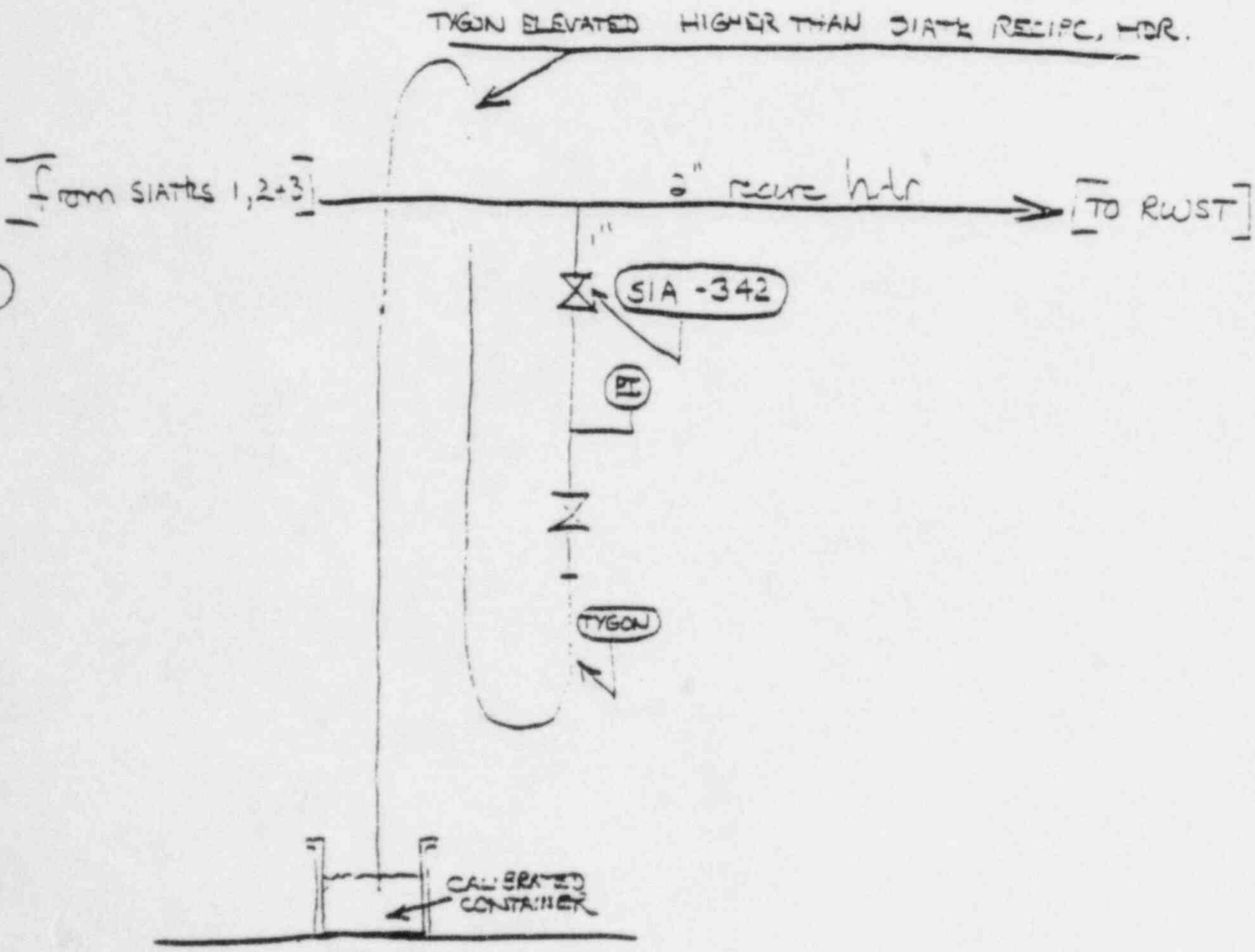
Compare these to levels in Step 3.4 to check for additional leakage pathways.

