UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

October 5, 1990

NRC INFORMATION NOTICE NO. 90-65: RECENT ORIFICE PLATE PROBLEMS

Addressees:

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose:

This information notice is intended to alert addressees to recent problems that have been identified with orifice plates. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

Recent licensee and NRC inspections have identified two problems associated with orifice plates. Namely, the installation of orifice plates in the reverse direction and the deformation of orifices in the direction of flow.

With respect to the first of the two problems, on August 8, 1988, operators at the San Onofre Nuclear Generating Station, Unit 1, discovered an error in several daily calorimetric power calibrations. Further investigation revealed that one of the three feedwater flow indicators was providing flow indication that was lower than the actual feedwater flow. This error resulted in the indicated power on the nuclear instrumentation system being adjusted as much as four percent lower than the actual reactor power. The licensee determined that the orifice plate for the deficient flow indicator was installed backwards, causing the indicated flow to be less than the actual flow. Subsequent evaluation showed that all accident scenarios described in the Final Safety Analysis Report produced acceptable results despite the error. In 1985, San Onofre Unit 1 reported a similar event (LER 50-206/85-014).

During an NRC walkdown of the containment spray system at the Farley Nuclear Plant in April 1989, inspectors found that an orifice plate in a flow element had been installed backwards. The flow element provided spray additive tank flow indication in the control room. The licensee subsequently found four other orifice plates, used in the charging system, the auxiliary feedwater system, and the containment spray system, that were reversed. Similarly, in July 1989 the Shearon Harris Nuclear Power Plant found a reversed orifice plate. This orifice plate also was used to determine the flow rate for the containment spray system spray additive tank.

Reversed orifice plates have also been found at the Salem Nuclear Generating Station, Brunswick Steam Electric Plant, Waterford Steam Electric Plant, Surry Power Station, and North Anna Power Station. At the Salem plant, in May 1989, the flow metering orifices for the high-head cold leg safety injection line were found installed backwards. After the orifices were correctly installed, the indicated flow rate was 15 percent greater. At Brunswick, in February 1989, the licensee discovered a flow restricting orifice installed backwards in the high-pressure core injection minimum flow line, and in two other systems. Waterford experienced problems with low indicated flow in the recirculation line of a high pressure safety injection pump. The problem was traced to a reversed flow orifice in May 1989. At Surry in August 1989, an NRC inspector discovered a reversed flow orifice after the completion of a corrective action program aimed at flow orifices. Further walkdowns by the licensee identified two additional flow orifices installed backwards. At North Anna in September 1989, a total of nine flow orifices were determined to be installed backwards. Only orifices which are accessible during power operation were inspected. The root cause of these events has generally been determined to be inadequate procedures for and inspection of installations.

In February 1989, a second problem with orifice plates was identified at Brunswick, i.e., several flow restricting orifices were deformed in the direction of flow. The orifices were located in the residual heat removal system, the core spray injection and minimum flow line, and the high-pressure coolant injection system. Each of the orifice plates was manufactured from A240-316 stainless steel and was 1/8-inch thick. This thickness was based on standard orifice design that did not consider the thickness needed to prevent deformation caused by flow and the differential pressure across the orifice plate. In one instance, the orifice bore had increased from 1.021 inches to 1.088 inches, and the plate had ballooned outward approximately 0.5 inch. Subsequently, the licensee evaluated the design of the orifice plates using allowable material stresses, orifice plate geometric configurations, and system flow rates. The results of this evaluation indicated that the applied stress exceeded several times the allowable material yield stress. The licensee determined that the root cause of the deformation was an inadequate design thickness specification.

Discussion:

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 have a handle on which pertinent data is permanently marked, such as orifice diameter, flange size, pressure rating, and, as appropriate, the word "Inlet." The two most common types of orifice plates are squared edge and beveled edge. 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 square edged orifice plate is not dependent upon orientation to perform its function. However, installation procedures for both types of orifice plates should be consistent. A beveled 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.

Orifice plates are also used as flow restrictors, to provide a specific hydraulic resistance in a piping system to limit flow rate. A failure of the orifice plate could cause excessive recirculation or bypass flow, which may decrease the flow being delivered to the main flow path during an accident. The failure of the orifice plate could also reduce the hydraulic resistance in the system, increasing the total pump flow rate and the probability of centrifugal pump runout. Runout could damage the internal components of the pump, lead to inadequate net positive suction head, and overload the pump motor. Increased flow rates in the orificed line could also lead to increased pipe vibration and erosion. In addition, permanently deformed orifice plates could provide inaccurate flow measurements.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate NRR project manager.

