NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/85

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
MCGUIRE NUCLEAR STATION UNIT 2	0 5 0 0 0 3 7 0	1 OF 1 0

TITLE (4)

PIPE IN AUX. LETDOWN SYSTEM DAMAGED BY WATER HAMMER

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
0 8	0 6	8 4	8 4	0 1 7	0 0	1 0	0 5	8 4		0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9)		THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
5		20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
POWER LEVEL (10)		20.405(a)(1)(i)	50.36(c)(1)	X 50.73(a)(2)(v)	73.71(c)
0 0 0		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)
		20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
		20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
		20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
SCOTT GEWEHR - LICENSING	AREA CODE 7 0 4 3 7 3 - 7 5 8 1

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	
B	C B	V	F 1 3 0	N							

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

On August 5, 1984, McGuire Unit 2 operators discovered a broken weld on the Residual Heat Removal (ND) System letdown line to the Chemical and Volume Control System (NV). The ND System was in service at the time, and water was spraying from the broken pipe and from the stem of a valve (2NV-121) in the NV System. An estimated 3000 to 7000 gallons of contaminated water was contained in the Heat Exchanger Room, the NC and containment spray sump, and the B floor drain sump and tank. Upon discovery the leaking line was isolated. A subsequent inspection revealed a number of support/restraints (S/Rs) damaged, and the broken socket weld completely separated.

Causes of this event are attributed to component malfunction/failure, due to loose packing on 2NV-121, and an unusual service condition, because a gas void in the line resulted in a water hammer.

The unit was in Mode 5, cold shutdown, at the time.

Damaged piping and support/restraints have been replaced. Other corrective actions planned and/or completed include testing of welds for cracks, measurement of vibration to study fatigue damage, and other evaluations and actions.

IE22
1/1

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
MCGUIRE NUCLEAR STATION UNIT 2	0 5 0 0 0 3 7 0	8 4	— 0 1 7	— 0 0	0 2 OF 1 0

TEXT (If more space is required, use additional NRC Form 366A's) (17)

INTRODUCTION: At approximately 0245 on August 6, 1984, operators discovered a broken weld on the Residual Heat Removal (ND) System [EIIS:BP] letdown line to the Chemical and volume Control (NV) System [EIIS:CB]. The ND system was in service at that time and water was spraying from the broken pipe and from the stem on 2NV-121 (valve which controls flow from ND system to the letdown heat exchangers) into the B train ND Heat Exchanger Room. The operator had entered the room to check on 2NV-121 [EIIS:V] which was not working properly. Upon discovering the leak he called the Control Room and the leaking line was isolated. A subsequent inspection found a number of support-restraints (S/Rs) [EIIS:SPT] damaged, and the broken socket weld completely separated.

Contaminated water from the leaks was contained in the Heat Exchanger Room, NC and NS [EIIS:BE] (containment spray) sump and the B floor drain sump and tank. Total leakage appeared to be between 3000 and 7000 gallons.

Causes of this event are Component Malfunction/Failure, because the packing on 2NV-121 was loose, and valve would not seat properly; and Unusual Service Condition, because a gas void in the auxiliary letdown line resulted in a water hammer.

EVENT DESCRIPTION: At the time of the event, Unit 2 was in Mode 5 and drained down to about 220 inches for maintenance. Operators were preparing to fill the Reactor Coolant (NC) System [EIIS:AB], which required 2NV-121 to be verified closed. After the operators began letdown flow, indications were received that 2NV-121 seemed to be at least partially open. An operator was sent to check on the valve. At about 0240, Chemistry personnel reported a high level alarm in the floor drain tank sump. At about that time, the operator entered the B ND Heat Exchanger [EIIS:HX] Room and discovered the leak. He notified the Control Room by phone, and the leak was isolated. Also about this time, a high level alarm in the ND and NS Pump Room sump was received, indicating a leak through the packing of 2NV-121.

