August 13, 1998

Mr. Roger O. Anderson, Director
Nuclear Energy Engineering
Northern States Power Company
414 Nicollet Mall
Minneapolis, Minnesota 55401

SUBJECT: PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2 - ISSUANCE OF AMENDMENTS RE: EF* STEAM GENERATOR ALTERNATE REPAIR CRITERIA (TAC NOS. M96654 AND M96655)

Dear Mr. Anderson:

The Commission has issued the enclosed Amendment No. 137 to Facility Operating License No. DPR-42 and Amendment No. 128 to Facility Operating License No. DPR-60 for the Prairie Island Nuclear Generating Plant, Units 1 and 2, respectively. The amendments consist of changes to the Technical Specifications in response to your application dated September 24, 1996, as supplemented October 17, 1996, January 3, January 20, and November 10, 1997, and January 9, June 8, 1998 and July 20, 1998.

The amendments revise the Technical Specifications (TSs) for the Prairie Island Nuclear Generating Plant Units 1 and 2 to allow use of an alternate steam generator tube repair criteria (elevated F-star or EF*) in the tubesheet region when used with the repair method of additional roll expansion. The amendments incorporate revised acceptance criteria for tubes with degradation in the tubesheet region and will enable Northern States to avoid unnecessary plugging and sleeving of steam generator tubes.

A copy of our related Safety Evaluation is also enclosed. The notice of issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,

ORIGINAL SIGNED BY:
Tae J. Kim, Senior Project Manager
Project Directorate III-1
Division of Reactor Projects - III/IV
Office of Nuclear Reactor Regulation

Docket Nos. 50-282 and 50-306

Enclosures:
1. Amendment No. 137 to DPR-42
2. Amendment No. 128 to DPR-60
3. Safety Evaluation

cc w/encl: See next page

DISTRIBUTION: See attached page

DOCUMENT NAME: G:\WPDOCS\PRAIRIE\PI96654.AMD *No major changes to SE

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DATE	7/30/98		8/12/98		7/30/98		7/1/98		8/7/98		8/13/98	

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Mr. Roger O. Anderson, Director
Northern States Power Company

Prairie Island Nuclear Generating Plant

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Tribal Council
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DATED: August 13, 1998

AMENDMENT NO. 137 TO FACILITY OPERATING LICENSE NO. DPR-42-PRAIRIE ISLAND UNIT 1
AMENDMENT NO. 128 TO FACILITY OPERATING LICENSE NO. DPR-60-PRAIRIE ISLAND UNIT 2

Docket File (50-282, 50-306)
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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

NORTHERN STATES POWER COMPANY

DOCKET NO. 50-282

PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNIT 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 137
License No. DPR-42

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Northern States Power Company (the licensee) dated September 24, 1996, as supplemented October 17, 1996, January 3, January 20, and November 10, 1997, and January 9, June 8, and July 20, 1998, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. DPR-42 is hereby amended to read as follows:

Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 137 , are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of the date of issuance, with full implementation within 30 days.

FOR THE NUCLEAR REGULATORY COMMISSION

Tae Kim, Senior Project Manager
Project Directorate III-1
Division of Reactor Projects - III/IV
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical Specifications

Date of Issuance: August 13, 1998

ATTACHMENT TO LICENSE AMENDMENT NO. 137

FACILITY OPERATING LICENSE NO. DPR-42

DOCKET NO. 50-282

Revise Appendix A Technical Specifications by removing the pages identified below and inserting the attached pages. The revised pages are identified by amendment number and contain vertical lines indicating the area of change.

REMOVE	INSERT
TS.4.12-2	TS.4.12-2
TS.4.12-4	TS.4.12-4
TS.4.12-5	TS.4.12-5
TS.4.12-6	TS.4.12-6
TS.4.12-7	TS.4.12-7
Table TS.4.12-1	Table TS.4.12-1
B.4.12-2	B.4.12-2
B.4.12-3	B.4.12-3

2. The first sample of tubes selected for each in-service inspection (subsequent to the preservice inspection) of each steam generator shall include:

   (a) All tubes that previously had detectable wall penetrations (>20%) that have not been plugged or sleeve repaired in the affected area.

   (b) Tubes in those areas where experience has indicated potential problems.