DATE/TIME 7-6-81 21:00

AUX. OPERATOR

SOS REV.

TEMPEORARY LEAK TEST FOR ESI-61, 62 & 63



Utility H

January 6, 1982

Mr. John Collette
EG and G (Idaho)
1284 Azalea Street
Idaho Falls, Idaho 83401

Subject: Utility H
Leak Rate Methodology

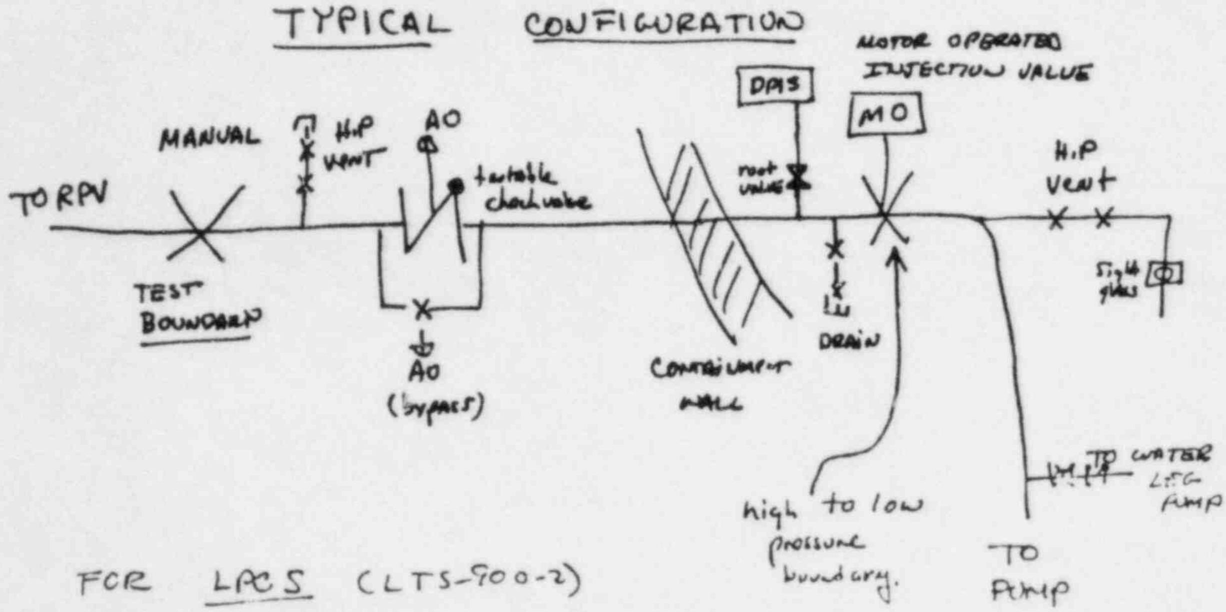
Dear Mr. Collette:

Attached information is provided to represent the typical procedures issued at Utility H for the determination of leak rates on containment isolation valves. The general procedure for leak-rate testing is LTS-900-1 and the specific procedure for one LPCS line is LTS-900-2. A schematic diagram of a typical valve configuration is shown also. The Utility H FSAR Table 6.2.21 indicates all types of valving configurations for the Utility H containment isolation function. Slight derivatives from this specific procedure would be necessary to obtain leakage information for the various valves in other configurations; the general procedure, however, outlines the approach which would be used.

The activity level at the station is such that higher priority and near-term activities are taking our time and resources just prior to receipt of the operating license. For these reasons, our input has been delayed. I hope this information is still useful to you.

Very truly yours,

TYPICAL CONFIGURATION



FOR LPCS (LTS-900-2)

MANUAL VALVE is 1E21-F051
MO VALVE is 1E21-F005
H.P vent 1E21-F321/322 / inside containment
H.P vent 1E21-F325/326 / outside "
AO testable check 1E21-F006

WATER LEAK RATE TEST METHOD

A. PURPOSE

The purpose of this procedure is to outline the method to be used to determine the water leakage of an isolated volume using a test pump.