EVALUATION: The auxiliary ND to NV letdown path consists of two ND headers (see Figure 1) to the normal NV letdown line. The path is isolated from each header by motor operated Kerotest valves, 2ND-17 and 2ND-32. Flow to the letdown line is controlled by piston operated, Fisher regulating valve, 2NV-121. The weld that was broken was immediately downstream of 2ND-17, following the break, the pipe was completely separated. Maintenance personnel also found the packing assembly on 2NV-121 had moved away from the valve body, along the valve stem. The two nuts that secure the packing flange were completely off of the studs and were later found on the floor of the B ND Heat Exchanger Room. Both of the studs were undamaged, indicating that it was forced from the stud during the event. Since the nuts were relatively undamaged, the packing flange must have been loose prior to the event.

It has been determined that the forces that caused the damage were the result of a water hammer. There was work activity performed on August 4, 1984, which could have introduced air into the letdown piping downstream of 2NV-121. Limit switches on divert valve 2NV-137A were being adjusted, and the valve was open to the Recycle Holdup Tank (RHT) for about two hours. During this time a drain path existed from 2NV-121 which is located near elevation 750, to the RHT which is located on the 716 elevation.

The vent for this draining operation would have been through the loose packing on 2NV-121. The RHT pressure was maintained near atmospheric during this time, which would not have prevented draining. In this fashion, at least some of the water in the line might have been replaced with air. The morning of the event was the first time the auxiliary letdown line was used after the air was drawn into the line. 2NV-121 was leaking through the seat extensively, as shown by the letdown flow rate observed by the operators when the line was put in service. This prevented the operators from gradually increasing flow in the line. Isolation valve 2ND-32 is an open/shut valve with seal-in circuits and a relatively quick opening Kerotest body. When the operators opened 2ND-32, flow increased rapidly in the auxiliary letdown line. The rapidly increasing flow combined with the air pocket resulted in the severe water hammer. In the event under discussion, the number and location of gas voids in the system is unknown. The size of the leak through the packing on 2NV-121 is also unknown, since the packing was further damaged during the event.

Although the water hammer is thought to have occurred about 0055, major leakage did not appear until 0230. All of the damage to the system including the broken weld (ND2FW22-23), S/R damage, and stem packing blown out of 2NC-121, apparently resulted from the same event. The only explanation found during this investigation is that the weld was broken at 0055, but did not completely separate until 0230. Chemistry personnel have stated that the major leakage could not have occurred much more than ten minutes prior to the B FDTS alarm at 0240. Control operators also saw a marked change in the VCT level and letdown flowrate about that time. VCT level, which had been steady for about 1 1/2 hours, began to drop; indicating the letdown flow or makeup flow to the VCT had decreased. Letdown flow dropped from 20 gpm to about 8 gpm, although this flow instrument is not accurate at low flows and the actual flow might have been less than 8 gpm. (The letdown flow drop was caused by water being directed through the leak instead of going to the letdown line.) Preliminary analysis of the broken weld found no evidence that would explain a delay in pipe separation after the break.

NC level throughout the event was above the minimum level necessary to operate the ND pumps. This fact eliminates the possibility of a water hammer caused by air entrainment in the ND suction line. Prior to August 4, the date when the letdown line is postulated to have been drained, the letdown line was used several times to reduce NC level without any apparent problems.

The auxiliary letdown line consists of 2" diameter, schedule forty, 304 stainless steel pipe connected to 3000 psig rated fittings by socket welds. All of the piping up to and including 2NV-121 is contained in the ND heat exchanger rooms between elevations 740 and 752. Piping supports consist of gravity hangers, seismic supports, and sometimes rigid supports that are designed to prevent thermal growth of a pipe in a direction that would impose excessive stresses on joints or components. The systems were designed to prevent vibration and water hammer problems. In addition, preoperational testing was used to help identify problem areas. When problems were found, the system design or operating methods were revised to eliminate them.

