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

January 30, 1995

NRC INFORMATION NOTICE 95-08: INACCURATE DATA OBTAINED WITH CLAMP-ON ULTRASONIC FLOW MEASUREMENT INSTRUMENTS

Addressees

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

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to difficulties in accurately measuring flow rates with clamp-on ultrasonic flow measurement instruments. 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 are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

On October 14, 1993, while performing a high head safety injection (HHSI) flow balance test, the licensee for North Anna Unit 2 determined that the as-found safety injection cold leg branch line flow rates did not meet the technical specification requirements. The as-found cold leg branch line flow rates had also failed to meet the technical specification requirements during the previous test in April 1992.

The North Anna Technical Specifications give limits related to both minimum and maximum safety injection line flow rates. For North Anna, these two technical specification limits resulted in an very narrow allowed operating band, which required the use of highly accurate flow measurement instruments for flow tests.

The licensee performed the flow balance using System 990 Uniflow Universal Transit-Time Flowmeters manufactured by Controlotron of Hauppauge, New York. The Uniflow flowmeter is a clamp-on non-intrusive portable flowmeter that uses multi-pulse, transit-time ultrasonic technology to measure precisely the flow rate. The flowmeter induces alternate upstream and downstream ultrasonic signals and measures the difference in transit times. This information is then used to determine the axial fluid velocity and the flow rate through the pipe. Inaccuracies associated with the use of these instruments at North Anna combined with the narrow band of allowable flows caused problems which contributed to the failure to meet technical specification requirements.

Discussion

The licensee examined the 1993 North Anna Unit 2 flow balance test data and observed that some of the data indicated that the instrument errors significantly exceeded accuracies assumed for the tests. Numerous factors may affect the accuracy of this flowmeter including pipe dimensions, fluid flow effects, transducer mounting, and instrument setup and operation. After the test, the licensee investigated and concluded that the instrument inaccuracy most likely was caused by flow effects associated with the piping configuration. The piping arrangement, which contained several out-of-plane bends that forced the flow to change direction numerous times before entering the straight section of pipe containing the ultrasonic transducers, may have caused a stable swirl-type flow profile corkscrewing down the pipe. The licensee postulated that the swirl flow added a radial flow error to the test instruments. The flowmeter was calibrated assuming a primarily axial flow profile. In subsequent testing at a national laboratory, Controlotron ultrasonic flowmeter data varied up to 5% at different orientations around the pipe at a position approximately 15 pipe diameters downstream of a single bend. The test configuration did not include any out-of-plane bends, indicating that it is also possible for a non-uniform flow profile to exist in the absence of out-of-plane bends, causing flow measurements with larger than expected errors.

The licensee noted that the instrument output during the test did not give any indication of measurement problems. The instruments displayed little noise and only the expected small-magnitude random flow fluctuations. The lack of erratic instrument readings could easily be interpreted as meaning the readings were valid (i.e., within the stated accuracy). However, the licensee tested the instrument and determined that it could register a stable reading while a significant error was occurring. Therefore, the licensee concluded that repeatability of the data does not prove that the flow has been measured accurately.

After the test failure, the licensee found several inconsistencies in the test data which indicated problems in data accuracy. As an example, when the A HHSI pump replaced the C HHSI pump as the operating pump, without any other changes in system resistance, the B cold leg flow rate increased by 8.4 percent while the A cold leg flow rate increased by 1.5 percent and the C cold leg flow rate did not change. The licensee concluded that these values corresponded to an implausible change in the highest cold leg flow path from loop A to loop B when the sole change was which injection pump was operating. In addition, the head curve for the A HHSI pump was lower than that for the

C HHSI pump; thus, the A HHSI pump would be expected to supply flow rates less than the C HHSI pump for the same system resistance. However, the ultrasonic instruments indicated that the A HHSI pump delivered 3.3 percent more flow than the C HHSI pump. This was contrary to the previously measured pump head curve data. At the same time, installed plant process instruments indicated that the A HHSI pump delivered 3.4 percent less flow than the C HHSI pump, a measurement consistent with the pump curves.

