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

May 7, 1992

NRC INFORMATION NOTICE 92-36: INTERSYSTEM LOCA OUTSIDE CONTAINMENT

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 of potential plant vulnerabilities to intersystem loss-of-coolant accidents (ISLOCAs). It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

This information notice provides information gathered during a concerted NRC staff effort to study plant vulnerabilities to ISLOCAs. The staff gathered this information by performing (a) detailed evaluations of operating events, (b) inspections of a limited sample of pressurized water reactors (PWRs), and (c) extensive analyses of the sample PWRs. The information may be of use in recipients' individual plant examination (IPE) programs.

Background

The ISLOCA is a class of accidents in which a break occurs in a system connected to the reactor coolant system (RCS), causing a loss of the primary system inventory. This type of accident can occur when a low pressure system, such as the residual heat removal (RHR) system, is inadvertently exposed to high RCS pressures beyond its capacity. ISLOCAs of most concern are those that can discharge the break flow outside the reactor containment building, primarily because they can result in high offsite radiological consequences but also because the RCS inventory lost cannot be retrieved for long-term core cooling during the recirculation phase.

In the "Reactor Safety Study," (WASH-1400), published in 1975, and in NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," the NRC described the ISLOCA outside containment as an event of low core damage frequency, but as one of the main contributors to plant risk. In those studies the NRC referred to the ISLOCA as "Event-V." Most probabilistic risk assessments (PRAs) have also shown that the ISLOCA is very unlikely. However, these PRAs typically have modelled only those Event-V sequences that include only the catastrophic failure of check valves that isolate the RCS from

low pressure systems. These PRAs included little consideration of human errors leading to an ISLOCA. Also, most existing PRAs have given little or no credit for operator actions to terminate an ISLOCA or to mitigate its radiological consequences if core melt were to occur.

On January 22, 1992, the Virginia Electric Power Company, licensee for the North Anna Power Station, reported that the RHR relief valves would not pass the design-basis flow to relieve an overpressurization of the RHR system when the latter is aligned to the RCS. The function of these relief valves is important when the RCS is water solid and therefore susceptible to overpressurization events, such as from a charging-letdown flow mismatch or a temperature change.

The licensee made this report after conducting an engineering evaluation to respond to a notification by the nuclear steam supply vendor, the Westinghouse Electric Corporation. In February 1990, Westinghouse reviewed the RHR relief valve design basis for the Westinghouse Owners Group and recommended that its customers review the following three items:

The adequacy of the RHR relief valves for protecting against cold overpressure events

Discharge capability of relief valves for probable back pressures

Design basis commitments for valve specifications, commitments in the final safety analysis report, and technical specifications

The NRC has issued several information notices to discuss certain operational events regarding ISLOCAs. In IN 90-05, "Inter-system Discharge of Reactor Coolant," the staff discussed an event during which about 68,000 gallons of reactor water was discharged outside the containment. The staff has also analyzed operational experience and documented its findings in augmented inspection team (AIT) reports. On October 23, 1990, the staff issued AIT Report 50-456/90-020 on an event at Braidwood that resulted in primary water leakage outside the containment and in the contamination of three personnel, one of whom received a second degree burn. Table 3 is a selected list of information notices and AIT reports that the staff has issued on ISLOCAs and related events.

Discussion

Although no ISLOCA has caused core damage, accumulated operational experience, both in the United States and abroad, indicates that ISLOCA-like events have occurred at a rate higher than expected. In conducting this study, the staff defined an ISLOCA-like event, or an ISLOCA precursor, as an event that results from the failure, degradation, or inadvertent opening of the pressure isolation valves (PIVs) between the RCS and lower pressure systems. An ISLOCA precursor may become an ISLOCA if it occurs during different plant conditions, or if some of the failures occur together.

The NRC staff conducted root cause analyses of ISLOCA precursors, extensive plant inspections, and detailed analyses of a sample of PWRs. These analyses

included thermal-hydraulic analyses, fragility analyses to determine the likely sizes and locations of a break, and human reliability analyses. The staff used the results of these analyses in PRAs to gain insights about the significant contributors to ISLOCA risk.

The staff directed the studies described in this information notice towards finding vulnerabilities of PWR plants to ISLOCAs, since the primary pressures present in PWRs are greater than those found in boiling water reactors (BWRs), while the design pressures of low pressure systems are about the same in both PWRs and BWRs. However, BWR licensees also may find this information to be relevant to their plants.

Upon conducting these studies, the staff made the following observations on the ISLOCA risk at nuclear power plants:

1. The estimated core damage frequency caused by ISLOCAs could be greater than was estimated in PRAs for some plants.

   The ISLOCA risk depends on both the accident initiators and the capabilities for recovery. These factors vary from plant to plant. The main contributors to ISLOCA initiation and/or recovery include (a) human errors and (b) the effects of the accident-caused harsh environment on plant equipment and recovery activities. Both factors have significant uncertainties. Existing PRAs have provided little or no treatment of these factors. Plants that are particularly vulnerable to either of these two factors could have a higher ISLOCA risk than indicated by existing PRAs.

