

# ACCELERATED DISTRIBUTION DEMONSTRATION SYSTEM

## REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

ACCESSION NBR: 9105150331      DOC. DATE: 91/05/08      NOTARIZED: NO      DOCKET #  
 FACIL: 50-270 Oconee Nuclear Station, Unit 2, Duke Power Co.      05000270  
 AUTH. NAME      AUTHOR AFFILIATION  
 LOWERY, H.R.      Duke Power Co.  
 BARRON, H.B.      Duke Power Co.  
 RECIP. NAME      RECIPIENT AFFILIATION

SUBJECT: LER 91-002-00: on 910408, flow transmitter found inoperable.  
 Insp revealed that flow transmitter orifice of HPI Loop A  
 installed backwards during 1980 installation. Indicated flow  
 limit reversed & new orifices installed. W/910508 ltr.

DISTRIBUTION CODE: IE22T      COPIES RECEIVED: LTR 1 ENCL 1      SIZE: 10  
 TITLE: 50.73/50.9 Licensee Event Report (LER), Incident Rpt, etc.

NOTES:

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INTERNAL:	ACNW	2	2	ACRS	2	2
	AEOD/DOA	1	1	AEOD/DSP/TPAB	1	1
	AEOD/ROAB/DSP	2	2	NRR/DET/ECMB 9H	1	1
	NRR/DET/EMEB 7E	1	1	NRR/DLPQ/LHFB11	1	1
	NRR/DLPQ/LPEB10	1	1	NRR/DOEA/OEAB	1	1
	NRR/DREP/PRPB11	2	2	NRR/DST/SELB 8D	1	1
	NRR/DST/SICB 7E	1	1	NRR/DST/SPLB8D1	1	1
	NRR/DST/SRXB 8E	1	1	<u>REG FILE</u> 02	1	1
	RES/DSIR/EIB	1	1	RGN2 FILE 01	1	1
EXTERNAL:	EG&G BRYCE, J.H	3	3	L ST LOBBY WARD	1	1
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AOF-4

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**DUKE POWER**

May 8, 1991

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

Subject: Oconee Nuclear Station  
Docket Nos. 50-269, -270, -287  
LER 270/91-02

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report (LER) 270/91-02 concerning an improperly installed Emergency Core Cooling System flow orifice.

This report is being submitted in accordance with 10 CFR 50.73 (a)(2)(i)(b). This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

H. B. Barron  
Station Manager

RSM/ftt

Attachment

cc: Mr. S. D. Ebnetter  
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Oconee Nuclear Station

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LICENSEE EVENT REPORT (LER)

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1) Oconee Nuclear Station, Unit 2	DOCKET NUMBER (2) 0 5   0 0   0 2   7 0	PAGE (3) 1 OF 0 9
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TITLE (4) **Flow Orifice Installed Backwards Due to Unknown Cause Results in Degraded Emergency Core Cooling System During Certain Small Break Loss of Coolant Accident Scenarios**

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		
0 4	0 8	9 1	9 1	0 0   2	0	0 5	0 8	9 1	DOCKET NUMBER(S) 0 5   0 0   0		

OPERATING MODE (9) N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR 8: (Check one or more of the following) (11)									
POWER LEVEL (10) 1   0   0	20.402(b)	20.406(c)	50.73(a)(2)(iv)	73.71(b)						
	20.406(a)(1)(i)	50.36(e)(1)	50.73(a)(2)(v)	73.71(c)						
	20.406(a)(1)(ii)	50.36(e)(2)	50.73(a)(2)(vi)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)						
	20.406(a)(1)(iii)	X 50.73(a)(2)(i) (b)	50.73(a)(2)(vii)(A)							
	20.406(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)							
20.406(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(ix)								

LICENSEE CONTACT FOR THIS LER (12)									
NAME Henry R. Lowery, Chairman, Oconee Safety Review Group							TELEPHONE NUMBER 8   0   3   8   8   5   -   3   0   3   4		

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)										
CAUSE	SYSTEM	COMPONENT	MANUF. TURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUF. TURER	REPORTABLE TO NPRDS	

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)

During Post Modification Testing on Unit 3, a flow transmitter was found to be inoperable. As part of the corrective action, on April 8, 1991, an inspection on Unit 2, while at 100% Full Power, revealed that the flow transmitter orifice for the High Pressure Injection loop 'A' Crossover Flow instrumentation was installed backwards. Investigations indicate that this flow orifice was installed backwards when the Crossover Flowpath was initially installed in 1980. The Crossover Flowpath consists of piping and associated valves connecting at each of the HPI pump normal discharge headers. This provides a parallel flowpath, bypassing the installed throttle valves, for protection against a single failure. The improperly installed orifice would give an indicated flow rate that is less than what is actually being delivered, and therefore could result in pump runout damage in some accident scenarios. As part of the corrective action, Design Engineering provided a revised indicated flow limit, which was incorporated into the operating procedure. The root cause of this event is Unknown, possible Inappropriate Action.