B. REFERENCES

1. FSAR Question 111.86.

C. PREREQUISITES

1. The test pump with appropriate hoses and fittings is available.

D. PRECAUTIONS

1. Care must be taken when performing these tests at full reactor pressure.

2. The water contained in the volume to be tested should be considered contaminated.

E. LIMITATIONS AND ACTIONS

1. All valves to be tested must be closed by normal means prior to the test.

F. PROCEDURE

1. Attach the high pressure hose from the test pump discharge to the test connection.

2. Place test pump suction line into calibrated water volume.

3. With the test connection valves closed, start the test pump and crack open the discharge hose vent valve to remove any air in the line.

NOTE

Additional water may need to be added to pump suction supply. Do not allow pump suction to run dry.

4. When the line is full of water, close the vent and stop the test pump. Install the cap on the vent.

5. Open the test connection valves.

6. Start the test pump and adjust the pressure to test pressure.

7. Record the pressure, initial level and time on Attachment A.

8. Allow the test to continue at least 5 minutes and determine the final water level and time and record on Attachment A.

9. Stop the test pump.

10. Determine the leak rate through the valve using the following method:

L = 0.00433 A (H1-H2)/(D)

where	H1 =	initial level (inches)
	H2 =	final level (inches)
	A =	area of water volume (square inches)
	D =	test duration (minutes)

NOTE

11. Remove the cap and crack the vent valve to depressurize volume.

12. Close the test connection valves and remove the high pressure hose from the test connection.

13. Notify the Shift Engineer of the leak rate test results.

14. If the leak rate test results exceed the allowable limit, perform the following steps:

    a. Notify the Shift Engineer of the affected valves and that the allowable leak rate has beenexceeded.

    b. Verify that the leakage rate is recorded in the Shift Engineer's logbook.

    c. Initiate a work request to have the necessary repairs made.

G. CHECKLISTS

1. None.

H. TECHNICAL SPECIFICATION REFERENCES

1. Section 4.4.3.2.2.

ATTACHMENT A

WATER LEAK RATE TEST METHOD

System ____________________

Valve number(s) ____________________

Date test performed ____________________

Initial Time ____________________
Final Time ____________________

Test Duration (D) ____________________ minutes

Initial level (H1) ____________________ inches

Final level (H2) ____________________ inches

Volume Area (A) ____________________ square inches

Test pressure ____________________ psig

[illegible]

Allowable leak rate ____________________ gal/min

Calculated Leak Rate (L) = 0.00433A(H1-H2)/D

= ____________________ gal/min

Remarks:

Performed by ____________________ / ____________
Signature Date

Reviewed by ____________________ / ____________
Technical Staff Supervisor

Trend Analysis ____________________

NOTE: Notify the Shift Engineer of the results and verify that the results are recorded in the Shift Engineers logbook. If the leak rate test fails, notify the Shift Engineer and initiate a work request to have the valve(s) repaired.

LOW PRESSURE CORE SPRAY PRESSURE ISOLATION VALVES LEAK TEST 1(2)E21-F006 and 1(2)E21-F005

A. PURPOSE

The purpose of this procedure is to outline the method to be used to determine the water leakage through valves 1(2)E21-F006 and 1(2)E21-F005 at full reactor pressure.

B. REFERENCES

1. P&ID M-94 (M-140), Low Pressure Core Spray System.

2. LTS-900-1 Water Leak Rate Test Method.

C. PREREQUISITES

1. The LPCS system shutdown and not required for operation.

2. The reactor shutdown and at atmospheric pressure.

D. PRECAUTIONS

1. During the performance of this test the volume, test pump and line will be at 1000 psig.

2. The water inside the volume should be considered contaminated.

E. LIMITATIONS AND ACTIONS

1. The leak rate limit for each valve is 1 gpm at 1000 psig.

2. This test is required to be performed once per 18 months.

F. PROCEDURE

1. Close LPCS Injection Manual Stop Valve 1(2)E21-F051.

2. Open LPCS Injection Stop Valve 1(2)E21-F005 at panel 1(2)H13-P601.

3. With the LPCS/RHR A Water Leg Pump running verify that the LPCS system is filled by removing the pipe plug and cracking open high point vent valves 1(2)E21-

F321 and 1(2)E21-F322 until water comes from the vent.