2NV-121

2NV-121 is a 2" piston actuated, Fisher control valve (type 476D-ES, 86 actuator), "Equal Percentage" internals provide good control qualities and positive shutoff capability. A positive positioner mounted on top of the cylinder assures predictable response and stem mounted limit switches provide full stroke position indication. The valve body is mounted in a vertical pipe with the flow upward. The actuator is, therefore, mounted in a horizontal position and is supported by S/R NV-5729(S). Stem packing leakoff is piped to the ND-NS pump room sump on elevation 695. Following the event, the packing hardware was found pushed back away from the valve body on the stem. Water from the valve packing leakoff line drained into the ND-NS pump room sump, filling it (along with other leaks not associated with the event) and setting off area radiation monitor EMF-1. (Control operators placed the Auxiliary Building Ventilation System filtered exhaust in the "Filter" mode in response to this alarm.) The actuator arms on the limit switches were found damaged, and several of the air tubes on the actuator were damaged. It was not possible to determine if the damage was caused by the water spraying out of the stem packing, the water hammer, or previous vibration. No work requests were found for any previous work on 2NV-121.

Two facts are known about the condition of 2NV-121 prior to the event. The valve would not control flow in the letdown line, and the packing flange was loose. Maintenance technicians who rebuilt the valve, found no visible signs of damage or wear on the internals. Due to time and exposure considerations, the entire valve internals package was replaced along with the positioner and stem mounted limit switch package. The valve was repacked and jam nuts were used to secure the valve stem packing flange. Mechanical Maintenance personnel also verified the valve was installed with the normal flow in the correct direction.

Support/Restraint Damage

Sixteen S/Rs were found damaged. The majority of damaged S/Rs were located in the ND heat exchanger rooms. Addition damaged S/Rs were found in the auxiliary letdown line downstream of 2NV-121. Spring supports were readjusted, but none of them were damaged in a way that would prevent continued support of the piping. Rigid support damage consisted of anchors loosened or pulled from concrete walls. Some mechanical snubbers were broken or leaked and were replaced. Also hydraulic and mechanical snubber anchors were loosed or pulled from the walls. These were all corrected.

The broken weld (ND2FW22-23) was a 2" socket weld. It was properly installed and tested using dye penetrant. Proper gap was maintained between the end of the pipe and the socket during the fitup. Although there was some lack of penetration of the weld metal, this was very small and not unusual for this type of weld. The weld was found to be satisfactory in all aspects. The weld was inspected at McGuire, following the event, using a glove box and unmagnified observation. It was then further decontaminated and sent to a research laboratory for more detailed examination. Although the final report

has not been received, a preliminary report showed the weld broke in a ductile fashion, probably due to one high stress event; however, they also found a majority of the weld break area had been fatigued. A crack had started on the inside diameter of the weld and progressed radially outward. Although the crack appeared to have included 360° of the weld, it had not penetrated the outer surface of the weld at any point. Therefore, the welded area was not leaking prior to the failure. Since the weld was found to have been degraded by the fatigue induced crack prior to the event, other welds in the system that might have been subjected to the same vibration were examined. A section of pipe downstream of the broken weld was cut out for examination. The section included four welds. All four of the welds were radiographed by QA, and the films were inspected for cracks. No cracks were found. Two of the welds were cut radially into four section, polished as necessary, and tested with dye penetrant. No indications of cracks were found.

Additional Weld Replacement and Destructive Examination

Although no cracks were found in the additional welds, it was decided to replace all of the socket welds in the auxiliary letdown lines that were not isolable from ND piping. This included the pipe sections between the 8" ND headers and the isolation valves 2ND-17 and 2ND-32. The two welds at the isolation valves, along with the two welds that connected the piping to the half couplings on the 8" headers, were sectioned and inspected. Each weld was cut radially into eight sections. The sections were polished, as necessary, and inspected for cracks using dye penetrant. No cracks were found in any of the 32 sections.