**LICENSEE EVENT REPORT (LER)  
TEXT CONTINUATION**

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TEXT (If more space is required, use additional NRC Form 386A's) (17)

BACKGROUND

The High Pressure Injection (HPI) System [EIIS:BQ] controls the Reactor Coolant System (RCS) [EIIS:AB] inventory, provides the seal water for the Reactor Coolant Pumps [EIIS:P], and recirculates RCS letdown for water quality maintenance and reactor coolant boric acid concentration control.

The HPI System is also a part of the Emergency Core Cooling System (ECCS) which mitigates the consequences of loss of coolant accidents (LOCA). The HPI System prevents uncovering of the core for smaller break sizes, where high RCS pressure is maintained, and delays the uncovering of the core for intermediate break sizes. The HPI System, during emergency operation, supplies borated water to the RCS from the Borated Water Storage Tank (BWST). The HPI System has three parallel HPI pumps that have the capability to take suction from the BWST. The HPI pumps have the capability to discharge through two redundant flow paths into the RCS, utilizing four injection nozzles (two per flowpath). The injection nozzles are located on each of the reactor inlet pipes downstream of the Reactor Coolant Pumps. Each HPI flowpath is connected by piping and associated valves at each HPI pump discharge header, making up the 'A' and 'B' Crossover Flow loops. This cross-connect provides for remote manual alignment to ensure flow to the core through both HPI trains should a single failure of an HPI pump or HPI injection valve prevent automatic injection through one train. (See Attachment 1)

Technical Specification 3.3.1 requires three HPI pumps and two HPI flow paths to be operable when RCS temperature is greater than 350 degrees with fuel in the core. Additionally, the valves in the cross-connect must be operable. This is based on considerations of potential small breaks at the Reactor Coolant Pump discharge piping for which two HPI trains (two pumps and two flow paths) are required to assure adequate core cooling. Included in the Technical Specification definition of operable is the requirement that essential auxiliary equipment, such as instrumentation and controls, be capable of performing its related support function.

An orifice plate is commonly used as a primary flow element, and produces a differential pressure from which a flow rate can be determined. Orifice plates usually have a handle on which pertinent data is permanently marked, such as orifice diameter, flange size, pressure rating, and as appropriate, the word "Inlet". On a beveled edge orifice plate that is properly installed, the word "Inlet" faces the inlet direction and the beveled edge faces the outlet direction. A beveled edge orifice plate that is installed backwards would provide a lower differential pressure across the flow element, resulting in a flow rate measurement that is lower than the actual flow rate.

EVENT DESCRIPTION

In 1980, cross connect lines were installed on Unit 2 to provide a backup flowpath for High Pressure Injection (HPI) into the core. This work was performed under Nuclear Station Modification (NSM) ON-1080 Part A,

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TEXT CONTINUATION**

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TEXT (If more space is required, use additional NRC Form 368A's) (17)

"Install Cross Connect Line, Tie-In Line, and Isolation Valves in HPI Discharge Lines (Mechanical portion)". The procedure under which this work was performed was TN/2/A/1080/0/A, "Procedure for Implementation and Verification of NSM ON-1080, Part A, Mechanical". During this NSM, two flow orifices were installed, one in the 'A' Loop Crossover Flow line and the other in the 'B' Loop Crossover Flow line.

The procedure contained a sign-off step that stated, "Install orifice plates in proper direction of flow and in accordance with MP/0/A/1800/3, Replacement of Gaskets in Flanges". This step was signed off by the Craft Supervisor. This step was followed by a Quality Control verification that the flange was installed correctly.

After this modification was completed, in June of 1980, procedure TT/2/A/203/11, "High Pressure Injection Cross-Connect Flow Test" was performed. The purpose of this test was to verify flow rates through the HPI crossover lines for Emergency Core Cooling System analysis. This test met the acceptance criteria of the required flow rate through each loop.