   (c) A tube inspection (pursuant to Specification 4.12.D.1.(h)) shall be performed on each selected tube. If any selected tube does not permit the passage of the eddy current probe for a tube inspection, this shall be recorded and an adjacent tube shall be selected and subjected to a tube inspection.

3. In addition to the sample required in Specification 4.12.B.2.a through c, all tubes which have had the F* or EF* criteria applied will be inspected in the F* and EF* regions of the roll expanded region. The region of these tubes below the F* and EF* regions may be excluded from the requirements of 4.12.B.2.a.

4. The tubes selected as the second and third samples (if required by Tables TS.4.12-1 or TS.4.12-2) during each inservice inspection may be subjected to a partial tube or sleeve inspection provided:

   (a) The tubes selected for these samples include the tubes from those areas of the tube sheet array where tubes with imperfections were previously found.

   (b) The inspections include those portions of the tubes or sleeves where imperfections were previously found.

The results of each sample inspection shall be classified into one of the following three categories:

Category	Inspection Results
C-1	Less than 5% of the total tubes inspected are degraded tubes and none of the inspected tubes are defective.
C-2	One or more tubes, but not more than 1% of the total tubes inspected are defective, or between 5% and 10% of the total tubes inspected are degraded tubes.
C-3	More than 10% of the total tubes inspected are degraded tubes or more than 1% of the inspected tubes are defective.

Note: In all inspections, previously degraded tubes must exhibit significant (>10%) further wall penetrations to be included in the above percentage calculations.

D. Acceptance Criteria

1. As used in this Specification:

(a) Imperfection means an exception to the dimensions, finish or contour of a tube from that required by fabrication drawings or specifications. Eddy-current testing indications below 20% of the nominal tube wall thickness, if detectable, may be considered as imperfections.

(b) Degradation means a service-induced cracking, wastage, wear or general corrosion occurring on either inside or outside of a tube.

(c) Degraded Tube means a tube containing imperfections $\geq$20% of the nominal wall thickness caused by degradation.

(d) % Degradation means the percentage of the tube wall thickness affected or removed by degradation.

(e) Defect means an imperfection of such severity that it exceeds the repair limit. A tube containing a defect is defective.

(f) Repair Limit means the imperfection depth at or beyond which the tube shall be removed from service by plugging or repaired by sleeving because it may become unserviceable prior to the next inspection and is equal to 50% of the nominal tube wall thickness. If significant general tube thinning occurs, this criteria will be reduced to 40% wall penetration. This definition does not apply to the portion of the tube in the tubesheet below the F* or EF* distance provided the tube is not degraded (i.e., no indications of cracks) within the F* or EF* distance for F* or EF* tubes. The repair limit for the pressure boundary region of any sleeve is 31% of the nominal sleeve wall thickness. This definition does not apply to tube support plate intersections for which the voltage-based repair criteria are being applied. Refer to Specification 4.12.D.4 for the repair limit applicable to these intersections.

(g) Unserviceable describes the condition of a tube if it leaks or contains a defect large enough to affect its structural integrity in the event of an Operating Basis Earthquake, a loss-of-coolant accident, or a steam line or feedwater line break.

(h) Tube Inspection means an inspection of the steam generator tube from the point of entry (hot leg side) completely around the U-bend to the top support of the cold leg.

(i) Sleeving is the repair of degraded tube regions using a new Alloy 690 tubing sleeve inserted inside the parent tube and sealed at each end by welding or by replacing the lower weld in a full depth tubesheet sleeve with a hard rolled joint. The new sleeve becomes the pressure boundary spanning the original degraded tube region.

(j) F* Distance is the distance from the bottom of the hardroll transition toward the bottom of the tubesheet that has been conservatively determined to be 1.07 inches (not including eddy current uncertainty). The F* distance applies to roll expanded regions below the midplane of the tubesheet.

(k) F* Tube is a tube with degradation, below the F* distance, equal to or greater than 40%, and not degraded (i.e., no indications of cracking) within the F* distance.

(l) EF* Distance is the distance from the bottom of the upper hardroll transition toward the bottom of the tubesheet that has been conservatively determined to be 1.62 inches (not including eddy current uncertainty). EF* distance applies to roll expanded regions when the top of the additional roll expansion is 2.0 inches or greater down from the top of the tubesheet.

