DATE: July 10, 1990

MEMORANDUM FOR: Office Allegation Coordinator, Region 1

FROM: Edward C. Wenteuer, Chief, Reactor Projects Branch 4

FROM: Donald F. Haverkamp, Chief, Reactor Projects Section 4A

SUBJECT: CLOSEOUT OF ALLEGATION RI-90-A-0031 FOR MILLSTONE NUCLEAR POWER STATION UNIT TWO.

This allegation is closed. The alleger has expressed his concerns to the Northeast Utilities Nuclear Safety Concerns Program, thereby no further NRC follow up specific to this allegation is required.

I have enclosed my working file to complete your records.

Donald F. Haverkamp, Chief
Reactor Projects Section 4A
Division of Reactor Projects

Enclosure: As stated

H/22

NU Corporate Engineer Disagreement with Steam Generator Tube Integrity Assessment prepared on January 31, 1990

Background

On June 5, 1989 NRC Region I requested Northeast Utilities (NU) to perform an in-cycle steam generator eddy current testing examination for Millstone 2. The specific NRC conclusion that a mid-cycle steam generator tube inspection was necessary was to confirm boric acid treatment has arrested the caustic cracking mechansim to assure continued operability of the steam generators.

On July 12, 1989 NU committed to an in-cycle inspection of the steam generator tubes. The definitive schedule and work scope was documented to the NRC on August 30, 1989. By letter dated October 10, NRC Region I accepted the licensee's scope of inspection provided an appropriate level of assurance regarding continued steam generator operation.

During early November, 1989 the licensee completed the eddy current testing of the steam generators. NRC specialist and resident inspector review of the preliminary results were conversed with Region I and NRR management.

On February 7, 1990 NU documented the Millstone 2 steam generator safety assessment to the NRC based on the examination conducted in November, 1989. On February 22, a NRC and Licensee meeting was conducted to discuss the November, 1989 examination results and safety assessment.

On March 2, local newspapers (New Haven Register and New London Day) documented an article in that a NU coporate engineer disagrees with the Millstone 2 steam generator safety assessment conclusions. Resident inspectors acquired the NU internal documents on disagreements to the safety evaluation from licensee staff on March 9.

On March 13, the resident inspector interviewed the licensee's corporate engineer. Below list the engineers major points of disagreement with the safety evaluation, further clarification of the issues based on the March 13 interview, and NU's response to the concerns.

Point 1

Engineer's Concern: Since the 10/89 in-cycle outage was the first time 100% ultrasonic test sampling was performed on cracked tubes, the conclusion drawn in the first paragraph of page 6 regarding the time dependency of depth of the cracking is not technically supported. Currently applied techniques similiar to those used in "Guidelines for Evaluating Circumferential Cracks in Pressure Loaded Steam Generator Tubes", Novtech Corp. 10/18/89 would indicate operation limited to less than 170 EFPD (April 4, 1990 for Millstone 2).

The first pragraph of page 6 of the 1/31/90 Safety Evaluation documents the following. The acutual circumferential extent and depth of the macrocrack is relatively independent of the operating time. The circumferential extent is controlled by the number of microcracks which have initiated around the circumference and the uniformity of the stresses in the tube at

H/23

the top of the tubesheet. The depth of the individual microcracks is controlled by the stress field. Once a microcrack has passed the initiation stage, the crack will propagate to the depth supported by the stress field fairly rapidly compared to the length of the operating cycle.

Clarification Points: A 0 - 100% throughwall 'microcrack' or grain boundary crack could take approximately two weeks in accordance with NU's Nuclear Material and Chemistry (NMC) organization. Macrocracks are time dependent in that tubes continuously in service progress to a macrocrack level based on historical ECT data. Engineering calculations not yet completed for secondary vs. live load spectrum to reinforce time dependency. ASME Section XI "Flaw Assessment" and crack growth determination was not used for the safety assessment.

Licensee's Response to Engineer Disagreement: See enclosures

Point 2

Engineer Concern: Traditional best estimate projections have underestimated the cracking problem as compared to the actual repair scope. The basis of 45 tubes specified on pages 6 and 8 should reflect historical cracking trends. This number should be around 100 to realistically determine a probability of a tube exceeding Regulatory Guide 1.121 requirements.

Clarification Points: The history of number of cracked tubes since 1987 are recorded in NU's presentation on February 22, 1990. The best estimate number has been an underestimation each outage. The development of old vs. new cracks were developed after November, 1989 outage. The engineer's basis of 100 additional cracks is the slope of the number of tube cracks time for the past three outages and to take a average of the slopes. No defined basis to predict cracking trends vs. boric acid treatment. The only evidence is based on the number of tubes actually repaired due to cracked tubes.

Licensee Response:

Point 3

Engineer Concern: On page 8 "equivalent" depth should read "average" depth since time did not permit a calculation of all 85 crack profiles to determine "equivalent" crack depths. Based on a sampling of the worst tubes the "equivalent" depth was on the order of 80 percent as compared to an average depth of 20-30 percent for the same crack and would result in major change to the probabilistic model used in the attached safety assessment. The practice of using average depth as an indicator of tube acceptability is good for uniformly degraded tubes (uniform depth, 360 circ. extent); however, an extremely poor method to assess tubes that challenge stability.

Clarification Point: The only data at the development of the 1/31/90 safety assessment was the average depth of a crack for structural acceptability stresses. The development of average depth does not take into account a bending moment as the centroid of the tube is altered by a non-uniform crack, thus acceptability of tube vs. stress loadings inappropriately used average depth of crack.

Licensee Response:

Point 4

Engineer Concern: The existing safety assessment assumes additional margins exist to rupture, based on data that is pressure based only. Potential external loads as the result of tube bowing, tube lock-up (from denting), secondary internals loading during accident conditions, etc., has not been considered. An evaluation of these loads by Combustion Engineering for Millstone Unit 2 steam generators present conditions needs to be performed before we try to strip our analysis of any potential conservatisms.

Clarification Points: The external load sensitivity testing by CE has a completion date by September, 1990. The previous CE evaluation in 1985 looked at loads at the top of the eggcrates and the licensee extrapolated the loads to the top of the tube sheet area. The loads resulted from tube denting. The amount of extrapolated load was approximately 1 PSI. Live loads during accident conditions as a result of secondary forces was not considered. This aspect is part of CE's evaluation to conclude by 9/90.

Licensee Response:

Point 5

Engineer Concern: The limit load analysis performed for the most complex flaws is in a preliminary status with no independent review and approval being accomplished and forms a weak basis for subsequent safety assessment assumptions. Also, this analysis did not include NU's standard practice of include NDE error in the analysis (a practice Regulatory Guide 1.121 also requests) or Section XI equivalent flaw length to depth criteria for multiple flaws.

Clarification Points: The limit load analysis is primarly the responsibility of the contractor Novtech with NU assistance. At the time of the meeting the Novtech report was still in draft. The development of Section XI equivalent flaw length is used to determine the acceptability of the tube at inspection for evaluation, not because the tube will be repaired as required in technical specifications.