Since the initial installation, other modifications have been performed that upgraded the crossover flow instrumentation, but documentation does not show that the flow orifices were removed or replaced. These modifications consisted of changes made to the instrument loop past the first set of root valves. After this work was performed, the Instrument and Electrical personnel performed calibration and string checks of the instruments. The results were within acceptable tolerance.

In response to Regulatory Guide 1.97, NSM ON-32589 was initiated, one purpose of which was to improve the accuracy of the HPI Crossover Flow instrumentation such that adequate Emergency Core Cooling System injection flow rate and HPI pump runout protection could be verified. This NSM was being performed on Unit 3 as the first of the three units to be upgraded. The instruments to be replaced and upgraded for higher accuracy were the Crossover Flow instruments, 3HPIFT0159 (for 'A' loop) and 3HPIFT0160 (for 'B' loop). On March 19, 1991, during Post Modification Testing, it was discovered that the impulse lines for the HPI loop 'B' Crossover Flow instrumentation had been installed incorrectly. The impulse lines to the manifold were crossed. This problem was corrected and Licensee Event Report 287/91-03 was submitted to the NRC.

As a corrective action for the event of the crossed impulse lines on Unit 3, Work Requests were issued for the other two Oconee Units to verify that the transmitters were connected to the process line correctly and to verify that the flow orifice plates were installed correctly. On April 8, 1991, at 1700 hours, Unit 2 HPI Crossover Flow orifice 2HPIFE0161, the primary flow element feeding 2HPIFT0159 flow transmitter, was discovered to be installed backwards.

Due to the discovery of this problem, Unit 2 was placed under a 72 hour Limiting Condition for Operation in accordance with Technical Specification 3.3.1.

**LICENSEE EVENT REPORT (LER)  
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TEXT (If more space is required, use additional NRC Form 386A's) (17)

On April 9, 1991, fabrication began on an identical orifice plate to be sent to a vendor for testing. This testing was to provide data to calculate the error of the flow instrument in the HPI Crossover Flow line. Also, in order to verify this calculated error of the flow instrument, a survey of industry operating experience was made, which revealed specific instances where orifice plates were installed backwards (both inadvertently and intentionally). Comparisons were made between indicated flow values for correctly installed flow orifices versus incorrectly installed flow orifices. NRC Information Notice 90-65, "Recent Orifice Plate Problems," was consulted during this evaluation process to evaluate error magnitude and industry experience.

On April 11, 1991, Design Engineering issued an operability evaluation based on the conclusions of calculation OSC-4323. This calculation states that the HPI system is conditionally operable with the orifice installed backwards as long as the applicable emergency procedures instruct the operator to limit flow through the 'A' Loop Crossover Flow line to a maximum indicated value of 300 gpm. This calculation states that the 300 gpm indicated value will protect the HPI pump from runout and will ensure that sufficient flow is delivered to the core. The Emergency Operating Procedure was changed to reflect this indicated value of 300 gpm through the 'A' Loop Crossover Flow line, effective until the next outage when the flow orifice will be correctly installed. Operator training was completed on this procedure change. These changes to the Emergency Operating Procedure were made before the expiration of the 72 hour Limiting Condition for Operation, which was exited at 1500 hours on April 11, 1991.

On April 17, 1991, flow calibration data was received from the vendor which stated that the indicated flow was 13.5 percent less than the actual flow rate. This confirmed that the 300 gpm indicated flow limit was conservative.

The Unit 2 HPI Crossover Flow line had not been used during the period that the flow orifice had been installed backwards.

The Craft Supervisor responsible for the initial installation in 1980 and the Quality Control Inspector who verified the installation were interviewed and did not remember this specific installation. However, both stated that they believed that the orifice was installed in accordance with the procedure and the documents that were included in the NSM package at that time.

The work history records were searched and no other documentation was found that showed that the orifice plate had been removed since the initial installation in 1980. The orifice plate was confirmed to be the original one installed, by the identification number engraved on the orifice.