(m) EF* Tube is a tube with degradation, below the EF* distance, equal to or greater than 40%, and not degraded (i.e., no indications of cracking) within the EF* distance.

2. The steam generator shall be determined OPERABLE after completing the corresponding actions (plug or repair by sleeving all tubes exceeding the repair limit and all tubes containing through-wall cracks or classify as F* or EF* tubes) required by Tables TS.4.12-1 and TS.4.12-2.

3. Tube repair, after October 1, 1997, using Combustion Engineering welded sleeves shall be in accordance with the methods described in the following:

CEN-629-P, Revision 2, "Repair of Westinghouse Series 44 and 51 Steam Generator Tubes Using Leak Tight Sleeves";

CEN-629-P, Addendum 1, Revision 1, "Repair of Westinghouse Series 44 and 51 Steam Generator Tubes Using Leak Tight Sleeves"

4. Tube Support Plate Repair Limit is used for the disposition of a steam generator tube for continued service that is experiencing predominantly axially oriented outside diameter stress corrosion cracking confined within the thickness of the tube support plates. At tube support plate intersections, the repair limit is based on maintaining steam generator serviceability as described below:

a. Steam generator tubes, whose degradation is attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with bobbin voltages less than or equal to 2.0 volts will be allowed to remain in service.

b. Steam generator tubes, whose degradation is attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with a bobbin voltage greater than 2.0 volts, will be repaired or plugged, except as noted in Specification 4.12.D.4.c below.

c. Steam generator tubes, with indications of potential degradation attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with a bobbin voltage greater than 2.0 volts but less than or equal to the upper voltage repair limit, may remain in service if a rotating pancake coil (or comparable examination technique) inspection does not detect degradation. Steam generator tubes, with indications of outside diameter stress corrosion cracking degradation with a bobbin voltage greater than the upper voltage repair limit will be plugged or repaired.

d. If an unscheduled mid-cycle inspection is performed, the following mid-cycle repair limits apply instead of the limits in Specifications 4.12.D.4.a, b and c. The mid-cycle repair limits are determined from the following equations:

$$V_{MURL} = \frac{V_{SL}}{1.0 + NDE + Gr\left(\frac{CL - \Delta t}{CL}\right)}$$

$$V_{MLRL} = V_{MURL} - (V_{URL} - 2.0)\left(\frac{CL - \Delta t}{CL}\right)$$

where:

V_{URL} = upper voltage repair limit

V_{LRL} = lower voltage repair limit

V_{MURL} = mid-cycle upper voltage repair limit based on time into cycle

V_{MLRL} = mid-cycle lower voltage repair limit based on V_{MURL} and time into cycle

Δ_t = length of time since last scheduled inspection during which V_{URL} and V_{LRL} were implemented

CL = cycle length (time between two scheduled steam generator inspections)

V_{SL} = structural limit voltage

Gr = average growth rate per cycle length

NDE = 95 percent cumulative probability allowance for nondestructive examination uncertainty (i.e., a value of 20 percent has been approved by the NRC)

Implementation of these mid-cycle repair limits should follow the same approach as described in Specifications 4.12.D.4.a, b and c.

Note: The upper voltage repair limit is calculated according to the methodology in Generic Letter 95-05 as supplemented.

E. Reports

1. Following each in-service inspection of steam generator tubes, if there are any tubes requiring plugging or sleeving, the number of tubes plugged or sleeved in each steam generator shall be reported to the Commission within 15 days.

2. The results of steam generator tube inservice inspections shall be included with the summary reports of ASME Code Section XI inspections submitted within 90 days of the end of each refueling outage. Results of steam generator tube inservice inspections not associated with a refueling outage shall be submitted within 90 days of the completion of the inspection. These reports shall include: (1) number and extent of tubes inspected, (2) location and percent of wall-thickness penetration for each indication of an imperfection and (3) identification of tubes plugged or sleeved.

3. Results of steam generator tube inspections which fall into Category C-3 require notification to the Commission prior to resumption of plant operation, and reporting as a special report to the Commission within 30 days. This special report shall provide a description of investigations conducted to determine cause of the tube degradation and corrective measures taken to prevent recurrence.