Licensee Response: The evaluation is being prepared and reviewed in parallel; while not normal, this does not invalidate the work. No errors have been found to date and it appears justified to use the preliminary results.

As previously noted, this problem is not the case at previous problems. In particular no flaw acceptance is allowed. All flaws have been removed from service. Therefore, a best estimate calculation to determine where wer are, versus a flaw acceptance calculation is warranted.

Point 6

Engineer Concern: NU has not performed a detailed Regulatory Guide 1.121 analysis for these tubes to date due to time constraints. Preliminary results identify that at least seven tubes will not meet this criteria.

Clarification Points: At the time of the evaluation with Regulatory Guide 1.121 the certified material test reports specific information to calculate flow stress was not incorporated. At the time of the interview 6 of the 7 tubes were rejectable in comparison to .7X the flow stress criteria; however, the engineer concludes the basis of this review should not be used based on the fact the evaluation is for axial crack configuration not for circumferential failure. In review one tube did not meet ASME Appendix F criteria; this information was presented to the NRC on 2/22/90. Licensee development of a repo tability evaluation is underway. The licensee is reviewing the regulatory guide acceptance criteria based on EDM notch specimens subjected to burst tests that is currently on-going.

Licensee response: This is the intent of the work, it is certainly more detailed than any that has been done in the past. All available information has been considered. Conclusions are based on the seven identified tubes and their relationship t the burst tubes.

Point 7

Engineer Concern: The present safety assessment identifies a safety marg of 1.52, for tube L32/R22, between room temperature burst test information and the preliminary analytical results. Regulatory Guide 1.121 requires the burst strength be determined experimentally at operating temperature. Margins may not be present.

Evaluation of end of cycle 8 pulled tube L25,R19, which leaked at .1 gpm in service shows zero margin between the analytical model and actual rupture point.

Clarification Points: By March 14, the licensee's contractor will acquire industry related burst test information to assist in the regulatory guide 1.121 evaluation. The preliminary analytical results were a result of insufficient CMTR information for the steam generator tubes.

Licensee response: It is the relationship between analytical and experimental values that is of interest from the burst test, not the actual values. Calculsitons or experimental data corrected for temperature should exhibit the same relationship.

The pulled tube could more properly be said to have an excess margin of 1 it meets the safety margin of 1.4. The rupture pressure of tube L25/R19

REVIEW AND CONCLUSIONS:

1. The resident did not achieve clarification for major points of disagreement on number 8,9, and 10.

2. Engineer provided licensee's steam generator structural integrity assessment action plan that includes: QA analytical evaluation of all 11/89 tube crack profiles, tube rupture pressure tests over three regions of the limit load curve, review of industry burst test results, 3-D finite element analysis of tube L45/R13 by combustion engineering, calculation of probability of one tube being unacceptable versus time at monthly increments, probability of secondary side depressurization event during the remaining fuel cycle, and licensee structural integrity position to generation engineering management. Completion date is 3/28/90.

3. Engineer did not attend presentation to NRC on 2/22, however senior vice president made it clear it was the engineer's option.

4. The safety assessment lead for the licensee was the NMC organization. Engineer believes organization comes to conclusion without a basis (i.e. evaluations.

5. Senior Vice President extention basis for presentation to NRC as reported internally to licensee organization was if there is no supporting basis, then extension, if no basis available shut the unit down.

6. The night prior to the NRC presentation, the licensee added the one tube failure to regulatory guide 1.121.

7. Senior Vice president according to engineer, made it clear to technical staff that resolution of his concerns is priority, and all available cooperation is necessary.

8. The steam generator safety evaluation according to the engineer is not normal NU engineering development.

9. The CE evaluation of the pulled steam generator tubes concluded the cause of stress corrosion cracking (i.e. caustic/acidic environs) is indeterminant. NMC influenci the CE conclusions in this regards.

10. Engineer did not go to local newspapers, nor did they come to him. He believes this was information within the licensee organization.

11. The NU response to the engineer, was not a collective response by those who signed the safety assessment (i.e. the engineers supervisor was the author of the response).

Conclusions: The resident inspectors recommendation for this issue based on review of the supporting documentation, attendance at the 2/22 meeting, and discussion with the engineer are as follows:

a. NRC review of the requested information, which was the NDV:ECT report on plug limit evaluations, CE report on burst tested tubes, and current engineering evaluation.

b. Development of questions during review, and in early April have licensee explain position based on additional scope of work, and if unsupported information was provided to the NRC on 2/22.

TO: CAC

FR: A Vigil

SUBJ: Allegation File RI-90-A-0032

On June 13, 1990 Bob Hamilton the author of the NL Day Article of March 2, 90. ~~he took~~ He stated that he did not have source other than MR. Keenan from NL who ~~made~~ discussed this issue at a news conference. He did agree to review his notes, and if he did find names of sources he will contact us.

V/R

AV

H/SG

APPENDIX 3.1

ALLEGATION RECEIPT REPORT

Date/Time Received: 3/9/90 Allegation No. RI-90-A-0032 (leave blank)

Name: ANONYMOUS Address: —

Phone: — City/State/Zip: —

Confidentiality:

Was it requested?	Yes ___	No X
Was it initially granted?	Yes ___	No ___
Was it finally granted by the allegation panel	Yes ___	No ___
Does a confidentiality agreement need to be sent to alleger?	Yes ___	No ___
Has a confidentiality agreement been signed?	Yes ___	No ___
Memo documenting why it was granted is attached?	Yes ___	No ___

Alleger's Employer: — Position/Title: —

Facility: MILLSTONE UNIT 2 Docket No.: 50-336

(Allegation Summary (brief description of concern(s): Received newspaper article (Wash. Dom 03/02/90) [discussed engineer dissenting view on S/G tube problem] → Engineering Data concerning S/G condition, ~~the info~~ engineering info provided to NRC was not complete

Number of Concerns: 1

Employee Receiving Allegation: P. Habighorst (first two initials and last name)

Type of Regulated Activity (a) X Reactor (d) ___ Safeguards
(b) ___ Vendor (e) ___ Other: ___ (Specify)
(c) ___ Materials

Materials License No. (if applicable): ___

Functional Area(s):
___(a) Operations ___(e) Emergency Preparedness
___(b) Construction ___(f) Onsite Health and Safety
___(c) Safeguards ___(g) Offsite Health and Safety
___(d) Transportation X(h) Other: Safety

(NRC Region I Form 207
Revised 10/89)

H/15

DATE [illegible]

FACSIMILE FROM MILLSTONE RESIDENT OFFICE

MESSAGE TO: Tony Vegel, Pete
Ed Wenzinger

FROM: Bill Raymond

MILLSTONE UNIT ____

NUMBER OF PAGES: 4
(including this form)

Millstone Fax No. (203) 443-5893
Millstone Phone Nos. (203) 447-3179
442-5357

MESSAGE: 1) Note references to dissenting view.
2) I have no details → I don't know if issue was discussed during NU presentation to NRR/Region I
3) We could take the article as a safety allegation and have NU arrange for NRC do a [illegible] mgs interview with the engineer to [illegible] we [illegible] have all inputs about [illegible]

MAR 10 '90 08:11 NRC MI [illegible] P01

New London Day March 2, 90

Generator problems won't close Millstone 2

By ROBERT A. HAMILTON
Day Staff Writer

Waterford — Northeast Utilities will continue to operate the Millstone 2 nuclear plant until a refueling in September, even though one of its own engineers said it could be unsafe because of cracks in steam generator tubes.