4. Close 1(2)E21-F005 LPCS Injection Stop Valve from panel 1(2)H13-P601.

5. Close 1(2)E21-F034 LPCS/RHR A Water Leg Pump Discharge to LPCS Valve.

6. Open high point vent valves 1(2)E21-F325 and 1(2)E21-F326 to provide a vent path.

7. Close 1(2)E21-F310 PDIS 1(2)E21-N006 High Side Root Valve.

8. Open LPCS Injection Testable Check Valve 1(2)E21-F006.

9. Perform the leak rate test on valve 1(2)E21-F005 in accordance with LTS-900-1 by pressurizing through the test connection between valves 1(2)E21-F051 and 1(2)E21-F006. Leave the test rig attached and vent pressure.

10. Close LPCS Injection Testable Check Valve 1(2)E21-F006.

11. Open LPCS Injection Stop Valve 1(2)E21-F005 at panel 1(2)H13-P601.

12. Perform the leak rate test on valve 1(2)E21-F006 in accordance with LTS-900-1.

13. Close high point vent valves 1(2)E21-F326 and 1(2)E21-F325.

14. Open 1(2)E21-F034 LPCS/RHR A Water Leg Pump Discharge to LPCS Valve.

15. Crack open high point vent valves 1(2)E21-F321 and 1(2)E21-F322 until water comes from the vent then close valves and replace pipe plug.

16. Open LPCS Injection Manual Stop Valve 1(2)E21-F051 and verify open indication on panel 1(2)H13-P601.

17. Close LPCS Injection Stop Valve 1(2)E21-F005 at panel 1(2)H13-P601.

18. Crack open high point vent valves 1(2)E21-F326 and 1(2)E21-F325 until water flows through sight glass 1(2)E21-D304.

19. Open 1(2)E21-F310 PDIS 1(2)E21-N006 High Side Root Valve.

20. Return the LPCS system to service as necessary.

G. CHECKLISTS

1. None.

H. TECHNICAL SPECIFICATION REFERENCES

1. Section 4.4.3.2.2.

Utility I

Mr. Robert A. Clark, Chief
U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Licensing
Operating Reactors Branch No. 3
Washington, D.C. 20555

Reference: Utility I

Dear Mr. Clark:

As requested by Mr. C. Trammell of your staff, Mr. John Collett of EG&G recently visited Utility I's corporate offices to review Event V valve concerns. It is the Utility I's understanding that Mr. Collett has been contracted by the Commission to conduct a study of problems experienced by utilities in testing of Event V valves. During this visit, Mr. Collett left a list of questions for which he desired additional information. The responses to Mr. Collett's questions are attached. Please note that a copy of this information has also been forwarded directly to Mr. Collett.

Please note that in our discussions with Mr. Collett of EG&G, he clarified his request for completion of the attached survey sheet. He is particularly interested in Event V isolation check valves. None of the valves in the Utility I can properly be referred to as "Event V"; therefore, only those check valves which were called out in the Commission's April 20, 1981 Order for Modification of License have been considered in responding to this survey. It continues to be the Utility I's position that the existence of motor operated isolation valves upstream of the two check valves in each injection line and the fact that these valves are maintained in the closed position throughout normal operation offers a significant difference from the Event V situation described by WASH-1400.

Sincerely,

RESPONSES TO INSERVICE TESTING OF VALVES IN
NUCLEAR POWER PLANTS SURVEY SHEET

Request 1

What version, year and addenda of the ASME Boiler and Pressure Vessel Code, Section XI, is implemented for "inservice testing requirements" for your facility?