4. The results of inspections performed under Specification 4.12.B for all tubes that have defects below the F* or EF* distance, and were not plugged, shall be reported to the Commission within 15 days following the inspection. The report shall include:

   a. Identification of F* and EF* tubes, and

   b. Location and extent of degradation.

5. For implementation of the voltage-based repair criteria to tube support plate intersections, notify the NRC staff prior to returning the steam generators to service should any of the following conditions arise:

   a. If estimated leakage based on the projected end-of-cycle (or if not practical, using the actual measured end-of-cycle) voltage distribution exceeds the leak limit (determined from the licensing basis dose calculation for the postulated main steamline break) for the next operating cycle.

   b. If circumferential crack-like indications are detected at the tube support plate intersections.

   c. If indications are identified that extend beyond the confines of the tube support plate.

   d. If indications are identified at the tube support plate elevations that are attributable to primary water stress corrosion cracking.

   e. If the calculated conditional burst probability based on the projected end-of-cycle (or if not practical, using the actual measured end-of-cycle) voltage distribution exceeds 1×10^{-2}, notify the NRC and provide an assessment of the safety significance of the occurrence.

TABLE TS.4.12-1

STEAM GENERATOR TUBE INSPECTION

1ST SAMPLE INSPECTION			2ND SAMPLE INSPECTION		3RD SAMPLE INSPECTION	
Sample Size	Result	Action Required	Result	Action Required	Result	Action Required
A minimum of S Tubes per S.G.	C-1	None	N/A	N/A	N/A	N/A
	C-2	Repair defective tubes and inspect additional 2S tubes in this S.G.	C-1	None	N/A	N/A
			C-2	Repair defective tubes and inspect additional 4S tubes in this S.G.	C-1	None
					C-2	Repair defective tubes
					C-3	Perform action for C-3 result of first sample
			C-3	Perform action for C-3 result of first sample	N/A	N/A
	C-3	Inspect all tubes in this S.G., Repair defective tubes and inspect 2S tubes in each other S.G. Prompt notification to NRC.	All other S.G.s are C-1	None	N/A	N/A
			Some S.G.s C-2 but no additional S.G. are C-3	Perform action for C-2 result of second sample	N/A	N/A
			Additional S.G. is C-3	Inspect all tubes in each S.G. and repair defective tubes. Prompt notification to NRC.	N/A	N/A

S=3%: When two steam generators are inspected during that outage.
S=6%: When one steam generator is inspected during that outage.

4.12 STEAM GENERATOR TUBE SURVEILLANCE

Bases continued

0.025 inches will have adequate margins of safety against failure due to loads imposed by normal plant operation and design basis accidents (Reference 1). Steam generator tube inspections of operating plants have demonstrated the capability to reliably detect wastage type defects that have penetrated 20% of the original 0.050-inch wall thickness (Reference 2).

Plugging or sleeving is not required for tubes meeting the F* or EF* criteria. Due to the variable effect of tubesheet bow with elevation, the F* criterion applies only below the tubesheet centerline and the EF* criterion is applied no higher than two inches down from the top of the tubesheet.

The F* and EF* distances will be controlled by a combination of eddy current inspection and/or process control. For a new additional roll expansion, the requirement will be at least 1.2 (1.8 inches for EF*) inches of new hard roll. This is controlled by the 1.25 inch (two inches for EF*) effective length of the rollers. The distance from the original roll transition zone is also controlled by the process in that the lower end of the new roll expansion is located one inch or greater above the original roll expansion. In the case of the new roll, eddy current examination will confirm there are no indications in the new roll region and that there is a new roll region with well defined upper and lower expansion transitions.

When eddy current examination, alone, must determine the F* or EF* distance, such as in the existing hard roll region, or when multiple lengths of additional hard rolls have been added, the eddy current uncertainty is qualified by testing against known standards. That value is expected to be 0.18 inches. Therefore, the F* distance measured by eddy current (sum of 1.07 and 0.18) will be conservatively set at 1.3 inches. The EF* distance measured by eddy current (sum of 1.62 and 0.18) will be conservatively set at 1.9 inches.

