U. S. NUCLEAR REGULATORY COMMISSION
REGION I

Report No. 50-423/91-27

Docket No. 50-423

License No. NPF-49

Licensee: Northeast Nuclear Energy Company
P.O. Box 270
Hartford, Connecticut 06141-0270

Facility Name: Millstone Nuclear Power Station, Unit 3

Inspection At: Waterford, Connecticut

Inspection Conducted: December 9-13, 1991 and February 13, 1992

Inspectors: R. Harris, NDE Technician
H. Kaplan, Sr. Reactor Engineer
K. Kolaczyk, Resident Inspector Millstone

J. Trapp, Sr. Reactor Engineer, Engineering Branch, DRS — Date: 2/20/92

Approved by: P. K. Eapen — Date: 2/20/92
Dr. P. K. Eapen, Chief, Systems Section, Engineering Branch, DRS

Areas Inspected: This inspection reviewed the Millstone Unit 3 service water system. Specific areas inspected are the American Society of Mechanical Engineers (ASME) code certification, pre-operational system testing, Design Deficiency Reports (DDRs), selected Northeast Utilities Significant Event Reports (NUSOER), and the results of the Generic Letter 89-13 testing. In addition, the current erosion/corrosion program enhancements were reviewed.

Inspection Results: The service water system was adequately designed, fabricated, constructed and tested as evidenced by the documentation reviewed. However, the failure by NNECO to implement the recommendations of the Nuclear Safety Engineering Group prevented timely detection of system biofouling and leakage due to erosion. The erosion/corrosion program enhancements exceed Nuclear Utility Management and Resource Council (NUMARC) guidelines.

1.0 Service Water System Testing

The inspectors reviewed the service water system test results and associated documentation to assure that the service water system is capable of providing the required flow to safety related components. The inspection findings are based on the review of selected sections of the following documents:

- Service Water Startup Test T3326-P.
- Design Deficiency Reports (DDRs) 590, 611, 986 including the dispositions and supporting calculations.
- ASME Section XI service water pump test results.
- Nuclear Review Board (NRB) minutes discussing DDRs 590, 611, 986.
- Northeast Utilities Service Company's (NUSCO) responses to the NRC regarding Generic Letter 89-13, "Service Water System Problems Affecting Safety-Related Equipment."
- Generic Letter 89-13 test results.
- Results of the PEGISYS computer flow model for the service water system.

The licensee performed a integrated startup test of the service water system in 1985, prior to the initial startup of the reactor. The service water startup test in part measured the flow to various safety related components. The tests were conducted by placing the system in configurations which simulated a loss of offsite power, safety injection, and a containment depressurization actuation with a loss of offsite power. The test results indicated that the emergency safety feature building air conditioning units, safety injection pump cooler, and the containment recirculation coolers test flows did not satisfy the acceptance criteria. In addition, significant differences were observed between the temporary and permanent flow instrumentation. These deficiencies were documented in design deficiency reports (DDRs) 590 and 611 in August of 1985.

Stone and Webster Corporation was requested by Northeast Utilities Service Company to review the flows to each component in the service water system and determine if the measured flows meet the design basis for each component. Stone and Webster provided Northeast Utilities the results of this review in November of 1985. The minimum required flow values used for the startup test acceptance criteria were based on the minimum required flow values provided in the Final Safety Analysis Report Table 9.2-1. The Final Safety Analysis Report minimum required flow values were in some cases the nominal design flow and provided a significant margin of

conservatism. Stone and Webster performed calculations to provide new minimum required flows for service water system components. All the measured startup test flows exceeded the new lower minimum required flows values. Design Deficiency Reports 590 and 611 were dispositioned as "Accept - As - Is" and closed in November 1985 based on the new Stone and Webster minimum required flow values.

During the closeout of DDRs 590 and 611, the licensee identified that the disposition of these DDRs does not include design pump suction low seawater level or margin for pump degradation. Design Deficiency Report 986 was written, in January of 1986, to address these concerns. NUSCO performed calculation NM-022-SWP to disposition DDR 986. This calculation provided a minimum allowable pump curve which is used as an acceptance criteria for the service water pump ASME Section XI inservice testing. The minimum allowable pump curve was used to disposition DDR 986 in January of 1986.