Unit 2 Support/Restraint Inspection

Following the discovery of the damaged S/Rs, sections of the plant that could have been affected by the water hammer event were inspected. The inspections of piping and S/Rs consisted of visual inspections and augmented inservice inspections. Augmented inservice inspections included visual examinations and some physical checks of S/Rs. Technicians attempted to move the S/Rs to insure the anchors and attachments were tight. Snubbers were stroked to insure no damage had occurred. Augmented inspections were performed on the auxiliary letdown piping, from each 8" ND header, downstream through 2NV-121, and put to the point where the 2" line connects to the 3" normal letdown line. Also included were sections of the 8" ND headers near the auxiliary letdown line connections. Visual-only inspections were extended to include the normal letdown line from the reactor building penetration, downstream to the volume control tank, excluding piping in the reactor coolant letdown filter rooms. Also included in the visual inspection was the letdown reheat heat exchanger of the Boron Thermal Regeneration System.

2ND-17 and 2NA-32

Isolation valves 2ND-17 and 2ND-32 are Kerotest globe valves which serve to isolate the "B" and "A" letdown system headers, respectively. These valves are open/shut only and cannot control flow due to their design. The valves have a tendency to chatter or cycle open/closed rapidly, when flow is introduced in the reverse direction, as is the case when an ND train is being pressurized. This can cause the pipe to vibrate severely. This potential for vibration was analyzed, as described below.

Vibration Measurement Program

A program to measure the vibration at various parts of the ND and auxiliary letdown systems was instituted, using several operating modes and conditions to find excessive vibration. Vibration probes (accelerometers), two per valve, were installed near 2ND-14, 2ND-29 ("B" and "A" ND Heat Exchanger outlets, respectively), 2ND-17, 2NC-32, and 2NV-121. Abnormal vibration was found only in a transitional mode, in which ND train "B" was used to pressurize Train A via the auxiliary letdown line. This procedure requires that water flow through the Train B discharge valve (2ND-17), backwards through the Train A discharge (2ND-32) into Train A. Kerotest valves, such as 2ND-32, have been known to close, or cycle open/closed, when flow is reversed. Due to its design, a sufficiently high reverse flow will close the valve. If the reverse differential pressure is not sustained, the valve will open again, and the cycle can begin again. This cycling caused the severe vibration observed in the test program. Following the vibration testing, the support/restraints were reinspected. Several S/Rs were found to have loosened, and were retorqued.

Operating Practice

The practice of pressurizing an idle ND train, as described above, before starting the associated pump was recommended in April of 1983, to prevent water hammer in the 8" ND header when starting a pump. The type of sever cycling observed during the vibration test probably did not occur each time an ND train was pressurized on the two units since April 1983. If it had, S/R damage would have been found on Unit 1, and also on Unit 2 prior to the water hammer event. The probability of the Kerotest valve chattering due to reverse flow, depends on the flow rate and static differential pressure across the valve when it is shut. Flow rate during the pressurization process while swapping ND trains would depend on the difference in pressure between the operating and idle trains, the volume of condensible and non-condensible gases in the idle train, leaks in the idle train, and leaks through the idle train heat exchanger outlet valve. Flow rates involved in pressurizing ND via 2NV-121 would depend on the aforementioned factors plus the setting of the 2NV-121 controller. Further testing of the 2" Kerotest valves to determine critical flow rates was not done because of possible damage to piping and S/Rs.

Unit 1 Inspections

The following actions were taken on Unit 1:

1. S/Rs on the Unit 1 auxiliary letdown line were checked for signs of damage. No damage was found.

2. 1ND-17 and 1ND-32 were checked for loose or missing bolts. No problems were found.