Response

ISI program is implemented under ASME Boiler and Pressure Vessel Code, 1974 Edition, with Summer 1975 addenda.

Request 2

List all "Category A" primary pressure isolation valves, Event V, in your facility for which the applicable edition and addenda of the ASME Boiler and Pressure Vessel Code, Section XI, Technical Specifications, or NRC orders require periodic leak testing. Provide valve name, manufacturer, identification number, age, type, and size.

Response

No "Category A" primary pressure isolation valves (Event V) exist at the Fort Calhoun Station for which an ISI criteria exists. As required by a Commission Order dated April 20, 1981, the District initiated a leak check program for 8 of our 12 primary system/safety injection check valves. The remaining 4 valves have instrumentation in place to allow continuous monitoring for excessive leakage.

The Commission's Order dated April 20, 1981 (Attachment 1) resulted in an addition to our Technical Specifications (Sections 2.1.1(12), Table 2.9, and 3.3, Attachment 2) requiring leak tests of 4 Low Pressure Safety Injection (LPSI) system check valves and 4 High Pressure Safety Injection (HPSI) check valves. The HPSI check valves were manufactured by Dresser Industries (see Attachment 3), and the 4 LPSI check valves were manufactured by Mission (now TRW-Mission) (see Attachment 4).

The valves are:

Mission	Type	Size	Years Since Manufactured	Years Used
SI-194	Butterfly	6"	11	8
SI-197	Butterfly	6"	11	8
SI-200	Butterfly	6"	11	8
SI-203	Butterfly	6"	11	8

Dresser	Type	Size	Years Since Manufactured	Years Used
SI-195	Poppet	2"	11	8
SI-198	Poppet	2"	11	8
SI-201	Poppet	2"	11	8
SI-204	Poppet	2"	11	8

Request 2a

Of the valves listed above, provide a history of the inservice leak testing they have received. Provide test medium, test pressure, and leak rates observed. List those valves found to be deficient during testing. Include the number of deficiencies observed for each valve over its service life to date. Describe each deficiency and the corrective action taken.

Response

Included in Attachment 5 (ST-CV-1, ST-CV-2) is a total history of our "inservice" leak testing of the 8 safety injection check isolation valves. So far, no deficiencies have been found.

Request 2b

Of the valves listed above, list those which at some time during their inservice life to date have missed a required inservice leak test. For each omission, describe the circumstances which caused the leak test to be omitted.

Response

Since the inclusion of our new Technical Specification (2.1.1(12)), none of the valves listed above (response to Request 2) have missed a required leak test.

Request 3

Provide a list and description of the various testing methods utilized to comply with ASME Section XI, as it applies to leak testing of "Category A" valves at your facility. Include sketches of equipment used, together with test piping diagrams, and instrumentation types and locations. Also, include copies of operating procedures used for leak testing, together with examples of logs, records, or other documentation utilized to record the testing data for each valve type.

Response

Since our plant has no ASME Section XI "Category A" valves, we have no leak tests for same (one should refer to Attachment 5 for details on the leak testing of the safety injection isolation valves).

Request 4

What problems have been encountered in your facility with applicable inservice leak testing requirements and procedures?

Response

We have had no difficulty in complying with our required check valve leak tests, ST-CV-1 and 2.

Request 4a

To what extent has personnel exposure to radiation presented problems in meeting inservice leak testing requirements?

Response

Our required check valve leak tests were performed in low radiation areas; approximately .05 manrem exposure was received during those tests.

Request 4b

Has the availability of personnel qualified to perform inservice leak testing presented problems or caused inservice leak testing to be delayed?

Response

Because our leak tests were not ASME Section XI tests, personnel qualification was not a problem.

Request 4c

Has component accessibility presented problems in performing inservice leak testing?

Response

All testing was designed so that it could be performed outside containment; thus, accessibility was not a problem.

Request 4d

Has the original design of the facility, in regard to the availability and location of test taps or orifices, been adequate to allow performance of inservice leak testing?