Carl H Berlinger
for Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contacts: Scott Sparks, Region II
(404) 331-4187

Andrew Kugler, NRR
(301) 492-0834

Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
90-64	Potential for Common-Mode Failure of High Pressure Safety Injection Pumps or Release of Reactor Coolant Outside Containment During A Loss-Of-Coolant Accident	10/4/90	All holders of OLs or CPs for pressurized-water reactors.
90-63	Management Attention to the Establishment and Maintenance of A Nuclear Criticality Safety Program	10/3/90	All fuel cycle licensees possessing more than critical mass quantities of special nuclear material.
90-62	Requirements for Import and Distribution of Neutron-Irradiated Gems	9/25/90	All irradiated gemstone importers and distributors, and all non-power licensees.
90-61	Potential for Residual Heat Removal Pump Pump Damage Caused By Parallel Pump Interaction	9/20/90	All holders of OLs or CPs for nuclear power reactors.
90-60	Availability of Failure Data In the Government-Industry Data Exchange Program	9/20/90	All holders of OLs or CPs for nuclear power reactors.
90-59	Errors In the Use of Radioactive Iodine-131	9/17/90	All medical licensees.
90-58	Improper Handling of Ophthalmic Strontium-90 Beta Radiation Applicators	9/11/90	All NRC medical licensees.
90-57	Substandard, Refurbished Potter & Brumfield Relays Misrepresented As New	9/5/90	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

FIRST CLASS MAIL
POSTAGE & FEES PAID
USNRC

PERMIT No. G-67

Orifice plates are also used as flow restrictors, to provide a specific hydraulic resistance in a piping system to limit flow rate. A failure of the orifice plate could cause excessive recirculation or bypass flow, which may decrease the flow being delivered to the main flow path during an accident. The failure of the orifice plate could also reduce the hydraulic resistance in the system, increasing the total pump flow rate and the probability of centrifugal pump runout. Runout could damage the internal components of the pump, lead to inadequate net positive suction head, and overload the pump motor. Increased flow rates in the orificed line could also lead to increased pipe vibration and erosion. In addition, permanently deformed orifice plates could provide inaccurate flow measurements.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate NRR project manager.

Carl H. Berlinger
for Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contacts: Scott Sparks, Region II
(404) 331-4187

Andrew Kugler, NRR
(301) 492-0834

Attachment: List of Recently Issued NRC Information Notices

Document Name: ORIFICE

*SEE PREVIOUS CONCURRENCES
**SEE PREVIOUS FAX CONCURRENCE

*OGCB:DOEA:NRR	**RII	*RPB:ADM	C/OGCB:DOEA:NRR	D/DOEA:NRR
AJKugler	SSparks	TechEd	CHBerlinger	CERossi
09/06/90	09/10/90	09/12/90	09/26/90	10/1 /90

Orifice plates are also used as flow restrictions, which provide a specific hydraulic resistance in a piping system to limit the flow rate. A failure of the orifice plate could cause excessive recirculation or bypass flow, which may decrease the flow being delivered to the main flow path during an accident. The failure of the orifice plate could also reduce the hydraulic resistance in the system, increasing the total pump flow rate and the probability of centrifugal pump runout. Runout could damage the internal components of the pump, lead to inadequate net positive suction head, and overload the pump motor. Increased flow rates in the orificed line could also lead to increased pipe vibration and erosion. In addition, permanently deformed orifice plates could provide inaccurate flow measurements.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate NRR project manager.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contacts: Scott Sparks, Region II
(404) 331-4187

Andrew Kugler, NRR
(301) 492-0834

Attachment: List of Recently Issued NRC Information Notices

Document Name: ORIFICE

*SEE PREVIOUS CONCURRENCES
**SEE PREVIOUS FAX CONCURRENCE

*OGCB:DOEA:NRR	**RII	*RPB:ADM	C/OGCB:DOEA:NRR	D/DOEA:NRR
AJKugler	SSparks	TechEd	CHBerlinger	CERossi
09/06/90	09/10/90	09/12/90	09/14/90	09/ /90

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate NRR project manager.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contacts: Scott Sparks, Region II
(404) 331-4187

Andrew Kugler, NRR
(301) 492-0834

Attachment: List of Recently Issued NRC Information Notices

Document Name: ORIF

OGCB:DOEA:NRR	RII *	RPB:ADM	C/OGCB:DOEA:NRR	D/DOEA:NRR
AKugler AJK	SSparks	TechEd **	CHBerlinger	CERossi
09/06/90	09/ /90	09/ /90	09/ /90	09/ /90

* SEE ATTACHED FAX CONCURRENCE.
** SEE ATTACHED FOR CONCURRENCE

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate NRR project manager.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contacts: Scott Sparks, Region II
(404) 331-4137

Andrew Kugler, NRR
(301) 492-0834

Attachment: List of Recently Issued NRC Information Notices

Document Name: ORIF

OGCB:DOEA:NRR	RII SES	RPB:ADM	C/OGCB:DOEA:NRR	D/DOEA:NRR
AKugler AK	SSparks	TechEd	CHBerlinger	CERossi
09/06/90	09/10/90	09/ /90	09/ /90	09/ /90

'90 SEP 10 P1:39

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate NRR project manager.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contacts: Scott Sparks, Region II
(404) 331-4187

Andrew Kugler, NRR
(301) 492-0834

Attachment: List of Recently Issued NRC Information Notices

Document Name: ORIF

OGCB:DOEA:NRR	RII	RPB:ADM	C/OGCB:DOEA:NRR	D/DOEA:NRR
AKugler	SSparks	TechEd mm	CHBerlinger	CERossi
09/ /90	09/ /90	09/12/90	09/ /90	09/ /90