The licensee recalculated and reestablished the minimum required service water flow values to safety related components in 1985 in response to measured flows during startup testing being less than the FSAR minimum required flows. The new minimum required flows were used to disposition the startup test deficiency. As of the time of this inspection, the licensee had not revised the FSAR to resolve the above inconsistency. As a result, the service water flows to various safety-related components do not meet the FSAR minimum required flow values described in Table 9.2-1 of the FSAR. This condition has existed since startup testing in 1985. This is contrary to 10 CFR 50.71 (e), which requires that licensees update the Final Safety Analysis Report to assure that the information in the FSAR contains the latest material developed. The failure to update the FSAR is a violation of NRC requirements (Violation 50-423/91-27-01).

The licensee's Nuclear Review Board (NRB) reviewed the disposition documentation for DDRs 590 and 611 in January 1986. The NRB found that the complete documentation of the calculations used to dispositions DDRs 590 and 611 were not available. In February 1987, the NRB chairman documented that "there was adequate engineering basis to justify the disposition Accept-As-Is, but significant rework, including detailed calculations were required to establish the bases and to provide adequate documentation." The NRB also raised the concern that other DDRs may have been dispositioned with inadequate documentation. The NRB recommendation to the Senior Vice President, NE&O, was to proceed with the configuration control program to capture the design documentation. The configuration control program was established as recommended by the NRB.

The pre-operational startup tests have been repeated using more accurate flow measurement instrumentation in response to Generic Letter 89-13 "Service Water System Problems Affecting Safety-Related Equipment." The licensee performed the NRC Generic Letter 89-13 flow testing in March of 1991. Additional test data were taken in November 1991 during the plant shutdown. The test results were intended to validate the computer model (PEGISYS) for the service water system. This computer model would be used to determine service water flows to safety related components including the effects of degraded pump performance, heat exchanger fouling, and low seawater level. The PEGISYS results indicated that the Millstone Unit 3 service water system provided adequate cooling water flow to all safety related components in the various accident scenarios.

The licensee dispositioned DDRs 590 and 611 in a timely manner; however, the licensee's NRB identified that the documentation used to disposition these DDRs was inadequate. Corrective actions were taken to provide adequate documentation. All the startup test data satisfied the newly established minimum required service water flow. Selected sections of this documentation were reviewed and found acceptable. The disposition of DDR 986 was also performed in a timely manner. Based on the current Generic Letter 89-13 testing and the results of the PEGISYS computer model the disposition to DDR 986 was verified to be conservative.

2.0 Service Water System Design Deficiencies

The inspectors reviewed the licensee's response to the initial and final drafts of the Northeast Utilities Significant Operating Experience Reports (NUSOERs) 10-83 and 10-83A, dated December 5, 1983, and April 2, 1985, respectively. The NUSOERs were prepared by the corporate Nuclear Safety Engineering Group (NSEG). The NSEG determined that the event was applicable to Millstone Unit 3. The Millstone Unit 3 service water system is fabricated with 90/10 copper nickel lined carbon steel pipe and contains backing rings. This material is susceptible to sulfide corrosion. The NUSOERs documented the accelerated corrosion of stainless steel backing rings, in service water system piping, which had occurred at another facility. Analyses of the backing rings indicated that decayed marine life had released sulfides which had induced the corrosion. In addition, the backing rings created crevices that had allowed the sulfides to concentrate and accelerate the corrosion mechanism.

The NSEG recommended the following actions in response to the NUSOER:

1. Minimize the organic material available for sulfide corrosion by not operating the service water system without chlorine injection.

2. Maintain velocities in the service water system between 10 and 4 feet per second (fps). This would reduce wear of the service water system caused by high velocity water, and prevent the settlement of suspended matter in low flow areas which could result in corrosion of the piping.

The NSEG documented in the NUSOER evaluation that NNECO was considering development of an inspection program for weld backing rings and relocation of the chlorine injection point to upstream of the service water pumps.