The company also has noticed "spikes," sudden temporary surges in radiation levels in the radioactivity of secondary coolant system water, indicating a leak in the steam generator system. Company officials said, however, that problem appears to be unrelated to the tube cracks.

Steven Scace, superintendent of Millstone Station, said plans are to replace the two steam generators at Millstone 2 in 1992. Previously, the company had said only that replacement might take place sometime in the 1990s.

Scace said the company hopes to do the job in six months and still has no firm estimate of the cost.

But Kenneth Bosson, director of the Critical Mass Energy Project, an anti-nuclear research organization, said the steam generators at other plants have cost $80 million to $100 million, "and a year is a bit more standard" as opposed to six months to do the job.

Bosson called it "highly unusual" that the company made public the engineer's objections to the application to run the plant through the summer. "Usually, by the time it's public, it's a consensus decision," he said.

The engineer "had concerns that some of the assumptions that were made were not supported by enough data, and some of the engineering analyses applied on top of the data were not justified," said Jack Keenan, superintendent of Millstone 2.

Approval expected

Northeast, owner and operator of the plant, has submitted the engineer's concerns with an analysis to justify continued operation, and federal regulators are likely to approve it, said U.S. Nuclear Regulatory Commission spokesman Karl Abraham.

"We feel they have things under control," Abraham said. "It appears, after their meeting with us, that there is not going to be a need for them to shut down. But that situation could change, if the behavior of the system changes."

In the event of a tube failure, radioactive water from the primary coolant loop could contaminate the secondary coolant loop and the turbine, and a large enough failure could release radiation from the plant.

Many utilities have experienced problems with steam generators similar to the problems at Millstone 2, a pressurized water reactor manufactured by Combustion Engineering of Stamford.

In the system, a primary coolant loop routes water through the reactor, where it is heated to

See MILLSTONE *page* A8

Millstone

From A1

about 620 degrees and pressures of 2,250 pounds per square inch (PSI), and from there to a steam generator.

In the generator, high pressure heated water passes through tubes and heats water in the secondary loop, which is at 1,000 PSI. That water boils into steam that spins the turbines, while the primary water, cooled to about 550 degrees, goes back to the reactor.

Problems not new

The seawater used in the secondary loop caused problems from the start of operations. Under the extreme heat and pressure, organic matter decomposed and positively charged sodium ions and negatively charged chloride ions were released, creating pitting on the tubes.

To correct that problem the company installed a water treatment system to remove the ions, and the concentration dropped from 30 parts per billion (ppb) to 1 ppb, said Keenan.

But in doing that, the water changed from slightly acidic to slightly caustic. That set up a chemical reaction that made the tubes prone to stress corrosion cracking.

Keenan said that problem has since been solved by adding boric acid to the defonized water. In the meantime, between 6,000 and 7,000 of the 17,000 tubes have been plugged or have had sleeves installed to cover damaged areas.

Keenan said, however, that the cracks are on the circumference rather than along the lengths of the tubes. Lengthwise cracks would weaken the tubes, he said.

Keenan said burst tests show the tubes would have to be cracked 79 percent of the way through their 0.048-inch thickness before they begin to weaken, and that none of the tubes found so far have been cracked more than 50 percent of their thickness.

In the tests, the cracked tubes withstood pressures up to 11,600 pounds before they burst, and even then they burst along their lengths, rather than along the cracks, he said.

"He (the engineer) is saying there's no proof those cracks will not go beyond 79 percent. And he's right, there isn't any," Keenan said. "But the best engineering judgment" is that the cracks will not progress that far.

Leak suspected

There has been some indication of a leak between the two coolant systems already, based on radiation detected in the secondary system, which should not be contaminated.

In recent days the leaks have been no more than a gallon a day, which is normal for a pressurized water reactor, although earlier this year they measured as high as 10 to 14 gallons a day, "which indicates we're having some periodic leakage," Keenan said.

But because the leaks are not steady, he said engineers believe they are the result of leaks in the plugs in the faulty tubes, rather than cracks in the operating tubes.

Keenan said the steam generators, scheduled to be installed in 1992, will cost about $30 million, but the company is still working on a cost estimate for the entire project. Scace said it should be completed within six months.

But at Critical Mass, spokesman Dan Borson said Northeast officials estimated in an interview with Nucleonics Week last year that the total cost could exceed $150 million, not including replacement power.

Borson said a 1982 steam generator replacement at two reactos owned by Florida Power and Light took 12 months and cost $165 million. A similar project at a much smaller reactor at Southern California Edison cost $53 million and took 13 months, Borson said.

Scace pointed out that the engineer who dissented was one of several who reviewed the data and was the only one who did not agree to continued operation.

"Obviously, the ideal situation would be to have everyone in agreement," Scace said. "But I'm perfectly satisfied that ... the conclusions are the right conclusions, based on the information we have."

Millstone leakage is safe, NRC says

By Terry Sacks
Register Staff

WATERFORD — Worn tubes in a Millstone 2 nuclear plant steam generator are leaking more radioactive water, but regulators have decided to let the plant keep operating, utility and regulatory officials said Thursday.

The increased leakage detected over the past few weeks is within legal safety limits, and regulators decided last week to allow the plant to operate until its next scheduled shutdown in October, Nuclear Regulatory Commission spokesman Karl Abraham said.

Radiation monitors have detected increased radioactivity in the "secondary" side of the 15-year-old plant where steam drives turbine generators that make electricity. Such leakage is cause for concern at nuclear plants because it could lead to radioactive gasses released into the environment.

But Louis Keezing, a spokesman for Northeast Utilities, the Berlin, Conn. company that owns and operates the plant, said there's no evidence of increased leakage into the environment.

The NRC allows a leakage rate into the secondary system of one-tenth of a gallon per minute, or 144 gallons a day. The NRC's Abraham said the actual leakage from the steam generator tubes has been about half a gallon a day.

NU officials met with the NRC last week to argue for continued operation of the plant, Abraham said.

"They convinced us that if there are no abrupt changes in any of these numbers, they can go until the next scheduled shutdown," he said.

Troubled by worn steam generator tubes, Millstone 2 has plugged or repaired nearly 3,000 of the 17,000 tubes since 1977. Plant operators discovered last year that they had plugged hundreds of tubes using Westinghouse Corp. plugs that the NRC believes were defective and possibly prone to

Indeed, NU engineers suspect that a tube plug may be cracked and leaking, Keezing said. The relatively slow rate of leakage suggests that a tube itself hasn't ruptured, he said.