When more than one Alternate Repair Criteria are used, the summation of leakage from all tubes left in service by all repair criteria must be less than the allowable leakage for the most limiting of those Alternate Repair Criteria.

Whenever the results of any steam generator tubing in-service inspection fall into Category C-3, these results will be promptly reported to the Commission prior to resumption of plant operation. Such cases will be considered by the Commission on a case-by-case basis and may result in a requirement for analysis, laboratory examinations, tests, additional eddy-current inspection, and revision of the Technical Specifications,if necessary.

Degraded steam generator tubes may be repaired by the installation of sleeves which span the section of degraded steam generator tubing. A steam generator tube with a sleeve installed meets the structural requirements of tubes which are not degraded.

The following sleeve designs have been found acceptable by the NRC Staff:
a. Westinghouse Mechanical Sleeves (WCAP 10757)
b. Westinghouse Brazed Sleeves (WCAP-10820)
c. Combustion Engineering Leak Tight Sleeves (CEN-294-P, for sleeves installed prior to October 1, 1997)

4.12 STEAM GENERATOR TUBE SURVEILLANCE

Bases continued

d. Combustion Engineering Leak Tight Sleeves (CEN-629-P, for sleeves installed after October 1, 1997)

Descriptions of other future sleeve designs shall be submitted to the NRC for review and approval prior to their use in the repair of degraded steam generator tubes. The submittals related to other sleeve designs shall be made at least 90 days prior to use.

Tube Support Plate Repair Limit

The voltage-based repair limits of Specification 4.12.D.4 implement the guidance in Generic Letter 95-05 and are applicable only to Westinghouse-designed steam generators with outside diameter stress corrosion cracking (ODSCC) located at the tube-to-tube support plate intersections. The voltage-based repair limits are not applicable to other forms of steam generator tube degradation nor are they applicable to ODSCC that occurs at other locations within the steam generator. Additionally, the repair criteria apply only to indications where the degradation mechanism is dominantly axial ODSCC with no significant cracks extending outside the thickness of the support plate. Refer to Generic Letter 95-05 for additional description of the degradation morphology.

Implementation of Specification 4.12.D.4 requires a derivation of the voltage structural limit from the burst versus voltage empirical correlation and then the subsequent derivation of the voltage repair limit from the structural limit (which is then implemented by this surveillance).

The voltage structural limit is the voltage from the burst pressure/bobbin voltage correlation, at the 95 percent prediction interval curve reduced to account for the lower 95/95 percent tolerance bound for tubing material properties at 650°F (i.e., the 95 percent LTL curve). The voltage structural limit must be adjusted downward to account for potential flaw growth during an operating interval and to account for NDE uncertainty. The upper voltage repair limit; V_{URL}, is determined from the structural voltage limit by applying the following equation:

$$V_{URL} = V_{SL} - V_{Gr} - V_{NDE}$$

where V_{Gr} represents the allowance for flaw growth between inspections and V_{NDE} represents the allowance for potential sources of error in the measurement of the bobbin coil voltage. Further discussion of the assumptions necessary to determine the voltage repair limit are discussed in Generic Letter 95-05.

The mid-cycle equation in Specification 4.12.D.4 should only be used during unplanned inspections in which eddy current data is acquired for indications at the tube support plates.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

NORTHERN STATES POWER COMPANY

DOCKET NO. 50-306

PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNIT 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 128
License No. DPR-60

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Northern States Power Company (the licensee) dated September 24, 1996, as supplemented October 17, 1996, January 3, January 20, and November 10, 1997, January 9, June 8, and July 20, 1998, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. DPR-60 is hereby amended to read as follows:

Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 128 , are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of the date of issuance, with full implementation within 30 days.

FOR THE NUCLEAR REGULATORY COMMISSION

Tae Kim, Senior Project Manager
Project Directorate III-1
Division of Reactor Projects - III/IV
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical Specifications

Date of Issuance: August 13, 1998

ATTACHMENT TO LICENSE AMENDMENT NO. 128

FACILITY OPERATING LICENSE NO. DPR-60

DOCKET NO. 50-306

Revise Appendix A Technical Specifications by removing the pages identified below and inserting the attached pages. The revised pages are identified by amendment number and contain vertical lines indicating the area of change.