NNECO did not fully implement the recommendations contained in the NSEG reports because of equipment problems, schedule pressures, and lack of a firm commitment. Also due to problems during the startup test of the gaseous chlorine system at Unit 3, a decision was made to abandon the system and utilize a liquid chlorine injection (hypochlorite) system. However, this decision resulted in the service water system running for approximately 13 months without continuous chlorine injection.

NNECO personnel concluded that high flows in piping will cause minor leaks and not catastrophic failure of the service water system; therefore a program to reduce service water velocities could be deferred until after commercial operation. NNECO has experienced numerous leaks in service water piping due to erosion caused by high velocity flow. Although the leaks did not result in catastrophic failure of service water system piping, a subsequent program was developed to reduce service water system flow velocities by changing the pipe geometry or replacing the as installed copper nickel pipe with more erosion resistant monel.

NSEG recommendations which were completed include the inspection of stagnant areas of the service water piping for degradation during the first refueling outage. These inspections were subsequently discontinued due to the satisfactory inspection results.

The inspector noted that in a July 1985 Nuclear Review Board (NRB) meeting which reviewed the NUSOER, NUSCO personnel stated that in lieu of moving the chlorine injection point, inspections of the piping downstream of service water pumps would occur during the first refuel period. However, a formal commitment to perform this task was not established, consequently a documented inspection of the piping was not conducted. The failure to relocate the chlorine injection point or conduct an inspection of the piping upstream of the chlorine injection point, resulted in the continued undetected growth of mussels in this section of pipe. This subsequently resulted in the shutdown of Unit 3 in July 1991 when mussels from this piping fouled safety related heat exchangers in the "B" service water train. The licensee has moved the chlorine injection point to the suction of the service water pumps during the current service water system forced shutdown.

3.0 Carbon Steel Trunion - Copper-Nickel Piping Weld Problem

The inspector reviewed a previous welding problem involving carbon steel trunion attachments to copper-nickel (Cu-Ni) service water (SW) system piping. The problem which surfaced in October 1983 during construction involved two areas of concern; excessive distortion and melt-through (penetration into the pipe wall) that occurred when fillet welding the carbon steel trunion to the relatively thin schedule 10 (.134" wall) Cu-Ni pipe. On the basis of a review of engineering correspondence and discussions with the assigned welding engineers, the inspector concluded that the welding problem had been corrected in an acceptable and effective manner. The corrective actions consisted of three actions: (1) eliminating supports with trunion attachments where possible, (2) replacing other trunion attachments with non-integral attachments, and (3) where welded trunions were required, carbon steel trunions were replaced with Cu-Ni trunions. In the latter case, the existing pipe/trunion assembly was removed and replaced with a short, shop fabricated spool assembly (pup piece that consisted of a heavier schedule 40 Cu-Ni pipe welded to a Cu-Ni trunion/Cu-Ni base plate/ steel buffer plate subassembly. The new Cu-Ni/carbon steel assembly was installed in the field utilizing a carbon steel to carbon steel attachment weld to the existing base plate with appropriate ASME IX welding procedures.

3.1 Service Water Pipe Integrity

The inspector reviewed a comprehensive report entitled, "Millstone 3 Service Water Piping Pressure Boundary Inspection and Report," dated November 25, 1991. The report, which was thoroughly discussed with key personnel, focused primarily on an assessment of the above ground large bore piping 14" NPS and larger. The pipe was fabricated from 90-10 copper-nickel roll bond clad carbon steel plate. The smaller bore underground piping was fabricated from solid 90-10 copper nickel pipe. Except for isolated systems which were not subject to flow conditions, 100% of the internal surfaces were visually inspected. The inspection revealed extensive cladding damage, and in some cases base metal damage that occurred in the component cooling primary (CCP) heat exchanger return lines in the auxiliary building, and cross connect lines at the 24' elevation. Significant cladding degradation was also detected in the "B" train supply piping in the SW access enclosure of the intake bay area. The greatest damage was found in areas upstream and downstream of orifice plates, near flanges, longitudinal and circumferential welds, changes in flow direction and branch line connections. In addition, the four 30 inch rubber lined butterfly (Pratt) valves were found to have extensive damage underneath the rubber lining as well as in the flanged areas adjacent to these valves. Damage was also found in the turbine plant component cooling water (TBCCW) supply and the recirculation spray system (RSS) piping in the engineered safety feature system (ESF). Except for a 45° elbow, the buried solid Cu-Ni piping was generally found in good condition. The report

concluded that the cladding degradation was most likely caused by erosion due to flow disturbance as the result of the presence of orifice plates, flanges, and welds. Once the cladding deteriorated the carbon steel wastage occurred by galvanic corrosion between the carbon steel and Cu-Ni cladding.