Problems with the steam generators prompted the plant to shut down in October for a mid-cycle inspection. The NRC's Abraham said NU had predicted, through theoretical calculations, that about 75 tubes would show signs of

Turn to Millstone, Page 44

Millstone: Plant stays in use despite radioactive leakage

Continued from Page 41

cracking. But NU actually found about 160 tubes with signs of cracking.

Keezing said engineers did pressure tests on three of the cracking tubes, which didn't fail until pressure reached more than 8,000 pounds per square inch. That was considered safe because the plant normally runs about 2,250 psi. Based on those tests, NU restarted the plant in November.

"We've had steam generator problems ever since we've had nuclear plants," said Abraham. "So we pay a lot of attention to the maintenance and quality of generators."

Keezing said NU plans to replace Millstone 2's steam generator system in 1992, at an estimated cost of about $190 million.

The worst accident involving a ruptured steam generator tube was in January 1982, at the Robert E. Ginna nuclear plant operated by the Rochester Gas and Electric Corp. in New York. A rupture of a steam generator tube resulted in "massive" amount of radiation going into the secondary side of the plant, allowing radioactive gases to leak into the environment, Abraham said. But weather conditions and snow on the ground prevented any ground contamination, he said.

"It showed that it is possible to have catastrophic failures of tubes and still not have an accident that impacts the public," he said.

RECORD OF ALLEGATION PANEL DECISIONS

SITE: Millstone Unit 2

ALLEGATION NO.: RI-90-A-0032

DATE: 3/15/90 (Mtg. (1) 2 3 4 5)

PRIORITY: High (Medium) Low

SAFETY SIGNIFICANCE: (Yes) No Unknown

CONCURRENCE TO CLOSEOUT: DD BC SC

CONFIDENTIALITY GRANTED: Yes (No)
(See Allegation Receipt Report)

IS THEIR A DOL FINDING: Yes (No)

IS CHILLING EFFECT LETTER WARRANTED: Yes No

HAS CHILLING EFFECT LETTER BEEN SENT: Yes No

HAS LICENSEE RESPONDED TO CHILLING EFFECT LETTER: Yes No

PANEL ATTENDEES:

Chairman - W. Kane

Branch Chief - E. Wenzinger

Section Chief (AOC) - D. Haverkamp

Others - C. White

P. Habighorst

B. Raymond

J. Stromsnider

A. Vegel

B. Olsen

ACTION:

1) DRS to perform inspection on MS-2 S/G Tube Leakage to verify engineering info provided to NRC was correct

2) Repanel after completion of inspection

3) AOC to contact newspaper to attempt to find source of story

4)

5)

NOTES:

H/26

MAR 20 1990 04:2... NRC MILLSTONE ... NEW LONDON ... DAY ...

...dstone problems monitored

NU says leak minor, but some not so sure

By ROBERT A. HAMILTON
Day Staff Writer

Waterford — In January, the monitor that measures atomic breakdowns in a pipe at the Millstone 2 nuclear power plant that vents radioactive gases to the air was set to trigger an alarm at 300 counts per minute.

Over the next few weeks, as the radiation count in the pipe climbed, the monitor was reset, first to 600 counts per minute, then to 900, about a week later to 1,000, and within the past three weeks to 4,000. This month, the monitor in the pipe measured more than 9,200 counts per minute, more than 25 times what would have triggered the alarm two months ago.

The counts mean there is a leak between the radioactive primary coolant water and the secondary cooling water, which powers the turbines and is supposed to re-

more than doubled the number of water and gas samples it is taking to detect problems, and has installed new monitors.

Although none of radiation releases has exceeded the plant's permit limits, some employees, and a former U.S. Nuclear Regulatory Commission official, have suggested the plant be shut down and examined to determine why the radiation counts have risen so sharply, and have been so erratic.

Northeast Utilities, which owns and operates the plant, contends it is safe to run the plant through September, when the plant is scheduled to be shut down for refueling. The NRC has agreed to allow the operation provided the problem does not grow any worse.

'Little bit of leakage'

"The reason the set point was originally at 360 was to detect any kind of leakage," said company spokesman Richard Gallagher. "Right now, we know there's a

9203310237-01

"... we had Morton Thiokol [illegible] recommending we do somethin[illegible] on the space shuttle, too, and w[illegible] required to listen to them."

plant safe, it raises the odds of a serious accident.

"A tube rupture is a loss of coolant accident, and defense in depth, the principle that is supposed to guide nuclear safety, requires that you prevent that," Pollard said. "You're increasing the likelihood that it will be more than a relatively minor economic loss."

Seawater started it

The problem started when seawater got into the secondary cooling system, setting up corrosion that caused pitting in the tubes. To fix that the company put in a purifier, but one of the results of that process is the water became caustic, which caused stress cracks. The company has for several months been adding boric acid to the cooling water to neutralize it, and it contends the cracking problem is under control. More than 6,000 tubes have already been plugged or repaired.

The company also maintains the current problem is not a cracked steam generator tube, but instead is a leaking plug, and the spikes are evidence of that. Jack Keenan, the Millstone 2 superintendent, explained that such a leak would allow primary water into a closed tube until it built up enough pressure to blow off the sludge that [illegible] around the bottom of [illegible] as the pressure is relieved [illegible] crack seals, until the pressure builds up again, he said.

[illegible] view of the company's [illegible] steam generators,

gineers
e about O rings
e weren't legally

Robert Pollard
ion of Concerned Scientists

became available last week
nts what seems to be a
problem.

dition to the rising radia-
nts, the number of cracked
as been rising, from 26 at
of the eighth fuel cycle in
er 1987 to 308 at the end of
h fuel cycle in February

the report contends the
was because of better and
rough inspections. It also
l when the company shut
a special inspection last
Its engineers said the
timate" was that 60 new
ould be found, 104 were
s well as 11 that were
er suspected cracks.

r through a tube crack or
plug, clearly there is a
ween the two systems, as
d by the radiation counts
econdary cooling system,
not supposed to be radio-

water from the primary
into the secondary loop,
t are dissolved under the
ary pressure come out of
and are siphoned off by a
air ejector that passes
radiation monitor.

mployee said most of the
nd in that air ejector are
, xenon 135, and a variant
non 135 metastable. All
es have short half-lives,
der of minutes to days. A
s the time during which
radioactive material will
decay and become safe.

At the maximum rate of 9,200 counts per minute that has been measured at the ejector, the radioactivity would be about 0.0001 microcuries per cubic centimeter, about 10 times the maximum exposure allowed for workers. But once out of the stack the radioactivity would quickly be diluted to much lower levels.

A serious situation

Clearly, the company is taking the situation seriously. One of the employees said the company has gone from one to two tests a day of air that is vented to the atmosphere, and some days as many as four samples are taken. In addition, liquid sampling in the coolant system has been tripled, to three times a day, the worker said.

Gallagher said there have also been new, sophisticated, and highly sensitive radiation monitors installed on the system. With all the extra provisions, he said, "We would see a definite trend before we would be concerned about a failure of a tube."

Employees said there are several reasons Northeast might not be shutting down, and the first is that while the steam generator replacements are on order, they are not ready. The company has scheduled replacement for 1992, which would be the first refueling outage after the generators are delivered.

