

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

March 25, 1993

**NRC INFORMATION NOTICE 93-21: SUMMARY OF NRC STAFF OBSERVATIONS COMPILED DURING ENGINEERING AUDITS OR INSPECTIONS OF LICENSEE EROSION/CORROSION PROGRAMS**

Addressees

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

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to inform addressees of NRC observations of the design and implementation of licensee erosion/corrosion programs. These observations are derived from a number of audits and reactive inspections performed by NRC audit teams and by Region I office inspectors. It is expected that recipients will review the information for applicability to their facilities. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Background

Erosion/corrosion has occurred in systems containing carbon steel components in certain nuclear plant systems, such as main feedwater or other power conversion systems, which are important to the safe operation of the plant. Failures at the Millstone Nuclear Power Station, Units 2 and 3, and numerous repairs and replacements in extraction steam and moisture separator systems at other facilities indicate that erosion/corrosion continues to be a problem in balance of plant systems. Some boiling water reactor (BWR) licensees have discovered erosion/corrosion in American Society of Mechanical Engineers (ASME) Code Class 1 portions of their feedwater systems. Some pressurized water reactor (PWR) licensees have discovered erosion/corrosion in ASME Code Class 2 portions of their feedwater systems and in ASME Code Class 3 portions of their main steam systems. The worn areas affected by erosion/corrosion in Class 1 piping have typically been in regions directly downstream of feedwater reducing tees which branch to the feedwater risers. The worn areas of the Class 2 feedwater piping have typically been just upstream of the feedwater nozzles to the steam generator, although the licensee for the Diablo Canyon, Unit 1, nuclear power plant recently reported erosion/corrosion wear behind a

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thermal sleeve on the interior of the feedwater nozzle and on the feedwater nozzle itself. The worn area in the Class 3 system at the North Anna, Unit 1, nuclear power plant was located in a main steam drain line upstream of a main steam trap valve (an automatic isolation valve). These findings indicate that erosion/corrosion can occur in safety-related portions of plant feedwater and main steam systems.

#### Summary of NRC Observations from Audits and Inspections

The results of recent NRR audits and regional inspections of licensee erosion/corrosion programs indicate that most licensees have spent substantial time and resources to implement erosion/corrosion programs in accordance with the guidelines of Generic Letter 89-08, "Erosion/Corrosion-Induced Pipe Wall Thinning." This information notice presents some specific observations on the design and implementation of erosion/corrosion programs, which vary in scope.

Most of the problems that licensees have had in implementing erosion/corrosion programs pertained to weaknesses or errors in (1) using predictive models, (2) calculating minimum wall thickness acceptance criteria of the code, (3) analyzing the results of ultrasonic testing (UT) examinations, (4) self-assessment of erosion/corrosion program activities, (5) dispositioning components after reviewing the results of the inspection analyses, or (6) repairing or replacing components that failed to meet the minimum wall thickness acceptance criteria of the licensee.

Concerning item (1) above, some licensees have selected systems and components for UT examinations based on the analytical results of predictive models, such as the CHEC or CHECMATE computer codes of the Electric Power Research Institute or the Massachusetts Institute of Technology method described in NUREG/CR-5007, "Prediction and Mitigation of Erosion-Corrosive Wear in Secondary Piping Systems of Nuclear Power Plants," which ranks systems and components according to their erosion/corrosion susceptibility. Other licensees have selected systems and components based on engineering judgment. Recent events at Millstone 2 [Licensee Event Report (LER) 50-336/91-12] and Millstone 3 (LER 50-309/92-07), before the licensee restructured its erosion/corrosion program, and at Maine Yankee (LER 92-007-00), indicate that such erosion/corrosion programs based on engineering judgment alone may lack the scope needed to predict these phenomena in high energy, carbon steel systems.