To correct and/or monitor the above conditions the licensee generated thirty-one nonconformance reports of which seventeen resulted in weld repairs to restore the wasted carbon steel to the required minimum ASME design thickness. A polymeric (Arcor) coating was applied to the inside surface after weld repairs, and to those areas in which the damage was limited to the cladding. The licensee selected Arcor because of their previous experience with the product. The coating was applied in accordance with Procedure MP3710AG. The inspector reviewed several of the aforementioned nonconformance reports (391-311, 391-250, 391-343) and attendant repair plans. In those cases where repair of base metal was employed, a magnetic particle or liquid penetrant inspection was used followed by hydrostatic testing. The 30" butterfly valves were returned to Pratt for repair. Several rusted ASTM 193 B7 bolts which were used with 3" and under silicone bronze flanges were examined by the inspector. After checking with maintenance, the licensee's metallurgist stated that the site had never experienced any bolt failures.

The licensee is preparing to develop a plan to inspect the SW system in the next refueling outage (RF04). The base line data for this plan will be the findings and recommendations generated in the aforementioned November 25, 1991 inspection report.

Except for one pin hole leak in a cast pump discharge elbow of low stress, and an emergency diesel generator bellows expansion joint which is currently under review by the NRC, all leaks in the SW system have been repaired in accordance with Section XI requirements.

3.2 N-5 Data Report Review

The inspector selected one of thirteen N-5 packages prepared by Stone & Webster, the ASME Code certificate holder and the licensee's agent. The N-5 package was identified as 3WP-03. The review focused on spool piece 3SWP-20-2-23, a carbon steel, nickel-copper roll bonded (30 inch diameter - 13 ft x 11 7/8 inch long) spool piece which was fabricated by Southwest Fabricating and Welding Co. The package contained various documents such as the Design Certification Report, Piping Material Specification, material and filler material certifications, related NDE reports, and various certificates of compliance. No deviations or deficiencies were noted in this review.

3.3 Class 1 Pipe Restraints

The inspector visually examined three randomly selected, safety related, seismically designed, small bore restraints in the high pressure safety injection system. The welded restraints were identified as 3-S1H-1-PSR-339,334, and 344. The subject restraints were found to conform dimensionally to the appropriate drawings. Although the restraints were painted which prevented a meaningful inspection of the quality of the fillet welds, no evidence of paint spalling or cracking was observed. The lack of spailing or cracking strongly suggests that these joints had not been subjected to any excessive force. The licensee also provided the appropriate stress calculations for each of these restraints. In addition, a computer check revealed no open deficiencies associated with these items.

4.0 Millstone Erosion/Corrosion Program

The inspector reviewed the enhancements made to the erosion/corrosion program following the November 6, 1991 failure of a moisture separator reheater drain line at Millstone Unit 2. The erosion/corrosion inspection program measures the wall thickness of non-safety related secondary system pipe to identify and replace degraded components prior to failure.

The Northeast Utilities erosion/corrosion program provides a systematic evaluation of pipe wall thinning inspection locations using Electric Power Research Institute (EPRI) CHEC/CHECMATE computer programs, plant specific experience, industry and engineering experience. In order to select plant systems to include in the erosion/corrosion program, each system in the plant is individually screened for susceptibility to erosion/corrosion wear. Locations are then selected for inspection based upon relative wall thickness wear ranking by CHEC/CHECMATE, time to minimum wall thickness based on CHEC/CHECMATE, and known problem areas from site specific and industry experience.