REMOVE	INSERT
TS.4.12-2	TS.4.12-2
TS.4.12-4	TS.4.12-4
TS.4.12-5	TS.4.12-5
TS.4.12-6	TS.4.12-6
TS.4.12-7	TS.4.12-7
Table TS.4.12-1	Table TS.4.12-1
B.4.12-2	B.4.12-2
B.4.12-3	B.4.12-3

2. The first sample of tubes selected for each in-service inspection (subsequent to the preservice inspection) of each steam generator shall include:

   (a) All tubes that previously had detectable wall penetrations (>20%) that have not been plugged or sleeve repaired in the affected area.

   (b) Tubes in those areas where experience has indicated potential problems.

   (c) A tube inspection (pursuant to Specification 4.12.D.1.(h)) shall be performed on each selected tube. If any selected tube does not permit the passage of the eddy current probe for a tube inspection, this shall be recorded and an adjacent tube shall be selected and subjected to a tube inspection.

3. In addition to the sample required in Specification 4.12.B.2.a through c, all tubes which have had the F* or EF* criteria applied will be inspected in the F* and EF* regions of the roll expanded region. The region of these tubes below the F* and EF* regions may be excluded from the requirements of 4.12.B.2.a.

4. The tubes selected as the second and third samples (if required by Tables TS.4.12-1 or TS.4.12-2) during each inservice inspection may be subjected to a partial tube or sleeve inspection provided:

   (a) The tubes selected for these samples include the tubes from those areas of the tube sheet array where tubes with imperfections were previously found.

   (b) The inspections include those portions of the tubes or sleeves where imperfections were previously found.

The results of each sample inspection shall be classified into one of the following three categories:

Category	Inspection Results
C-1	Less than 5% of the total tubes inspected are degraded tubes and none of the inspected tubes are defective.
C-2	One or more tubes, but not more than 1% of the total tubes inspected are defective, or between 5% and 10% of the total tubes inspected are degraded tubes.
C-3	More than 10% of the total tubes inspected are degraded tubes or more than 1% of the inspected tubes are defective.

Note: In all inspections, previously degraded tubes must exhibit significant (>10%) further wall penetrations to be included in the above percentage calculations.

D. Acceptance Criteria

1. As used in this Specification:

(a) Imperfection means an exception to the dimensions, finish or contour of a tube from that required by fabrication drawings or specifications. Eddy-current testing indications below 20% of the nominal tube wall thickness, if detectable, may be considered as imperfections.

(b) Degradation means a service-induced cracking, wastage, wear or general corrosion occurring on either inside or outside of a tube.

(c) Degraded Tube means a tube containing imperfections $\geq$20% of the nominal wall thickness caused by degradation.

(d) % Degradation means the percentage of the tube wall thickness affected or removed by degradation.

(e) Defect means an imperfection of such severity that it exceeds the repair limit. A tube containing a defect is defective.

(f) Repair Limit means the imperfection depth at or beyond which the tube shall be removed from service by plugging or repaired by sleeving because it may become unserviceable prior to the next inspection and is equal to 50% of the nominal tube wall thickness. If significant general tube thinning occurs, this criteria will be reduced to 40% wall penetration. This definition does not apply to the portion of the tube in the tubesheet below the F* or EF* distance provided the tube is not degraded (i.e., no indications of cracks) within the F* or EF* distance for F* or EF* tubes. The repair limit for the pressure boundary region of any sleeve is 31% of the nominal sleeve wall thickness. This definition does not apply to tube support plate intersections for which the voltage-based repair criteria are being applied. Refer to Specification 4.12.D.4 for the repair limit applicable to these intersections.

(g) Unserviceable describes the condition of a tube if it leaks or contains a defect large enough to affect its structural integrity in the event of an Operating Basis Earthquake, a loss-of-coolant accident, or a steam line or feedwater line break.

(h) Tube Inspection means an inspection of the steam generator tube from the point of entry (hot leg side) completely around the U-bend to the top support of the cold leg.

(i) Sleeving is the repair of degraded tube regions using a new Alloy 690 tubing sleeve inserted inside the parent tube and sealed at each end by welding or by replacing the lower weld in a full depth tubesheet sleeve with a hard rolled joint. The new sleeve becomes the pressure boundary spanning the original degraded tube region.