The licensee could not determine with certainty the factors that resulted in the unanticipated measurement errors in this event. Conditions specific to an application can cause deviations from the vendor-supplied instrument accuracies. However, during the investigation the licensee developed methods that could be used to determine when the ultrasonic flowmeter may not yield the assumed accuracy. These methods include comparing ultrasonic flowmeter data from several locations or different orientations at the same location or by comparing the data from these instruments with data from permanently installed instruments. Test results can also be compared with expected system behavior.

The NRC staff has approved a request from the licensee of the North Anna plant to modify the technical specification that specifies the acceptance criteria for the HHSI pump flow rates. The change removes the specific fixed values for the flow from the technical specifications and permits the licensee to establish allowable values by analysis, providing greater operational flexibility. The licensee is also planning to (1) install permanent flow instrumentation that will supply highly accurate data for future flow balance testing and (2) supply training concerning the accuracy of clamp-on ultrasonic flowmeters to the personnel who use them.

Licensees frequently use flow measurements to demonstrate that safety-related component performance is adequate to meet the demands indicated by the accident or transient analyses. Therefore, obtaining accurate flow measurements is important to safety. When balancing the flow of HHSI injection paths, flow rates need to be accurately measured to demonstrate that the unit complies with the assumptions in safety analyses and is operated in an analyzed condition. At North Anna the licensee initially failed to detect inaccurate flow data because of a failure to verify the consistency, repeatability and reasonableness of the data from the ultrasonic flow measurement instruments. Although technical specification requirements were not met at North Anna, the licensee later analyzed the issue and concluded that the HHSI system would have performed its design safety function.

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

Brian K. Grimes, Director
Division of Project Support
Office of Nuclear Reactor Regulation

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(703) 894-5421

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(404) 331-4663

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(301) 504-2929

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Attachments filed in Jacket

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
95-07	Radiopharmaceutical Vial Breakage during Preparation	01/27/95	All USNRC medical licensees authorized to use byproduct material for diagnostic procedures.
95-06	Potential Blockage of Safety-Related Strainers by Material Brought Inside Containment	01/25/95	All holders of OLs or CPs for nuclear power reactors.
95-05	Undervoltage Protection Relay Settings Out of Tolerance Due to Test Equipment Harmonics	01/20/95	All holders of Construction Permits for nuclear power reactors.
95-04	Excessive Cooldown and Depressurization of the Reactor Coolant System Following a Loss of Offsite Power	01/19/95	All holders of OLs or CPs for nuclear power reactors.
95-03	Loss of Reactor Coolant Inventory and Potential Loss of Emergency Mitigation Functions While in a Shutdown Condition	01/18/95	All holders of Ols or CPs for nuclear power reactors.
95-02	Problems with General Electric CR2940 Contact Blocks in Medium-Voltage Circuit Breakers	01/17/95	All holders of OLs or CPs for nuclear power reactors.
95-01	DOT Safety Advisory: High Pressure Aluminum Seamless and Aluminum Composite Hoop-Wrapped Cylinders	01/04/95	All U.S. Nuclear Regulatory Commission licensees.

OL = Operating License
CP = Construction Permit

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Original signed by
Brian K. Grimes

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DOCUMENT NAME: 95-08.IN

NOTE: VENDOR COMMENTS RECEIVED, NO SIGNIFICANT CHANGES WERE MADE

OFFICE	*RPB:ADM by Email	*OGCB:DORS	*RII by Phoncon	*DRP:RII by Phoncon
NAME	TechEd	AJKugler	DRTaylor	LWGarner
DATE	09/07/94	09/13/94	09/22/94	09/22/94
OFFICE	*DRP:RII by Phoncon	*HICB:DRCH	*C/HICB:DRCH	*D/DRCH
NAME	DMVerrelli	HCGarg	JSWermiel	BABoger
DATE	09/27/94	09/19/94	09/22/94	09/22/94
OFFICE	C/OECB:DOPS	D/DOPS		
NAME	AEChaffee*	BKGrimes		
DATE	11/22/94	01/27/95		

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AEB 10/5/94

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