3. 1NV-121 was inspected with particular attention to the packing flange and packing flange nuts. The flange was in place and the nuts were tight. Maintenance personnel found some signs that the packing had been leaking slightly, and they made plans to repack the valve during the next opportunity (upcoming refueling outage). Jam nuts were installed to secure the packing flange nuts.

4. The welds between the 8" ND headers and the isolation valves were inspected visually for signs of leakage. No leakage was found. Overlay welds were made on all six of the socket welds between the 8" ND headers and the isolation valves. (B train has an elbow in the pipe, which accounts for the two extra sockets.) Overlay welds consist of additional weld material which is applied from the socket to the pipe, over the existing weld (see Figure 2). The overlay welds were designed to insure the integrity of the non-isolable socket joints for all design events. No credit was taken for any strength that may be added to the joints by the original welds. Current plans are to replace the 2" piping located between the B train 8" ND header and 1ND-17, and the 2" piping located between the A train 8" ND header and 1ND-32, at the next refueling outage. The plans may change if Duke personnel learn new methods of non-destructively testing socket welds between now and the outage.

Corrective Action

All support/restraints, piping and valves damaged during the event have been repaired. Extensive radiographic and/or dye-penetrant testing was performed on ND system welds to verify that no cracks existed. Evaluations have been performed which verify the suitability of existing bolt holes in concrete walls to reinstall S/Rs.

A vibration measurement program was conducted to determine the cause of the fatigue damage found on weld number ND2FW22-23. The problem was found to be caused by back flow through the Kerotest valves when operators pressurized idle ND trains from operating trains. The ND system startup procedure was changed to use the 8" crossover line including valves 2ND-18 ("B" ND HX BYPASS) and 2ND-33 ("A" ND HX BYPASS) for this purpose. 2ND-18 and 2ND-33 control circuits were modified to allow operators to electrically throttle the valves.

Vibration of the ND and auxiliary letdown system will be monitored during the next Unit 2 cooldown.

Unit 1 ND piping between the 8" headers and the isolation valves 1ND-17 and 1ND-32 will be replaced at the next refueling outage unless the welds on this piping are inspected and verified to be satisfactory, and/or the weld overlays are determined to be a substitute for the original welds. Inspection of these welds depends on the qualification of a radiographic method of testing socket welds. This event has also been evaluated for applicability to Duke's Catawba Station (Reference Significant Deficiency Report 413/84-01).

SAFETY ANALYSIS: The broken weld was located downstream of isolation valves 2ND-17 and 2ND-32. Operators were able to isolate the break without disturbing ND operation. Had the break occurred in an area that was non-isolable from one train of ND, the other train would have been used to continue core cooling. All of the contaminated water was contained and processed without any danger of release. Although some airborne contamination occurred outside of the heat exchanger room, no general evacuation of areas of the auxiliary building was necessary and all of the contaminated air was contained within the building. Operators swapped the auxiliary building ventilation system to the charcoal filter mode, as a precaution, when they received the EMF-1 alarm. Automatic swapover would have occurred if radiation levels had risen significantly in the auxiliary building ventilation system exhaust. The reactor was not endangered by this incident and no radioactive releases occurred. Therefore, the health and safety of the public were not affected.

The operation of Unit 1 in the interim period between the Unit 2 event and the addition of weld overlays to Unit 1 ND piping was considered justified based on the negative results of the inspections which were performed. The absence of damage to S/Rs and valves 1ND-17, 1ND-32 and 1NY-121 indicate that the system had not experienced abnormal vibration or unusual operating conditions, and therefore could be expected to operate satisfactorily.