Response

As indicated in the test procedure (ST-CV-1, Page 6), one special test rig was installed. This was in a low radiation area, with adequate accessibility.

Request 4e

Have documentation requirements been restrictive to an extent you consider unnecessary? Explain.

Response

Standard surveillance procedure formats were used but presented no difficulty.

Request 4f

Has inservice leak testing been hindered by the availability of test equipment or procedures?

Response

New procedures were prepared for the testing required by the new Technical Specifications, with no delays in testing.

Request 4g

Has interpretation of ASME Section XI presented problems in establishing your inservice leak testing program?

Response

As noted above, ASME XI does not apply to the required check valve tests.

Request 5

List -- as a function of valve type, service, size, age, and manufacturer -- the allowable leak rate you consider practical from the standpoint of measurement and valve repair.

Response

Our leakage criteria are based on the NRC Order and Technical Specification, Table 2.9 (Attachment 2).

Request 6

Provide examples of design reports or comparable documentation which delineates the manner in which ASME Sections III and XI code requirements for valves were met at the time of the original installation.

Response

Copies of the original hydrostatic tests of SI-194, 197, 200, and 203 and SI-195, 198, 201, and 204 are attached (Attachment 6). Our original tests were conducted pursuant to ASME B31.70, not ASME III or XI.

Request 7

Provide examples of applicable portions of Plant Operating Manuals, Inservice Inspection Manuals, Technical Specifications, or comparable documentation which outline inservice leak testing of "Category A" valves in your facility.

Response

See Attachment 2 (Technical Specifications) and Attachment 5 (leak rate tests) for examples of our documentation of the required check valve tests.

ATTACHMENT 1

FCFile (2)

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

April 20, 1981

Docket No. 50-285

Mr. W. C. Jones
Division Manager, Production
Operations
Omaha Public Power District
1623 Harney Street
Omaha, Nebraska 68102

Dear Mr. Jones:

SUBJECT: ORDER FOR MODIFICATION OF LICENSE CONCERNING PRIMARY COOLANT SYSTEM PRESSURE ISOLATION VALVES

This letter transmits an Order for Modification of License which revises the Technical Specifications for Facility Operating License No. DPR-40 for the Fort Calhoun Station, Unit No. 1 Nuclear Plant. The change is a result of the information you provided in response to our 10 CFR 50.54(f) letter of February 23, 1980, regarding primary coolant system pressure isolation valves. Based upon our review of your response, as well as other previously docketed information, we have concluded that a WASH-1400 Event V valve configuration exists at your facility and that corrective action as defined in the attached Order is necessary.

Attached to the Order for Modification of License is the Technical Evaluation Report (TER) which supports the Order; and the plant Technical Specifications which will ensure public health and safety over the operating life of your facility. We are aware that there may be editorial corrections to the attached TER. Please note that the Technical Specifications correctly delineate the requirements for your facility.

In addition to Event V valve configurations, we are continuing our efforts to review other configurations located at high pressure/low pressure system boundaries for their potential risk contribution to an intersystem LOCA. Therefore, further activity regarding the broader topic of intersystem LOCA's may be expected in the future.

A copy of the enclosed Order is being filed with the Office of the Federal Register for publication.

Sincerely,

Robert A. Clark, Chief
Operating Reactors Branch #3
Division of Licensing

Enclosure:
Order for Modification
of License

cc w/enclosure:
See next page

ATTACHMENT 2

2.0 LIMITING CONDITIONS FOR OPERATION

2.1 Reactor Coolant System (Continued)

2.1.1 Operable Components (Continued)

(a) A pressurizer steam space of 60% by volume or greater exists, or

(b) The steam generator secondary side temperature is less than 50°F above that of the reactor coolant system cold leg.

(12) Reactor Coolant System Pressure Isolation Valves

(a) The integrity of all pressure isolation valves listed in Table 2-9 shall be demonstrated, except as specified in (b). Valve leakage shall not exceed the amounts indicated.