2. Most plants lack contingency plans to provide backup water supplies that can be transferred readily to provide long-term core cooling after an ISLOCA.

   By examining a plant's emergency procedures, a licensee can find insights for improving the plant's features to address the concerns for both ISLOCAs and other accidents.

3. The root cause analyses of operational events indicate that ISLOCA precursors most likely would be initiated by human errors, notably during testing and maintenance or because of procedural deficiencies. This may be attributed to the general lack of awareness of the possibility or consequences of an ISLOCA.

   Licensees may significantly reduce the probability of ISLOCA precursors by improving the ability of operators and maintenance personnel to recognize ISLOCAs, mechanisms that can cause them, actions to prevent them, and methods to manage them if they occur.

4. Most observed ISLOCA precursors have low public risk consequences. However, an ISLOCA precursor can require a shutdown or extension of a shutdown, require radioactivity cleanup operations, and cause personnel injury.

Table 1 presents the staff's observations from root cause analyses and plant inspections. Table 2 presents insights gained from the ISLOCA PRAs.

The staff is completing its ISLOCA research program under Generic Issue 105, "Intersystem Loss of Coolant Accidents in Light Water Reactors." Upon completing this research, the staff may issue further generic correspondence to licensees.

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 Office of Nuclear Reactor Regulation (NRR) project manager.

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Attachments:
1. Table 1. "Observed Plant Vulnerabilities to ISLOCA Precursors"
2. Table 2. "ISLOCA Risk Insights"
3. Table 3. "A Selected List of ISLOCA Reports and References"
4. List of Recently Issued NRC Information Notices

Table 1. Observed Plant Vulnerabilities to ISLOCA Precursors

(Obtained from root cause analyses of ISLOCA precursors and plant inspections)

1. Lack of awareness of the nature or consequences of ISLOCAs
2. Inadequate emergency procedures for ISLOCA outside containment, especially for non-power operational modes
3. Poor or incorrect valve labels
4. Different nomenclature used for the same equipment in the same plant
5. Poor coordination between concurrently run tests
6. Miscommunications between the control room operators and auxiliary operators ("get the valve" is meant as "crack open then close," but understood to mean "open")
7. Poor shift turn-over communications
8. Poor post-maintenance testing or operability checks
9. Inadequate application of independent verification
10. Tendency not to check diverse instrument indications
11. Tendency to commit personnel to extensive overtime work, especially during shutdown and startup operations, thus increasing the fatigue level and the likelihood of errors

Table 2. ISLOCA Risk Insights

(Obtained from ISLOCA PRAs)

1. The staff's studies suggest that the core damage frequency caused by an ISLOCA could be substantially greater than previous PRA estimates for some plants. This is primarily caused by the effects of operator errors and harsh environments caused by the accident. Valve alignment errors during transition between operating modes can be particularly important.

2. Equipment qualified for a harsh environment is likely to survive the adverse ISLOCA temperature and humidity, but not the possible submersion caused by flooding.

3. Multiple system failures may result from the ISLOCA harsh environment or flooding, depending on the size and location of the break in relation to affected equipment, the separation of redundant trains, and the effect of fire sprays on flooding.

4. ISLOCA recovery is limited by harsh environments, which may damage essential equipment thus complicating long-term cooling, and the rate of loss of reactor water outside the containment. If the water is not quickly replenished, an ISLOCA may lead to core damage, even after the leak has been isolated.

5. Symptom-based procedures may lead the operator to realize that an ISLOCA has occurred. However, unless the emergency procedures refer to plant provisions for conserving and replenishing water, the operator may have difficulty managing the accident.

6. Most observed ISLOCA precursors have low risk consequences, primarily because of the presence of one or more of the following conditions: small leak size, redundant means of detecting and isolating a leak, and low power or shutdown conditions.