Gallagher said, though, that the planned replacement could be moved up, or moved back, depending on the performance of the plant.

"That date is for planning purposes, the target date," Gallagher said. "We're not saying we're definitely going to do it then. We're going to take things as they go along, and if conditions change, our plans will change."

Employees also said the corporate image is at stake. Northeast prides itself on having one of the top performance records in the industry. But Millstone 2 is starting to slip towards average, and the company does not want it to seem the plant has slipped into mediocrity. In addition, shareholders would start to get edgy if it appeared the company's performance was slipping, the employees said.

In 1988 Millstone 2 was operating at 75.3 percent of capacity, compared with 65.1 percent for the industry; by 1989, that had slipped to 64.7 percent, compared with an industry average of 61.9 percent.

Gallagher, though, said the 1989 results were because the plant had a refueling outage early in the year, followed by a planned mid-cycle shutdown in October, that lasted more than a month, for inspection of the steam generator tubes.

Capacity factor good

"When you take those things into consideration, the capacity factor for 1989 was actually quite good," Gallagher said.

Finally, some employees have said Northeast, and the NRC, are concerned that if there are extended shutdowns at Millstone 2, following the long Connecticut Yankee shutdown, it would be used in an attempt to question the company's management practices during proceedings in the company's application to take over the bankrupt Public Service Co. of New Hampshire, including the Seabrook nuclear power plant.

But Gallagher said such speculation is meaningless, that if the company believed there was any threat to public safety, or threat of damaging the plant, it would be shut down and inspected immediately.

"The fact is, any leakage that we're seeing is well within tolerances for this plant," Gallagher said. "And in the last week, the leak has been basically one or two gallons per day. It was four to five gallons per day. So there really isn't any trend."

9203310237-02

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION I
475 ALLENDALE ROAD
KING OF PRUSSIA, PENNSYLVANIA 19406

JUL 10 1990

Docket No. 50-336

Northeast Nuclear Energy Company
ATTN: Mr. E. J. Mroczka
Senior Vice President - Nuclear
Engineering and Operations Group
P. O. Box 270
Hartford, Connecticut 06141-0270

Gentlemen:

Subject: Inspection Report No. 50-336/90-08

This letter refers to the routine inspection conducted by Mr. R. Winters and Mr. P. Habighorst of this office on April 25 - 27, 1990 at the Northeast Nuclear Energy Company office in Berlin, Connecticut and at the Millstone Unit 2 plant in Waterford, Connecticut. Mr. Winters discussed the results of the inspection with Mr. Wells in the corporate office, and Mr. Habighorst discussed the onsite portion of the inspection with Mr. Keenan of your staff at the conclusion of the inspection.

This inspection was directed at activities related to the results of the October 1989 inspection of the steam generators. Areas examined during this inspection are described in the NRC Region I Inspection Report which is enclosed with this letter.

Within the scope of this inspection, no violations were observed.

No reply to this letter is required. Your cooperation with us in this matter is appreciated.

Sincerely,

Jacque P. Durr

Jacque P. Durr, Chief
Division of Reactor Safety

Enclosure. NRC Region I Inspection Report No. 50-336/90-08

9007240134

H158

cc w/encl:
W. D. Romberg, Vice President, Nuclear Operations
S. E. Scace, Station Director, Millstone
D. O. Nordquist, Director of Quality Services
R. M. Kacich, Manager, Generation Facilities Licensing
E. A. DeBarba, Station Director, Haddam Neck
Gerald Garfield, Esquire
Public Document Room (PDR)
Local Public Document Room (LPDR)
Nuclear Safety Information Center (NSIC)
NRC Resident Inspector
State of Connecticut

bcc w/encl:
Region I Docket Room (with concurrences)
Management Assistant, DRMA (w/o encl)
R. Bellamy, DRSS
DRP Section Chief
M. Conner, SALP Reports Only
J. Shedlosky, SRI, Haddam Neck
W. Raymond, SRI, Millstone
K. Abraham, PAO (20) SALP Report and (2) All Inspection Reports
J. Caldwell, EDO
G. Vissing, PM, NRR

U.S. NUCLEAR REGULATORY COMMISSION
REGION I

Report No. 50-336/90-08

Docket No. 50-336

License No. DPR-65

Licensee: Northeast Nuc ear Energy Company
P. O. Box 270
Hartford, Connecticut

Facility Name: Millstone Nucleur Power Station - Unit 2

Inspection At: Berlin, Connecticut

Inspection Dates: April 25-27, 1990

Inspectors: _____ 6/26/90
R. W. Winters, Reactor Engineer, Materials & Processes Section, EB, DRS — date

_____ 6/26/90
A. Lohmeier, Reactor Engineer, Materials & Processes Section, EB, DRS — date

_____ 6/26/90
P. Habighorst, Resident Inspector, Millstone, DRP, Region I — date

_____ 6/26/90
E. Murphy, Senior Engineer, NRR, Materials and Chemical Engineering Branch — date

Approved by: _____ 7/2/90
J. Strosnider, Chief, Materials & Processes Section, Engineering Branch, DRS, RI — date

Inspection Summary: Announced inspection from April 25-27, 1990 (Report No. 50-336/90-08).

Areas Inspected: The result of the eddy current examination of the steam generators performed during October 1989 was inspected with emphasis on the dissenting opinion expressed by one member of the licensee's staff regarding the acceptable period of operation for the steam generators.

Results: No violations or deviations were identified. One unresolved item concerning the trending of primary-to-secondary leakage was identified.

9007240136

DETAILS

1.0 Persons Contacted

Northeast Nuclear Energy Company

* G. Alkire, Project Engineer, Piping Systems Engineering
* F. Anderson, Senior Engineer, Nuclear Materials and Chemistry
* P. Blasioli, Supervisor Nuclear Licensing
* K. Colgan, Engineer, Nuclear Materials and Chemistry
* D. Dube, Supervisor, Probabilistic Risk Analysis
* J. Ely, Supervisor, General Engineering
* J. Fackelman, Project Engineer, Nuclear Materials and Chemistry
* W. Hutchins, Millstone Unit 2, Licensing
  V. Jones, Project Engineer, Nuclear Materials and Chemistry
** J. Keenan, Superintendent, Millstone Unit 2
* M. Kupinski, Manager, Piping Systems Engineering
* R. Linthicum, Engineer, Probabilistic Risk Analysis
* R. Wells, Manager, Nuclear Materials and Chemistry

United States Nuclear Regulatory Commission

* W. Raymond, Senior Resident Inspector, Millstone

* Denotes those attending the exit meeting in the Corporate Office.
** Denotes those attending the exit meeting at the site

The inspectors also contacted other administrative and technical personnel during the inspection.