(b) In the event that the integrity of any pressure isolation valve specified in Table 2-9 cannot be demonstrated, reactor operation may continue, provided that at least two valves in each high pressure line having a non-functional valve are in and remain in, the mode corresponding to the isolated condition.*

(c) If Specifications (a) and (b) above cannot be met, an orderly shutdown shall be initiated and the reactor shall be in the cold shutdown condition within 24 hours.

Basis

The plant is designed to operate with both reactor coolant loops and associated reactor coolant pumps in operation and maintain DNBR above 1.30 during all normal operations and anticipated transients.

In the hot shutdown mode, a single reactor coolant loop provides sufficient heat removal capability for removing decay heat; however, single failure considerations require that two loops be operable.

In the cold shutdown mode, a single reactor coolant loop or shutdown cooling loop provides sufficient heat removal capability for removing decay heat, but single failure considerations require that at least two loops be operable. Thus, if the reactor coolant loops are not operable, this specification requires two shutdown cooling pumps to be operable.

The requirement that at least one shutdown cooling loop be in operation during refueling ensures that: (1) sufficient cooling capacity is available to remove decay heat and maintain the water in the reactor pressure vessel below 210°F as required during the refueling mode, and (2) sufficient coolant circulation is maintained through the reactor core to minimize the effects of a boron dilution incident and prevent boron stratification.

* Manual valves shall be locked in the closed position; motor operated valves shall be placed in the closed position and power supplies deenergized.

2.0 LIMITING CONDITIONS FOR OPERATION

2.1 Reactor Coolant System (Continued)

2.1.1 Operable Components (Continued)

The requirement to have two shutdown cooling pumps operable when there is less than 15 feet of water above the core ensures that a single failure of the operating shutdown cooling loop will not result in a complete loss of decay heat removal capability. With the reactor vessel head removed and 15 feet of water above the core, a large heat sink is available for core cooling; thus, in the event of a failure of the operating shutdown cooling loop, adequate time is provided to initiate emergency procedures to cool the core.

When reactor coolant boron concentration is being changed, the process must be uniform throughout the reactor coolant system volume to prevent stratification of reactor coolant at lower boron concentration which could result in a reactivity insertion. Sufficient mixing of the reactor coolant is assured if one low pressure safety injection pump or one reactor coolant pump is in operation. The low pressure safety injection pump will circulate the reactor coolant system volume in less than 35 minutes when operated at rated capacity. The pressurizer volume is relatively inactive; therefore, it will tend to have a boron concentration higher than the rest of the reactor coolant system during a dilution operation. Administrative procedures will provide for use of pressurizer sprays to maintain a nominal spread between the boron concentration in the pressurizer and the reactor coolant system during the addition of boron.[1]

Both steam generators are required to be filled above the low steam generator water level trip set point whenever the temperature of the reactor coolant is greater than the design temperature of the shutdown cooling system to assure a redundant heat removal system for the reactor.

The design cyclic transients for the reactor system are given in FSAR Section 4.2.2. In addition, the steam generators are designed for additional conditions listed in FSAR Section 4.3.4. Flooded and pressurized conditions on the steam side assure minimum tube sheet temperature differential during leak testing. The minimum temperature for pressurizing the steam generator steam side is 70°F.

Formation of a 60% steam space ensures that the resulting pressure increase would not result in an overpressurization, should a reactor coolant pump be started when the steam generator secondary side temperature is greater than that of the RCS cold leg.

For the case in which no pressurizer steam space exists, limitation of the steam generator secondary side/RCS cold leg ΔT to 50°F ensures that a single low set point PORV would prevent an overpressurization due to actuation of a reactor coolant pump.

The exception to Specification 2.1.1(4) requiring all containment penetrations providing direct access from the containment to the outside atmosphere be closed within 4 hours requires that the equipment hatch be closed and held in place by a minimum of four bolts.