The Office of Nuclear Reactor Regulation (NRR) audit teams and regional inspection teams found, for those cases in which CHECMATE was used as a predictive model, that licensees sometimes made errors in entering the proper plant parameters into the computer code. The most common of these errors had to do with selecting the proper geometry code for a component of a system. Errors in entering plant parameters into CHECMATE can result in errors in the predicted wear rate.

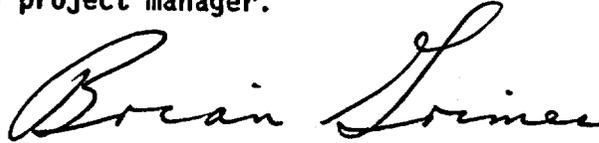
Concerning item (4) above, the inspection teams also observed that some licensees do not have programs to assess their own erosion/corrosion-related activities, especially for activities associated with computer-generated analyses. Licensee Quality Assurance (QA) programs typically did not cover the implementation of the erosion/corrosion programs for safety-related piping, although some licensees assessed their erosion/corrosion programs during audits of their inservice inspection programs. ASME Section XI, referenced in 10 CFR 50.55a(g)(4), requires that activities within the jurisdiction of the Code be covered by a quality assurance program (ASME Section XI, IWA 1400).

Concerning item (6) above, the inspections also revealed that not all repairs or replacements of erosion/corrosion-worn safety-related components are being performed in accordance with the applicable requirements of the ASME Code, Section XI, Article IWA 4000/7000. One licensee (Susquehanna; Combined Inspection Reports 50-387/92-05 and 50-388/92-05) repaired a worn, Class 1 feedwater riser by depositing a weld overlay on the exterior of the pipe. Repairs or replacements of worn components in systems designed or reclassified as ASME Code Class 1, 2, or 3 systems must satisfy the requirements of 10 CFR 50.55a(g) and ASME Code, Section XI. Reinforcement of worn areas by weld overlays on the outside of high energy, safety-related pipe do not comply with the ASME Code because the Code requires that flaws be removed from the pipe before the weld material is applied (ASME XI, IWA-4300) for repairs of safety-related pipe.

NRC inspection teams have also observed the following during inspections of licensee erosion/corrosion programs:

- An improper determination of code minimum wall thickness acceptance criteria, resulting in improper disposition of degraded components (Salem Unit 1; Inspection Report 50-272/92-08)
- A lack of baseline thickness measurements (history) on originally designed piping (Hope Creek; Inspection Report 50-354/92-11) and on replacement piping before the replacement piping is put into service (Millstone Unit 1; Inspection Report 50-245/92-80)
- Inconsistency in reproducing UT grid locations during later UT examinations of the same component (Maine Yankee; Inspection Report 50-309/92-14)
- Use of engineering personnel who are not familiar with plant operating conditions, plant as-built designs, or erosion/corrosion history (Millstone Unit 2; Inspection Report 50-336/91-81 and Hope Creek; Inspection Report 50-354/92-11)

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.



Brian K. Grimes, Director  
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Office of Nuclear Reactor Regulation

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Attachment:  
List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED  
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
93-20	Thermal Fatigue Cracking of Feedwater Piping to Steam Generators	03/24/93	All holders of OLs or CPs for PWRs supplied by Westinghouse or Combustion Engineering.
93-19	Slab Hopper Bulging	03/17/92	All nuclear fuel cycle licensees.
93-18	Portable Moisture-Density Gauge User Responsibilities during Field Operations	03/10/93	All U.S. Nuclear Regulatory Commission licensees that possess moisture-density gauges.
93-17	Safety Systems Response to Loss of Coolant and Loss of Offsite Power	03/08/93	All holders of OLs or CPs for nuclear power reactors.
93-16	Failures of Nut-Locking Devices in Check Valves	02/19/93	All holders of OLs or CPs for nuclear power reactors.
93-15	Failure to Verify the Continuity of Shunt Trip Attachment Contacts in Manual Safety Injection and Reactor Trip Switches	02/18/93	All holders of OLs or CPs for nuclear power reactors.
93-14	Clarification of 10 CFR 40.22, Small Quantities of Source Material	02/18/93	All licensees who possess source material.
93-13	Undetected Modification of Flow Characteristics in the High Pressure Safety Injection System	02/16/93	All holders of OLs or CPs for nuclear power reactors.
93-12	Off-Gassing in Auxiliary Feedwater System Raw Water Sources	02/11/93	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License  
CP = Construction Permit