2.0 Followup of Structural Integrity Action Plan

Scope

The scope of this portion of the inspection was to review licensee actions taken as a result of the October 1989 steam generator eddy current testing at Millstone Unit 2 with emphasis on the licensee's action plan for evaluation of the steam generator tube structural integrity. The results of the October 1989 inspection and the status of the licensee's tube integrity evaluation were previously discussed at a meeting with NRC on February 22, 1990. At this meeting the licensee committed to perform additional testing and analysis of the cracked tubes removed from the steam generators during the October 1989 inspection. Also, as a result of newspaper articles reporting a differing opinion by an individual in the licensee organization, this inspection reviewed comments of this individual and the responses made by the licensee to determine if the individual's concerns were adequately addressed.

2.1 Tube Evaluation

The licensee has performed an evaluation of the 86 crack profiles of tubes found during the October 1989 inspection using the ASME Code, Section III, Appendix F acceptance criteria. The results of this evaluation were that 85 tubes met these requirements and one tube (L45R13) did not after the 170 effective full power days (EFPD) of operation prior to the October 1989 inspection.

Independent review by a licensee consultant of these 86 tubes using different analytic techniques identified the same tube as not meeting Regulatory Guide 1.121 safety margins after the 170 EFPD of operations.

The calculated factor of safety for low probability, postulated accident conditions (faulted conditions) did not satisfy the R.G. 1.121 criteria. Margin still existed against tube rupture under normal operating conditions.

Burst Testing

Burst testing of tube samples was performed by the licensee to ascertain the validity of the analytic methods used in predicting failure of tubes with varying crack geometries. Six tube samples containing manufactured flaws simulating actual crack geometries were pressure tested. Two tube specimens removed from the steam generator were also pressure tested. Based on these tests the licensee concluded that the analytical model was conservative.

3-Dimensional Finite Element Analysis of Tube L45R13

The analytical models used in the above tube evaluation did not explicitly consider crack ligament strengthening effects and tubesheet constraint. A 3-D finite element analysis of the L45R13 was performed to assess the effects. The results indicated that the above analytical models were conservative, but not over conservative.

2.2 Tube Life Calculations

The licensee has concluded that in the absence of an initiating event (main steam line break or main feedwater break) any tubes that fail will exhibit leak-before-break behavior. Under these circumstances, the licensee has concluded the existing leak detection systems will be adequate to allow corrective action before a tube rupture. However, based on the eddy current examination performed in October 1989, calculations show that after 170 EFPD there is a significant probability that stress in at least one tube could exceed the allowable level as required by Regulatory Guide 1.121 or ASME, Section III, Appendix F for faulted conditions. An independent analysis by a licensee contractor indicated that the 170 EFPD was a conservative estimate of the time at which a tube would reach an unacceptable stress level.

A probabilistic assessment was made by the licensee's Probabilistic Risk Assessment Organization on the basis of either 45 or 100 tubes susceptible to crack formation and propagation. The licensee estimated the probability of one or more tubes exceeding a stress of 83,800 psi (the stress causing rupture during a initiating event) for rupture ranges from 0.17 in March 1990 to 0.91 in September 1990 for the assumption of 45 tubes and ranges from 0.34 to 1.0 over the same period for the assumption of 100 tubes. At the same time, however, the probability of an initiating event (e.g. steam line break) was estimated as being of a much lower order of magnitude. The combination of probability of tube rupture due to an initiating event was assessed in a licensee probabilistic analysis which indicated approximately a probability of 0.013 (between March and September 1990) for all cases of susceptible tubes (45 or 100). Therefore, the licensee concluded that the probability of the tube rupture event combined with an event such as a steam line break is of such low magnitude as to justify continued operation through September.

It should be recognized that this finding was tempered somewhat by the belief that tube rupture in the absence of an initiating event will be prevented by detection of a leak before break.

2.3 Concerns Expressed by Individual With Dissenting Opinion

The following is a listing of concerns developed by a licensee engineer regarding the length of time for which the steam generators should be operated and the findings of the NRC inspector regarding these concerns.

Concern 1

"Since the October 1989 in-cycle inspection was the first time 100 percent UT sampling was performed of cracked tubes, the conclusion drawn in the first paragraph of page 6 (of the safety analysis) regarding the time dependency of depth of cracking is not technically supported. Currently applied techniques would indicate operation should be limited to less than 130 effective full power days (EFPD)."

Inspectors Observations

The inspectors discussed this concern with the individual. The individual stated that based on further testing and calculations subsequent to his original letter a revised estimate of the time for a projected tube to develop defects similar to the worst case found during the October 1989 inspection was 170 EFPD.

Concern 2

"Traditional best estimate projections have underestimated the cracking problem as compared to the actual repair scope. The basis of 45 tubes should reflect historical cracking trends. This number should be around 100 to realistically determine a probability of a tube exceeding Regulatory Guide 1.121 requirements."

Inspectors Observations

The inspectors discussed this concern with the individual. The individual is satisfied that Probabilistic Risk Analysis (PRA) performed by the licensee's PRA Department accounts for uncertainty in the number of tubes which may develop significant cracking.

Concern 3

""Equivalent" depth should read "average" depth since time did not permit a calculation of all 85 crack profiles to determine "equivalent" crack depths. Based on a sampling of worst tubes the "equivalent" depth was on the order of 83 percent as compared to an average depth of 20 - 30 percent for the same crack and would result in a major change to the probabilistic model used in the safety assessment. The practice of using average depth as an indicator of tube acceptability is good for uniformly degraded tubes (uniform depth, 360° circumferential extent); however, it is an extremely poor method to assess tubes what challenge stability."

Inspectors Observations

The inspectors discussed this concern with the individual. The individual was satisfied with recalculations that were performed using the "equivalent" depth that included a bending component in the calculations. These calculations considered the basis of the actual geometry of the tube defects.

Concern 4

"The existing safety assessment assumes additional margins exist to rupture, based on data that is pressure based only. Potential external loads as a result of tube bowing, tube lockup (from denting), secondary internals loading during accident conditions, etc., have not been considered. An evaluation of these loads by Combustion Engineering for Millstone Unit No. 2 steam generators present conditions needs to be performed before we try to strip our analysis of any potential conservatisms."

Inspectors Observations

The inspectors discussed this concern with the individual. The individual is satisfied that a 650 psi pressure load adjustment has been retained in the analysis to account for these external loading effects. This value is an estimate but calculations by Combustion Engineering determined that this value is conservative.

Concern 5

"The limit load analysis performed for the most complex flaws is in a preliminary status with no independent review and approval being accomplished and forms a weak basis for subsequent safety assessment assumptions. Also, this analysis did not include Northeast Utilities (NU's) standard practice of including NDE error in the analysis (a practice Regulatory Guide 1.121 also requests) or Section XI equivalent flaw length to depth criteria for multiple flaws."

Inspectors Observations

The inspectors discussed this concern with the individual and determined that the individual accepts that the limit load calculations have now been completed, reviewed and approved in accordance with the licensee's procedures. The interpretation of the analysis results has been upgraded to reflect additional test results, revised interpretation of flaw geometry, and improved analytic methods provided by the independent contractor.

The individual has accepted the omission of inspection tolerance in the limit analysis because good correlation was found between the ultrasonic testing measurement and actual test values.

Concern 6

"NU has not performed a detailed Regulatory Guide 1.121 analysis for these tubes to date due to time constraints. Preliminary results identify that at least seven tubes will not meet this criteria."