References

(1) FSAR Section 4.3.7

TABLE 2-9

REACTOR COOLANT SYSTEM PRESSURE ISOLATION VALVES

System	Valve No.	Maximum (a)(b) Allowable Leakage
High-Pressure Safety Injection		
Loop 1A, Cold leg	SI-216	≤ 5 gpm
	SI-201	≤ 5 gpm
Loop 1B, cold leg	SI-220	≤ 5 gpm
	SI-204	≤ 5 gpm
Loop 2A, cold leg	SI-208	≤ 5 gpm
	SI-195	≤ 5 gpm
Loop 2B, cold leg	SI-212	≤ 5 gpm
	SI-198	≤ 5 gpm
Low-Pressure Safety Injection		
Loop 1A, cold leg	SI-200	≤ 5 gpm
Loop 1B, cold leg	SI-203	≤ 5 gpm
Loop 2A, cold leg	SI-194	≤ 5 gpm
Loop 2B, cold leg	SI-197	≤ 5 gpm

Footnotes:

(a) 1. Leakage rates less than or equal to 1.0 gpm are considered acceptable.

2. Leakage rates greater than 1.0 gpm but less than or equal to 5.0 gpm are considered acceptable if the latest measured rate has not exceeded the rate determined by the previous test by an amount that reduces the margin between measured leakage rate and the maximum permissible rate of 5.0 gpm by 50% or greater.

3. Leakage rates greater than 1.0 gpm but less than or equal to 5.0 gpm are considered unacceptable if the latest measured rate exceeded the rate determined by the previous test by an amount that reduces the margin between measured leakage rate and the maximum permissible rate of 5.0 gpm by 50% or greater.

4. Leakage rates greater than 5.0 gpm are considered unacceptable.

(b) Minimum test differential pressure shall not be less than 150 psid.

Tube Inspection means an inspection of the steam generator tube from the point of entry (hot leg side) completely around the U-bend to the top support of the cold leg.

(ii) The steam generator shall be determined OPERABLE after completing the corresponding actions (plug all tubes exceeding the plugging limit and all tubes containing through-wall cracks) required by Table 3-8.

e. Reporting Requirements

(i) Following each in-service inspection of steam generator tubes, the number of tubes plugged in each steam generator shall be reported to the Commission within 30 days.

(ii) The complete results of the steam generator tube inservice inspection shall be reported to the Commission within six (6) months following completion of the inspection. This report shall include:

1. Number and extent of tubes inspected.

2. Location and percent of wall thickness penetration for each imperfection.

3. Identification of tubes plugged.

(iii) Results of steam generator tube inspections which fall into Category C-3 and require prompt notification of the Commission shall be reported pursuant to Section 5.9.2 of the Technical Specifications prior to resumption of plant operation. The written follow-up of this report shall provide a description of investigations conducted to determine cause of the tube degradation and corrective measures taken to prevent recurrence.

(3) Surveillance of Reactor Coolant System Pressure Isolation Valves

a. Periodic leakage testing* on each valve listed in Table 2-9 shall be accomplished prior to entering the power operation

* To satisfy ALARA requirements, leakage may be measured indirectly (as from the performance of pressure indicators) if accomplished in accordance with approved procedures and supported by computations showing that the method is capable of demonstrating valve compliance with the leakage criteria.

3.3 Reactor Coolant System, Steam Generator Tubes, and Other Components Subject to ASME XI Boiler & Pressure Vessel Code Inspection and Testing Surveillance (Continued)

mode every time the plant is placed in the cold shutdown condition for refueling, each time the plant is placed in a cold shutdown condition for 72 hours if testing has not been accomplished in the preceding 9 months, and prior to returning the valve to service after maintenance, repair or replacement work is performed.

b. Whenever the integrity of a pressure isolation valve listed in Table 2-9 cannot be demonstrated the integrity of the remaining valve in each high pressure line having a leaking valve shall be determined and recorded daily. In addition, the position of one other valve located in the high pressure line shall be recorded daily.