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Original signed by  
Brian K. Grimes

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Office of Nuclear Reactor Regulation

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Attachment: *Filed to Shely*  
List of Recently Issued NRC Information Notices

**\*SEE PREVIOUS CONCURRENCE**

Document Name: 93-21.D  
D/DORS:NRR  
BKGrimes  
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C/OGCB:DORS:NRR RPB:ADM  
GMarcus\* TechEd\*  
02/03/93 01/04/93

D/DE:NRR  
JERichardson\*  
02/02/93

OGCB:DORS:NRR EMCB:DE:NRR  
CVHodge\* JMedoff\*  
02/03/93 01/27/93

EMCB:DE:NRR EMCB:DE:NRR  
KIParczewski\* RAHermann\*  
01/27/93 01/27/93

C/EMCB:DE:NRR  
JRStrosnider\*  
01/27/93

Harold Gray of Region I consulted on this information notice

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- Inconsistency in reproducing UT grid locations during later UT examinations of the same component (Maine Yankee; Inspection Report 50-309/92-14)
- Use of engineering personnel who are not familiar with plant operating conditions, plant as-built designs, or erosion/corrosion history (Millstone Unit 2; Inspection Report 50-336/91-81 and Hope Creek; Inspection Report 50-354/92-11)

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CONCURRENCE: \*SEE PREVIOUS CONCURRENCE

Document Name: EROS0301.CVH

D/DORS:NRR	C/OGCB:DORS:NRR*RPB:ADM	D/DE:NRR
BKGrimes	GMarcus*	TechEd
03/ /93	02/03/93	01/04/93
OGCB:DORS:NRR	EMCB:DE:NRR	EMCB:DE:NRR
CVHodge	JMedoff*	KIParczewski*
<del>02/03/93</del>	01/27/93	01/27/93
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Attachments:

1. List of Pilot Program Audit and Inspections Reports
2. List of Recently Issued NRC Information Notices

CONCURRENCE: \*SEE PREVIOUS CONCURRENCE

Document Name:	EROS0301.CVH			
D/DORS:NRR	BKGrimes	C/OGCB:DORS:NRR*RPB:ADM	TechEd	D/DE:NRR
03/ /93	02/03/93	01/04/93	02/02/93	JERichardson*
OGCB:DORS:NRR	EMCB:DE:NRR	EMCB:DE:NRR	EMCB:DE:NRR	C/EMCB:DE:NRR
CVHodge	JMedoff*	KIParczewski*	RAHermann*	JRStrosnider*
02/03/93	01/27/93	01/27/93	01/27/93	01/27/93

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The inspections also revealed that not all repairs or replacements of EC-worn safety-related components are being performed in accordance with the applicable requirements of the ASME Code, Section XI, Article IWA 4000/7000. One licensee (Combined IRs 50-387/92-05 and 50-388/92-05) repaired a worn, Class 1 feedwater riser by depositing a weld overlay on the exterior of the pipe. Repairs or replacements of worn components in systems designed or reclassified as ASME Code Class 1, 2, or 3 systems must satisfy the requirements of 10 CFR 50.55a(g) and ASME Code, Section XI. The NRC does not accept reinforcement of worn areas by weld overlays on the outside of high energy, safety-related pipe because Code repairs of safety-related pipe require that the flaws be removed from the pipe before the weld material is applied (ASME XI, IWA-4300).