Inspectors Observations

The inspectors discussed this concern with the individual and determined that the individual agreed that Regulatory Guide 1.121 analysis had been performed in full by the time of this inspection. In the revised analysis in accordance with the Regulatory Guide 1.121 it was found that one tube did not meet the regulatory guidelines after 170 EFPD.

Concern 7

"The present safety assessment identified a safety factor of 1.52, for tube L62/R22, between room temperature burst test information and the preliminary analytical results. Regulatory Guide 1.121 requires the burst strength be determined experimentally at operating temperature. Margins may not be present.

Evaluation of end of cycle (EOC) 8 pulled tube L25/R19, which leaked at 0.1 gpm in service shows zero margin between the analytical model and actual rupture point.

Inspectors Observations

The inspectors discussed this concern with the individual and determined that the individual believes it is acceptable to use room temperature test for determining rupture properties at operating temperatures because there are only small differences between the properties at these temperatures.

More recent testing has shown safety factors greater than 1.24 between burst test results and analytical predictions, compared to the 1.52 margin from initial testing.

Regarding tube L25 R19, the crack may have exhibited further growth after it was plugged, but prior to its being removed from the field. The individual does not consider the size of the crack to have direct implications for the current operating cycle.

Concern 8

"The minimum calculated wall thickness of 77% was based on a flow stress of 69,000 psi. This flow stress was assumed to be conservative since this was considered to be a code based (3 Sm) number. A detailed review of Millstone Unit No. 2 certified material test reports identified that twenty-nine heats have flow stresses below this value. The minimum flow stress is 65,000 psi and results in a minimum wall thickness of 75%. This minimum wall thickness was not being utilized in the safety assessment submitted to the NRC prior to the February 22, 1990 meeting. The number determines a statistical interval used to arrive at the current safety assessment's conclusion."

Inspectors Observations

The inspectors discussed this concern with the individual and determined that the individual based his question regarding the results of analysis and testing on information available at the time of his question. Since that time however, new considerations and additional tests, analyses, and evaluations, have resulted in a somewhat different safety assessment with which he agrees.

Concern 9

"A review of tubes with uniform through wall cracks over 360° of the circumference was performed with a comparison to the 77 percent acceptance criteria. This review was not performed for the new 75 percent acceptance criteria due to time constraints."

Inspectors Observations

The inspectors discussed this concern with the individual and determined that the individual agrees with the method presently in use that includes provision for including total stress (with bending).

Concern 10

"EOC 8 leaking tube L25R19 exhibited a circumferentially predominate degraded region of 190° which resulted in a through wall crack of 35° and a leak of 0.1 gpm under normal operating conditions. The tubes presently being evaluated have regions greater than 190° and are UT determined to be 80% through wall. Longer term operation of tubes similar to these could provide for through wall cracks greater than 0.1 gpm at normal operating conditions.

Inspector Observations

The inspectors discussed this concern with the individual and determined that the individual agrees that as a result of the testing and evaluations the plant can operate for 170 EFPD before reducing the safety margin below Regulatory Guide and ASME limits.

2.4 Conclusions

Based on discussions with the individual who had expressed concerns about the length of time the steam generators should be operated, the inspectors concluded he now believes his concerns have been fully addressed and given due consideration by his management. Based on discussions with the engineer having the dissenting opinion and after reviewing the results of the investigations made by the licensee as a result of this dissenting opinion the inspectors concluded that the 10 concerns had been adequately addressed.

The licensee has performed a probabilistic assessment of tube rupture under faulted conditions in justification of operation through the end of the fuel cycle. Included in their assessment is the assumption that a leaking tube can be identified during normal operation. On the basis of the calculations and testing performed on tubes removed from the steam generators, the licensee stated that the conclusions expressed in the February 22, 1990 meeting are still valid and operation to the end of cycle 10 is justified.

3.0 Primary-to-Secondary Leakage Monitoring

Scope

A review of available licensee radiation monitoring and radiochemistry sampling process to detect primary-to-secondary leakage was performed to assess the adequacy of the licensee's program. Specifically, the inspector reviewed detection methods, procedures, administrative controls, and operator actions in response to applicable control room alarms, radiochemistry results, and licensee management awareness to the leakage program.

3.1 Detection Methods

The radiation monitoring instruments used at Millstone 2 to detect leakage from the primary-to-secondary are: (1) steam jet air ejector radiation monitor (RM-5099); (2) steam generator blowdown radiation monitor (RM-4262) (3) N-16 radiation monitors; (4) main steam line radiation monitors (RM-4299 A,B,C) and (5) alternate steam jet air ejector monitor. The radiochemistry analysis includes steam generator blowdown grab samples, secondary tritium calculations, and steam jet air ejector grab samples.

The steam jet air ejector radiation monitor (RM-5099) is located at the 14'6" elevation of the turbine building. The monitor's required operability is based on technical specification (TS) 3.3.3.9. The design basis is to monitor noble gas activity in the condenser air removal system and to provide a control logic signal to close the steam generator blowdown valves to terminate discharge of blowdown to the circulating water canal. The control logic signal is to prevent 10 CFR 20 radioactivity limits from being exceeded to unrestricted areas. The licensee considers RM-5099 to be one of the first monitors to sense primary-to-secondary leakage.

The steam generator blowdown radiation monitor (RM-4262) is located on the 14'6" elevation of the auxiliary building. RM-4262 monitors a combined blowdown activity from both steam generators. The monitors operability is based in TS 3.3.3.9. The design basis is similar to RM-5099, except for the monitored location point. The licensee's radiological assessment branch review of RM-4262 indicates it is not a sensitive indication of primary-to-secondary leakage based on industry experience. Specifically, in actual past industry tube rupture events it often took up to 30 minutes for activities in the steam generator water to buildup to cause a monitor alarm.

The N-16 monitors are located on each main steam line on the 38'6" elevation of the turbine building. The monitors were installed in July, 1989 under licensee inservice test T89-019. The licensee determined within the inservice test no unreviewed safety question per 10 CFR 50.59 existed. This monitor was installed as an independent action by the licensee and is not a regulatory requirement. Therefore, it is not required to be operable nor is it identified in the Final Safety Analysis Report. The monitors detect the presence of gamma radiation in the main steam lines. The digital leak rate calculations are based on high energy gamma radiation from the radioactive decay of Nitrogen-16 and the total counts per second readout display the detected low energy gamma. The monitors detect the presence of a steam generator leak, and identify the affected steam generator unlike RM-5099 and RM-4262 that do not isolate the source of the leakage.

The main steam line radiation monitors (RM-4299 A,B,C) are located in the 38'6" east and west penetration rooms. The monitors are located on the main steam lines to detect primary-to-secondary leakage and quantify a postulated post accident release thru the main steam line safety valves and atmospheric dump valves. The operability of the monitors is prescribed in TS 3.3.3.6 and NRC Regulatory Guide 1.97.