CONCLUSIONS

The root cause of this flow orifice being installed backwards is unknown. Possibly an inappropriate action could have occurred on the part of the craft personnel who installed the orifice plate and the Quality Assurance personnel

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who verified the installation, when the Crossover Flow orifice was initially installed under Nuclear Station Modification (NSM) ON-1080 in 1980. The procedure contained a sign off step that stated, "Install orifice plates in proper direction of flow and in accordance with MP/O/A/1800/3, Replacement of Gaskets in Flanges". The step was followed by a Quality Control verification that the flange was installed correctly. The method for determining the proper direction of flow was not included in the procedure. If, during the initial installation of the orifice plate, the personnel involved made an error as to the direction of flow within the piping, the orifice plate could have been installed backwards. Contributing to this possibility could have been that the procedure did not give adequate instructions to ensure that the orifice plate was installed correctly. It is also possible that the drawings that were used to determine the direction of flow could have been incorrect. Due to the length of time since installation, this was unable to be determined.

The orifice plate that was found installed backwards was confirmed, by the identification number imprinted on the orifice, to be the same one that was installed in 1980. The orifice plate has the imprinted mark of "Inlet" stamped on the exposed portion of the plate and is facing the outlet direction of the flange in relation to the direction of flow within the piping. No other documentation was found that indicated that the orifice plate had ever been removed since the initial installation. However, this is not conclusive evidence that the orifice plate was never removed since 1980, although an extensive search of work history records was performed.

Many improvements have been made to the NSM process since 1980. Design and technical reviews of modification packages have been enhanced.

Training of craft personnel installing Nuclear Station Modifications has also been improved since 1980. They receive Basic Mechanical Training and more recently have attended Nuclear Station Modification Worker Training. These training classes emphasize the proper use of drawings, procedures, independent verification, and functional verification.

This event did not involve a component failure or malfunction, therefore it is not NPRDS reportable. A review of events occurring in the past two years shows that the cause of unknown, possible inappropriate action, to be assigned for three events. However, these events did not involve the same work group, equipment, or administrative controls. The recent event (LER 287/91-03) in which it was discovered that the impulse lines were crossed to a flow transmitter on the HPI Crossover Flow line is considered a similar event, but is assigned a different root cause. This event is not recurring. This event did not result in the release of any radioactive materials, any radiation exposures or personnel injuries.

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TEXT (If more space is required, use additional NRC Form 386A's) (17)

CORRECTIVE ACTIONS

Immediate

1. Unit 2 was placed under a 72 hour Limiting Condition for Operation.

Subsequent

1. Design Engineering performed an operability evaluation based on calculation OSC-4323.
2. The Emergency Operating Procedure was revised to limit the maximum indicated flow through the 'A' crossover loop to 300 gallons per minute. Operators were given training on this change.
3. An identical orifice was fabricated and tested to obtain flow data in order to confirm the operability evaluation.

Planned

1. The reversed flow orifice will be reinstalled in the correct position during the next outage of sufficient duration.
2. All other flow orifices that are installed in safety related systems on all three units will be inspected to ensure correct installation.
3. Mechanical personnel having responsibility for installation of orifices, will be trained on the importance of proper installation and given training concerning the installation of basic types of orifices emphasizing the guidelines set forth in NRC Information Notice 90-69.
4. The Nuclear Station Modification Program will ensure that procedures to install orifice plates include instructions that define the direction of flow within the piping.

SAFETY ANALYSIS

The Emergency Core Cooling System (ECCS), is designed to meet criteria established in 10 CFR 50.46, Acceptance for Emergency Core Cooling Systems for Light Water Reactors. One criterion in this section requires the establishment of long term cooling. This criterion states, "After any calculated successful initial operation of the ECCS, the calculated core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by the long-lived radioactivity remaining in the core." Although the FSAR Chapter 15 Loss of Coolant Accident (LOCA) analyses demonstrate ECCS acceptability during the



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initial phase of the LOCA, it is implied that long term cooling can be established by virtue of the ECCS system design.

The worst case scenario for this event would be a small break LOCA on the discharge side of the reactor coolant pump in either of the 'B' cold legs along with an electrical failure of the 4160 volt switchgear 2TC which provides power to the 'A' High Pressure Injection (HPI) pump and to 2HP-26 ('2A' HPI Injection Valve). The probability of a power failure on the 2TC switchgear is considered to be very low, however, this scenario would initially result in no flow in the 'A' train and only a portion of the flow from the 'C' HPI pump being available for core cooling. The design basis safety analyses for this scenario would assume operator action at ten minutes to open 2HP-410 (2HP-26 Bypass Valve). With 2HP-410 open, the HPI flow from two HPI pumps injecting through two trains would satisfy the requirements of the design basis safety analyses.