NRC staff members have also observed the following during inspections of licensee EC programs (see Attachments 1 and 2):

- An improper determination of code minimum wall thickness acceptance criteria, resulting in improper disposition of degraded components;
- A lack of baseline thickness measurements (history) on new or replaced piping before placing the piping in service;
- Inconsistency in reproducing UT grid locations during later UT examinations of the same component; and
- Use of engineering personnel who are not familiar with plant operating conditions and EC history.

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2. List of Erosion/Corrosion Inspections Performed by the Division of Reactor Safety in Region I
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**CONCURRENCE: \*SEE PREVIOUS CONCURRENCE**

Document Name: EROSCORR.IN2

D/DORS:NRR	C/OGCB:DORS:NRR*RPB:ADM	D/DE:NRR		
BKGrimes	GMarcus GHM TechEd	JERichardson*		
02/ /93	02/3 /93	01/04/93		
02/03/93	01/27/93	02/02/93		
OGCB:DORS:NRR	EMCB:DE:NRR	EMCB:DE:NRR	EMCB:DE:NRR	C/EMCB:DE:NRR
CVHodge	JMedoff*	KIParczewski*	RAHermann*	JRStrosnider*
02/03/93	01/27/93	01/27/93	01/27/93	01/27/93

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BKGrimes	GMarcus	TechEd	JERichardson
02/ /93	02/ /93	01/04/93	02/02/93
OGCB:DORS:NRR	EMCB:DE:NRR	EMCB:DE:NRR	C/EMCB:DE:NRR
CVHodge*	JMedoff*	KIParczewski*	RAHermann*
02/01/93	01/27/93	01/27/93	01/27/93
			JRStrosnider*
			01/27/93

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Document Name: EROSCORR.IN2

D/DORS:NRR	C/OGCB:DORS:NRR*RPB:ADM	D/DE:NRR	#3-2/ Cap	
BKGrimes	GMarcus	JERichardson		
01/ /93	01/ /93	01/04/93	01/ /93	
OGCB:DORS:NRR	EMCB:DE:NRR	EMCB:DE:NRR	C/EMCB:DE:NRR	
CVHodge	JMedoff*	KIParczewski*	RAHermann*	JRStrosnider*
01/10/93	01/27/93	01/27/93	01/27/93	01/27/93

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Document Name: EROSCORR.IN2

D/DORS:NRR	C/OGCB:DORS:NRR*RPB:ADM	D/DE:NRR
BKGrimes	GMarcus	JERichardson
01/ /93	01/ /93	01/ /93
OGCB:DORS:NRR	EMCB:DE:NRR	EMCB:DE:NRR
CVHodge	JMedoff	RAHermann
01/ /93	01/27/93	01/27/93
	KIParczewski	JRStrosnider
	01/27/93	01/27/93

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Document Name: EROSCORR.IN

D/DORS:NRR	C/OGCB:DORS:NRR*RPB:ADM	D/DE:NRR		
BKGrimes	GMarcus	JERichardson		
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OGCB:DORS:NRR	EMCB:DE:NRR	EMCB:DE:NRR	C/EMCB:DE:NRR	
CVHodge	JMedoff	KIParczewski	RAHermann	JRStrosnider
01/25/93	01/26/93	01/26/93	01/26/93	01/21/93

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*E*. Herman Gray of Region I consulted on this information notice

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OGCB:DORS:NRR  
CVHodge:mkm  
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JMain Q  
12/ /92  
1/4/92

EMCB:DE:NRR  
JMedoff  
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EMCB:DE:NRR  
KIParczewski  
12/ /92

\*EMCB:DE:NRR  
RAHermann  
12/ /92

\*C:EMCB:DE:NRR  
JRStrosnider  
12/ /92

\*D:DE:NRR  
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12/ /92

C:OGCB:DORS:NRR  
GHMarcus  
12/ /92

D:DORS:NRR  
BKGrimes  
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