The alternate steam jet air ejector monitor was installed on April 12, 1990 under authorized work order M2-90-03698. The monitor is located upstream of RM-5099, at the 14'6" elevation of the turbine building. The monitor's primary function is a backup and verification of monitor RM-5099. No design basis or requirements exist for the alternate steam jet air ejector monitor.

The radiochemistry input into detection of activity in the steam generators is in part required by the technical specifications and further amplified by procedures and licensee administrative guidance. TS surveillance requirement 4.7.1.4 specifies the time interval for gross activity and dose equivalent iodine in the steam generators, and TS 4.11.1.1, radioactive liquid samples levels not to exceed 10 CFR 20 Appendix B, Table II, Column 2 for release from the site.

Procedurally, per SP-2833, "Secondary Coolant Analysis for Total Activity", the licensee samples steam generator blowdown grab samples and air ejector grab samples daily, and upon a RM-5099 or RM-4262 alarmed condition. In addition, the frequency is increased based on a calculated primary-to-secondary leakage. (i.e. SJAE grab samples three times per day when leakage exceeds .05 gallons per minute).

The leakage rate calculations are based on three methods identified in licensee procedure CP-2806Y. The calculation methods are based on Electric Power Research Institute (EPRI) NP-5960-SR "Primary Water Chemistry Guidelines." The methods implemented by the licensee consist of a tritium balance, air ejector gas method, and soluble liquid nuclei determination of steam generator leakage. The licensee employs the tritium analysis as a confirmation and backup to the air ejector gas method for leakage rate determinations. The air ejector gas method is the primary method implemented by the licensee. This method provides a rapid response to leak rate changes, however, the detection sensitivity is significantly less than the tritium samples, based on detectability of liquid scintillation vice the gamma spectrometry. The disadvantage of the tritium method is a relatively slow response in analysis acquisition and determination of time constant.

The licensee calculates, as a minimum, a daily leak rate calculation using the air ejector gas method.

3.2 Procedures and Administrative Controls

The inspector reviewed licensee's procedures and actions for a primary-to-secondary leak to assess the adequacy of required actions at the facility. Procedures reviewed are listed below:

-- OP 2260 "Millstone 2 Emergency Operating Procedure (EOP) Users Guideline."

-- AOP 2569 "SG Tube Leak"

-- EOP 2534 "SG Tube Rupture"

-- SP 2833 "Secondary Analysis for Total Gamma Activity"

-- CP 2806Y "Calculating Primary to Secondary Leak Rates"

-- OP 2316A Section 6.15 "Main Steam System"

-- Plant Operations Night Order 7/14/89-1

-- OP 2383A "Process Radiation Monitors Operation"

Inspector review identified adequate required operator response to alarms for the diagnostics of a primary-to-secondary leak, increased radiochemistry sampling in response to increases in leakage, and the licensee's process to evaluate radiochemistry data. In AOP 2569, the decision to continue plant operation with a known leakage resides with plant management, and if technical specifications for leak or SG activity are exceeded, a required shutdown of the plant is reinforced by procedure and in accordance with the applicable action statement.

The present licensee procedures do not provide trending of leakage rates to take plant operational action prior to exceeding required TS limits or onset of a postulated steam generator tube rupture. The above enhancement program was addressed for information to Millstone 2 via NRC Bulletin 88-02 dated February 5, 1988. The inspector considers this issue open (90-08-01) and will follow licensee actions to this regard in future inspections.

3.3 Operator Actions to Applicable Radiation Monitor Alarms and Radiochemistry Results

Inspector observations of control room activities noted that, once RM-5099 or RM-4299 alarms and isolates the steam generator blowdown, control room operators request a chemistry department sample of either the steam jet air ejector or blowdown. The control room logs document the time of the alarm, automatic action, chemistry radioactivity samples, and N-16 radiation monitor readings. The above actions are in accordance with procedure OP 2316A and plant operations night order 7/14/89-1.

Control room alarms available to provide indication of a primary-to-secondary leak are: "Main Steam Line High Radiation/Instrument Failure," Process Monitor Radiation High and local alarms at the RM-4262, RM-5099, and the N-16 monitors.

3.4 Licensee Management Awareness

Inspector observation at licensee daily work planning meetings indicates heightened awareness of leak rate calculations on a daily basis, and control room operators are cognizant of current leakage values. Utility management actions pursuant to current leakage rates include (1) implementation of alternate air ejector monitor (2) confirmation of leakage rates by tritium analysis and predictions (3) ratios of noble gas half-lifes to determine an approximate time delay between primary and secondary systems, and (4) evaluation of air ejector radiation "spikes".

3.5 Conclusions

No deficiencies were observed in the licensee's primary-to-secondary leak rate monitoring program. The program includes monitoring capabilities not required in TS or other regulatory requirements and additional sampling actions by the chemistry department (i.e. tritium predictive analysis).

4.0 Water Chemistry

Millstone Unit 2 receives makeup water from the New London, Connecticut city water supply. This water is suitable for human consumption but contains impurities detrimental to the operation of the steam generators. The licensee treats the city water by filtering and ion exchange to remove most of the impurities. The next step is to use reverse osmosis to remove organic materials peculiar to the area, then another ion exchange for final treatment. The treated water is then stored in a stainless steel tank for later use. Makeup water is fed into the secondary system through the 'A' hot well of the main turbine condenser as needed to replace blowdown losses. This serves to remove any dissolved oxygen or other noncondensible gases through the steam jet air ejectors.

From the condenser hot wells the flow is through the condensate pumps, polishers, feedwater heaters, feedwater pumps, to the steam generators, as steam to the turbine and back to the condensers. In line chemical monitoring is done before and after the condensate pumps, and on the steam generator blowdown. Radiation detectors to monitor for steam generator tube leaks are at the steam jet air ejectors, and on the steam generator blowdown lines. In addition there is an N_{16} radiation monitor located in the main steam line between the steam generator and the turbine. Water flow through this system is on the order of 18,000 gallons per minute.

Chemical additions of ammonia and hydrazine are made downstream of the condensate polishers to adjust the pH and control oxygen respectively. These additions are made by continuous, automatic injection of solutions to the main flow. A boric acid solution is also injected downstream of the polishers by manual control of the injection pump. The boric acid is added to the secondary water in an attempt to eliminate the cracking the steam generator tubes have experienced at the top of the tubesheet.

During transients, the water chemistry undergoes changes. During these transients, special attention is required to maintain the chemistry at appropriate levels.

Conclusions

The licensee has developed an excellent system for the control of water chemistry. Purity is approaching the current technological limit of the ability to measure the impurities present.

5.0 Unresolved Items

Unresolved items are matters about which more information is required in order to ascertain whether they are acceptable items or violations. Unresolved items are discussed in paragraph 3.0.

6.0 Management Meetings

Licensee management was informed of the scope and purpose of the inspection at the entrance interview on April 25, 1990. The findings of the inspection were discussed with licensee representatives during the course of the inspection and presented to licensee management at the April 27, 1990 exit interviews (see paragraph 1 for attendees).

At no time during the inspection was written material provided to the licensee by the inspector. The licensee did not indicate that proprietary information was involved within the scope of this inspection.