FIGURE 1

SIMPLIFIED DRAWING
OF
AUXILIARY LETDOWN LINE

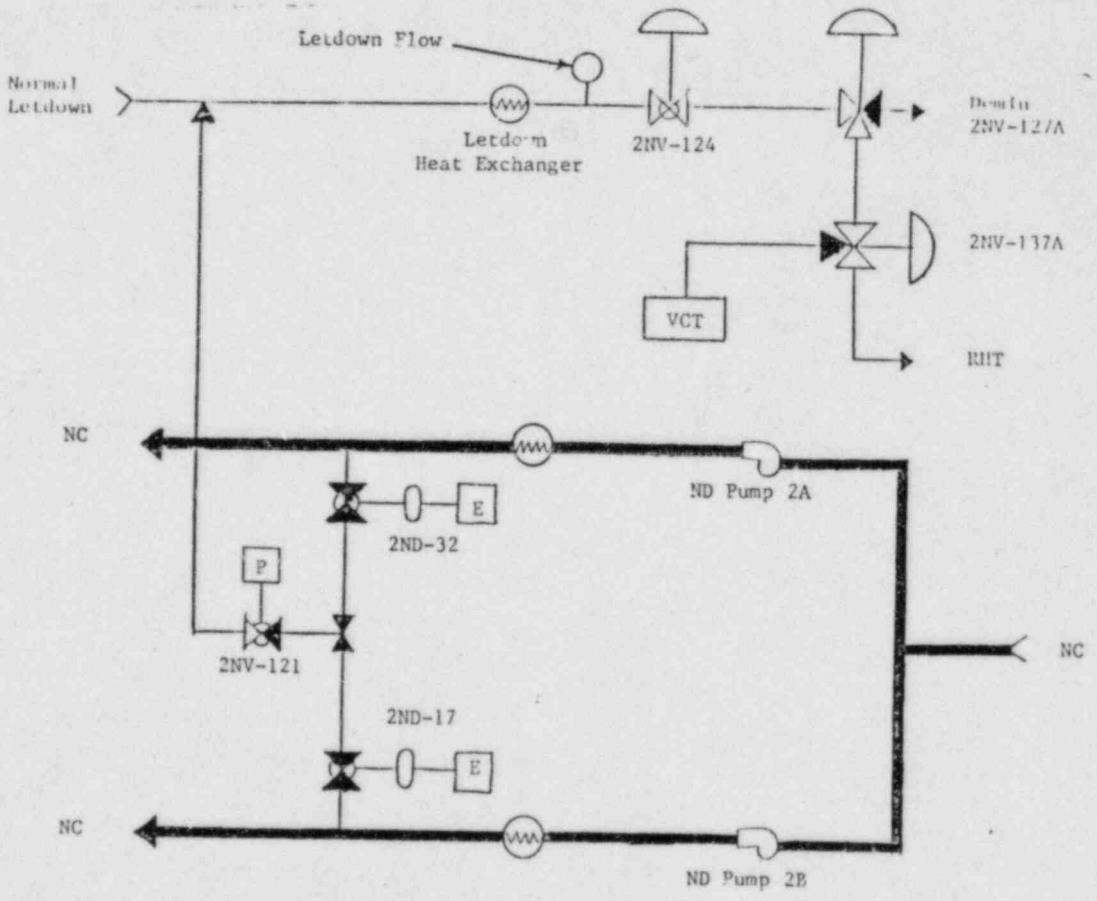
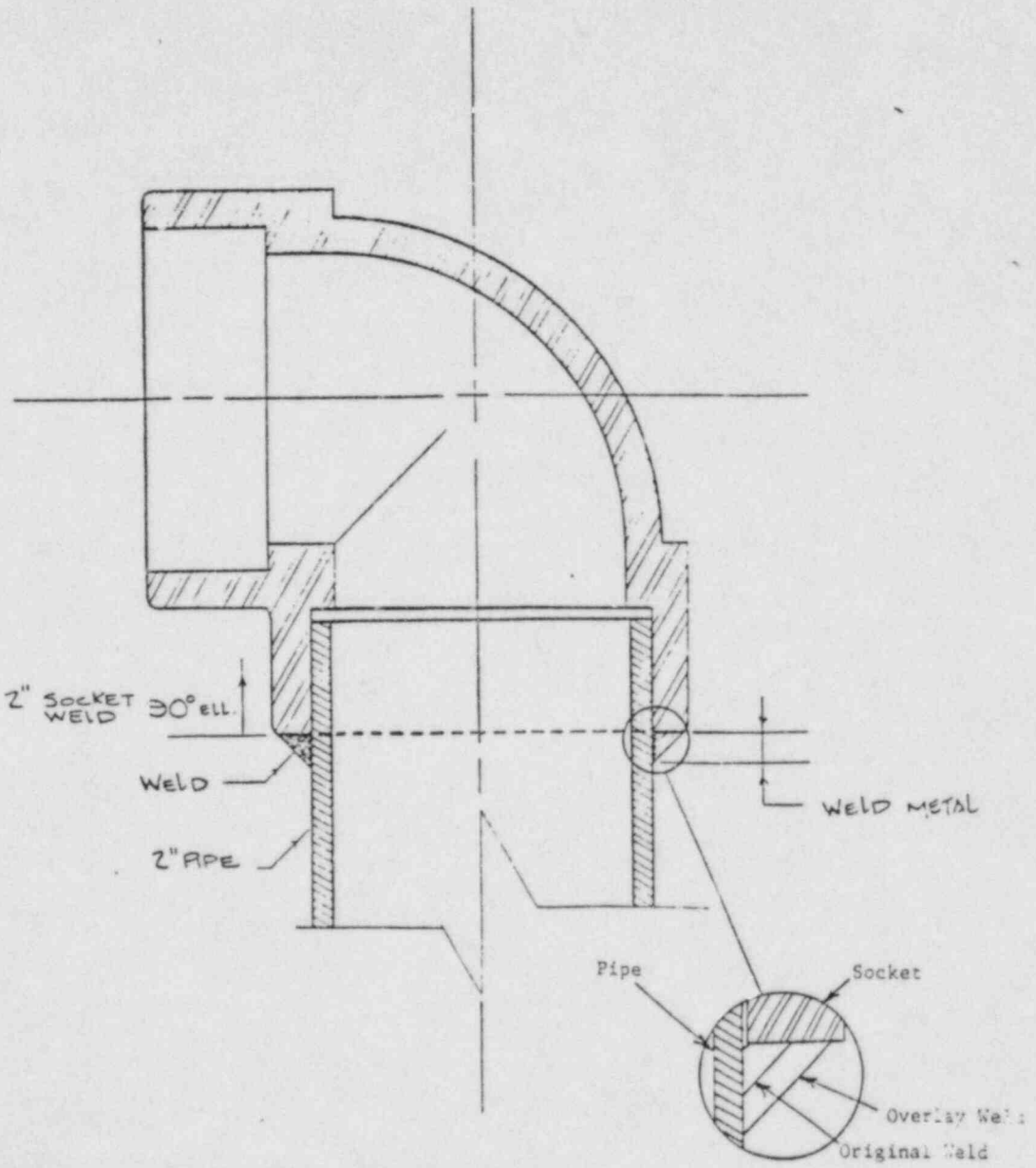


FIGURE 2

SOCKET WELD
(NO SCALE)



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October 31, 1984

Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Subject: McGuire Nuclear Station, Unit 2
Docket No. 50-370
LER 370/84-17

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report 370/84-17 concerning a pipe break in the auxiliary letdown line which is submitted in accordance with §50.73 (a)(2)(v)/(vi). Initial notification of this event was made (pursuant to §50.73 Section (a)(3)) with the NRC Operations Center via the ENS on August 26, 1984, and an unusual event was declared. This event was considered to be of no significance with respect to the health and safety of the public.

Due to an administrative oversight, this report was not submitted by October 5, 1984, as committed to by letter of September 5, 1984.

Very truly yours,

Hal B. Tucker

Hal B. Tucker

SAG/mjf

Attachment

cc: Mr. James P. O'Reilly, Regional Administrator
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