The operators would throttle HPI flow to prevent pump runout and to maintain an appropriate subcooled margin. Thus, even with the Crossover Flow orifice installed backwards and the actual flow being delivered to the RCS being greater than the indicated flow, it is possible that HPI throttling to control subcooled margin may also prevent pump runout. However, because of the erroneous flow indication, the possibility of pump runout does exist when the Reactor Coolant System (RCS) depressurizes to approximately 600 psig. During a small break LOCA, a loss of two of the HPI pumps, one due to pump runout ('B' HPI pump) and one due to a power failure ('A' HPI pump), would invalidate the design basis safety analyses. In this condition, if the remaining pump ('C' HPI pump) would not adequately cool the core through the intact 'B' injection line, the Emergency Operating Procedure would instruct the operators to depressurize the RCS using steam generator cooling. This depressurization would allow injection from the core flood tanks (at about 600 psig) and eventually long term core cooling via the Low Pressure Injection System. If inadequate core cooling conditions are indicated, the operators would also open the pressurizer power operated relief valve (PORV) and the reactor vessel and hot leg high point vents to further depressurize the RCS per instructions in the Emergency Operating Procedure. Although this approach may result in enough ECCS injection to prevent core damage, the criteria in 10 CFR 50.46 may not be met for some break sizes.

During the time period that this HPI Crossover Flow orifice was installed backwards, there have been no failures of the HPI system that required the use of this instrumentation. This event did not cause any release of radioactive materials, radiation exposures, or personnel injuries. The health and safety of the public were not compromised by this event.

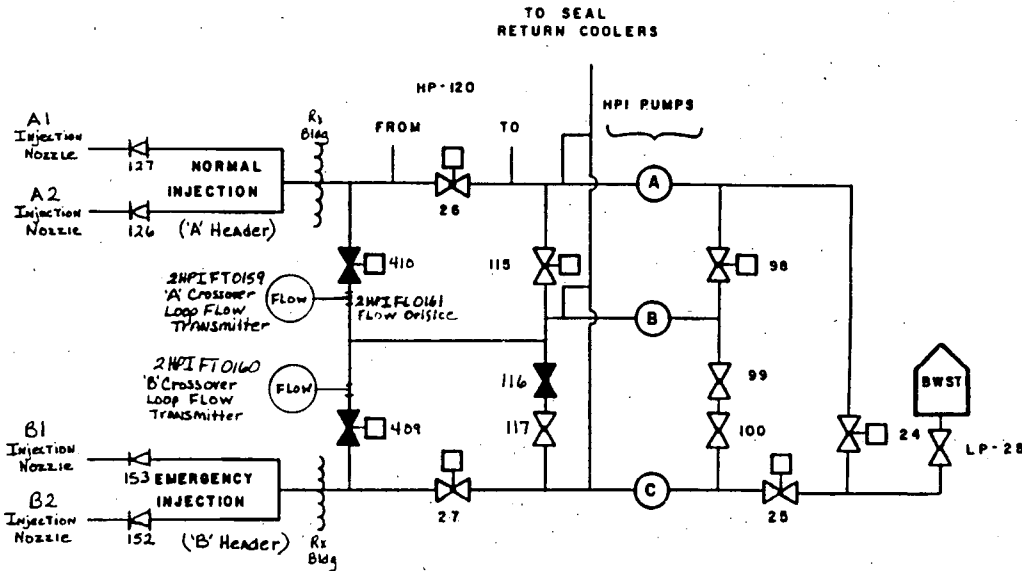
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TEXT (If more space is required, use additional NRC Form 388A's) (17)

**ATTACHMENT 1**



<b>TITLE</b> High Pressure Injection (HPI)	<b>NOTES:</b> Emergency Injection (All Valves Are HP Valves Unless Otherwise Indicated)	DOC: SY-HPI-13    DATE: 10-3-84
		REVISION: PO-101-A/B MDT/ARB    FILE: 227 <b>TRAINING USE ONLY</b>

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TEXT CONTINUATION**

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1)  <b>Oconee Nuclear Station, Unit 2</b>	DOCKET NUMBER (2)  0 5   0 0   0 2   7 0   9 1	LER NUMBER (6)			PAGE (3)		
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER			
			- 0   0   2	- 0   0	0   9	OF	0   9

TEXT (If more space is required, use additional NRC Form 388A's) (17)

**ATTACHMENT 2**

**HIGH PRESSURE INJECTION PUMP  
CROSSOVER FLOW INSTRUMENTATION**