Table 3. A Selected List of ISLOCA Reports and References

Identification	Title or Subject	Date
IN 90-64	Potential for Common-Mode Failure of HPSI Pumps or Release of Reactor Coolant Outside Containment During a LOCA	10/04/90
IN 90-05	Inter-system Discharge of Reactor Coolant	01/29/90
IN 89-73	Potential Overpressurization of Low Pressure Systems	11/01/89
AIT Report 50-456/90-20	An assessment of the 10/4/90 Braidwood loss of reactor coolant inventory and personnel contamination and injury	10/23/90
AIT Report 50-293/89-80	An assessment of the 4/12/89 Pilgrim overpressurization event, which occurred during the conduct of the RCIC logic test	05/08/89
Inspection Report 50-382/90-200	ISLOCA Program Inspection of the Waterford plant	09/14/90
Inspection Report 50-413,414/90-200	ISLOCA Program Inspection of the Catawba plants	06/11/90
Inspection Report 50-346/89-201	ISLOCA Program Inspection of the Davis Besse plant	12/21/89
Audit Report Docket No. 50-213	Haddam Neck ISLOCA Audit Report: July 24 - August 4, 1989, Enclosure to Memorandum from Frank J. Congel, NRC, to Steven A. Varga, NRC*	09/20/89
NUREG/CR-5745	Assessment for ISLOCA Risks - Draft Methodology and Application: Combustion Engineering Plant	June 91
NUREG/CR-5744	Assessment for ISLOCA Risks - Draft Methodology and Application: Westinghouse Four-Loop Ice Condenser Plant	Feb 91
NUREG/CR-5604	Assessment for ISLOCA Risks - Draft Methodology and Application: Babcock and Wilcox Nuclear Power Station	Feb 91
NUREG/CR-5124	Interfacing Systems LOCA, Boiling Water Reactors	Feb 89
NUREG/CR-5102	Interfacing Systems LOCA, Pressurized Water Reactors	Feb 89

*A copy of this report is available in the NRC Public Document Room, 2120 L Street, N.W., Washington, DC.

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
92-35	Higher Than Predicted Erosion/Corrosion in Unisolable Reactor Coolant Pressure Boundary Piping Inside Containment at A Boiling Water Reactor	05/06/92	All holders of OLs or CPs for nuclear power reactors.
92-34	New Exposure Limits for Airborne Uranium and Thorium	05/06/92	All licensees whose operations can cause airborne concentrations of uranium and thorium.
92-33	Increased Instrument Response Time When Pressure Dampening Devices are Installed	04/30/92	All holders of OLs or CPs for nuclear power reactors.
92-32	Problems Identified with Emergency Ventilation Systems for Near-Site (Within 10 Miles) Emergency Operations Facilities and Technical Support Centers	04/29/92	All holders of OLs or CPs for nuclear power reactors.
92-31	Electrical Connection Problem in Johnson Yokogawa Corporation YS-80 Programmable Indicating Controllers	04/27/92	All holders of OLs or CPs for nuclear power reactors.
92-30	Falsification of Plant Records	04/23/92	All holders of OLs or CPs for nuclear power reactors and all licensed operators and senior operators.
92-21, Supp. 1	Spent Fuel Pool Reactivity Calculations	04/22/92	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

Table 1 presents the staff's observations from root cause analyses and plant inspections. Table 2 presents insights gained from the ISLOCA PRAs.

The staff is completing its ISLOCA research program under Generic Issue 105, "Intersystem Loss of Coolant Accidents in Light Water Reactors." Upon completing this research, the staff may issue further generic correspondence to licensees.

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Attachments:
1. Table 1. "Observed Plant Vulnerabilities to ISLOCA Precursors"
2. Table 2. "ISLOCA Risk Insights"
3. Table 3. "A Selected List of ISLOCA Reports and References"
4. List of Recently Issued NRC Information Notices

Document Name: IN 92-36
*See previous concurrence.

C/OGCB:DOEA:NRR	D/DOEA:NRR
*CHBerlinger	CERossi
04/24/92	05/1/92

RPB:ADM	D/DSIR:RES	C/RPSIB:DSIR:RES	RPSIB:DSIR:RES	C/EIB:DSIR:RES
*TechEd	*WMinners	*KKniel	*GBurdick	*RLBaer
04/09/92	04/15/92	04/14/92	04/13/92	04/13/92

OGCB:DOEA:NRR	SC/RAB:DREP:NRR	C/RAB:DREP:NRR	D/DREP:NRR	EIB:DSIR:RES
*CVHodge	*KCampe	*WBeckner	*FCongel	*SDiab
04/08/92	04/09/92	04/09/92	04/09/92	04/13/92

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1. Table 1. "Observed Plant Vulnerabilities to ISLOCA Precursors"
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Document Name: ISLOCA REV 2

C/OGCB:DOEA:NRR	D/DOEA:NRR			
CHBerlinger	CERossi			
04/24/92	04/ /92			
RPB:ADM	D/DSIR:RES	C/RAB:DSIR:RES	RPB:DSIR:RES	C/EIB:DSIR:RES
TechEd	WMinners	KKniel	GBurdick	RLBaer
04/ 9/92	04/15/92	04/14/92	04/13/92	04/13/92
OGCB:DOEA:NRR	SC/RAB:DREP:NRR	C/RAB:DREP:NRR	D/DREP:NRR	EIB:DSIR:RES
CVHodge	KCampe	WBeckner	FCongel	SDiab
04/08/92	04/9 /92	04/9 /92	04/9 /92	04/13/92