An independent review was conducted by the Northeast Utilities engineering group, prior to plant restart, to assure the quality of the erosion/corrosion program. This review verified that the inspection locations were correctly identified, identified locations were inspected and inspection results were adequately dispositioned.

The inspector reviewed the licensees program against the EPRI and NUMARC standards. The licensee is committed to a long term program that exceeds NUMARC recommendations for E/C program. The inspector observed a team of licensee personnel reviewing ultrasonic test data, and concluded that the licensee is adequately implementing the CHECMATE program.

No violations or concerns were identified by the inspector.

.0 Unresolved Items

(Closed) Unresolved Item (UNR) 50-423/91-22-04: The unresolved item addressed the adequacy of service water system to provide design basis flow to safety related components with degraded service water pump performance. The small margin between the measured and required service water flow to the safety injection pump oil coolers was identified as a potential system weakness with degraded pump performance. The licensee issued plant incident report 3-91-285 in part to address this concern. The plant incident report uses the results of service water system flow testing and a computer flow model (PEGISYS) to disposition this concern. Based on the computer model, the licensee has determined that safety related components will receive adequate flow under degraded pump conditions provided that the pump performance remains in compliance with the existing ASME Section XI pump performance requirements. In addition, analysis has been provided to Northeast Utilities by Westinghouse which reduces the minimum required flow to the safety injection pump oil coolers to 21 gallons per minute. The reduction in the minimum required flow provides additional margin between the measured and minimum required flow. The team concluded based on the plant incident report disposition and supporting analysis that the service water flow to the safety injection oil coolers is adequate during degraded pump conditions provided that the pumps satisfy the ASME Section XI pump performance requirements.

.0 Exit Meeting

The inspector discussed the findings of this inspection with station management at the exit meetings held on December 13, 1991 and February 14, 1992.

Appendix A
Entrance/Exit Meeting Attendees

Northeast Nuclear Energy Company Corporate and Station Personnel

* P. Austin	NUSCO - Mgr. System Eng.
* C. Clement	Director, Unit 3
* J. Harris	MP3 Eng. Mgr.
* M. Hess	Engineering Supervisor, Unit 3
* D. Gerber	MP3 PSD
D. McDaniel	MP3 Eng.
. Nichols	MP3 Eng.
McMullen	NUSCO - ESD
cace	Station Director
rinzoni	NUSCO - ESD

C Personnel

nd
st Sr. Resident Inspector, Millstone
Resident Inspector, Millstone Unit 2

at exit meeting conducted on December 13, 1991.

5.0 Unresolved Items

(Closed) Unresolved Item (UNR) 50-423/91-22-04: The unresolved item addressed the adequacy of service water system to provide design basis flow to safety related components with degraded service water pump performance. The small margin between the measured and required service water flow to the safety injection pump oil coolers was identified as a potential system weakness with degraded pump performance. The licensee issued plant incident report 3-91-285 in part to address this concern. The plant incident report uses the results of service water system flow testing and a computer flow model (PEGISYS) to disposition this concern. Based on the computer model, the licensee has determined that safety related components will receive adequate flow under degraded pump conditions provided that the pump performance remains in compliance with the existing ASME Section XI pump performance requirements. In addition, analysis has been provided to Northeast Utilities by Westinghouse which reduces the minimum required flow to the safety injection pump oil coolers to 21 gallons per minute. The reduction in the minimum required flow provides additional margin between the measured and minimum required flow. The team concluded based on the plant incident report disposition and supporting analysis that the service water flow to the safety injection oil coolers is adequate during degraded pump conditions provided that the pumps satisfy the ASME Section XI pump performance requirements.

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* M. Hess	Engineering Supervisor, Unit 3
* D. Gerber	MP3 PSD
* D. McDaniel	MP3 Eng.
* B. Nichols	MP3 Eng.
* R. McMullen	NUSCO - ESD
* S. Scace	Station Director
* P. Tirinzoni	NUSCO - ESD

U. S. NRC Personnel

* W. Raymond	Sr. Resident Inspector, Millstone
P. Habighorst	Resident Inspector, Millstone Unit 2

* Denotes present at exit meeting conducted on December 13, 1991.