(j) F* Distance is the distance from the bottom of the hardroll transition toward the bottom of the tubesheet that has been conservatively determined to be 1.07 inches (not including eddy current uncertainty). The F* distance applies to roll expanded regions below the midplane of the tubesheet.

(k) F* Tube is a tube with degradation, below the F* distance, equal to or greater than 40%, and not degraded (i.e., no indications of cracking) within the F* distance.

(l) EF* Distance is the distance from the bottom of the upper hardroll transition toward the bottom of the tubesheet that has been conservatively determined to be 1.62 inches (not including eddy current uncertainty). EF* distance applies to roll expanded regions when the top of the additional roll expansion is 2.0 inches or greater down from the top of the tubesheet.

(m) EF* Tube is a tube with degradation, below the EF* distance, equal to or greater than 40%, and not degraded (i.e., no indications of cracking) within the EF* distance.

2. The steam generator shall be determined OPERABLE after completing the corresponding actions (plug or repair by sleeving all tubes exceeding the repair limit and all tubes containing through-wall cracks or classify as F* or EF* tubes) required by Tables TS.4.12-1 and TS.4.12-2.

3. Tube repair, after October 1, 1997, using Combustion Engineering welded sleeves shall be in accordance with the methods described in the following:

CEN-629-P, Revision 2, "Repair of Westinghouse Series 44 and 51 Steam Generator Tubes Using Leak Tight Sleeves";

CEN-629-P, Addendum 1, Revision 1, "Repair of Westinghouse Series 44 and 51 Steam Generator Tubes Using Leak Tight Sleeves"

4. Tube Support Plate Repair Limit is used for the disposition of a steam generator tube for continued service that is experiencing predominantly axially oriented outside diameter stress corrosion cracking confined within the thickness of the tube support plates. At tube support plate intersections, the repair limit is based on maintaining steam generator serviceability as described below:

a. Steam generator tubes, whose degradation is attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with bobbin voltages less than or equal to 2.0 volts will be allowed to remain in service.

b. Steam generator tubes, whose degradation is attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with a bobbin voltage greater than 2.0 volts, will be repaired or plugged, except as noted in Specification 4.12.D.4.c below.

c. Steam generator tubes, with indications of potential degradation attributed to outside diameter stress corrosion cracking within the bounds of the tube support plate with a bobbin voltage greater than 2.0 volts but less than or equal to the upper voltage repair limit, may remain in service if a rotating pancake coil (or comparable examination technique) inspection does not detect degradation. Steam generator tubes, with indications of outside diameter stress corrosion cracking degradation with a bobbin voltage greater than the upper voltage repair limit will be plugged or repaired.

d. If an unscheduled mid-cycle inspection is performed, the following mid-cycle repair limits apply instead of the limits in Specifications 4.12.D.4.a, b and c. The mid-cycle repair limits are determined from the following equations:

$$V_{MURL} = \frac{V_{SL}}{1.0 + NDE + Gr\left(\frac{CL - \Delta t}{CL}\right)}$$

$$V_{MLRL} = V_{MURL} - (V_{URL} - 2.0)\left(\frac{CL - \Delta t}{CL}\right)$$

where:

V_{URL} = upper voltage repair limit

V_{LRL} = lower voltage repair limit

V_{MURL} = mid-cycle upper voltage repair limit based on time into cycle

V_{MLRL} = mid-cycle lower voltage repair limit based on V_{MURL} and time into cycle

Δt = length of time since last scheduled inspection during which V_{URL} and V_{LRL} were implemented

CL = cycle length (time between two scheduled steam generator inspections)

V_{SL} = structural limit voltage

Gr = average growth rate per cycle length

NDE = 95 percent cumulative probability allowance for nondestructive examination uncertainty (i.e., a value of 20 percent has been approved by the NRC)

Implementation of these mid-cycle repair limits should follow the same approach as described in Specifications 4.12.D.4.a, b and c.

Note: The upper voltage repair limit is calculated according to the methodology in Generic Letter 95-05 as supplemented.

E. Reports

1. Following each in-service inspection of steam generator tubes, if there are any tubes requiring plugging or sleeving, the number of tubes plugged or sleeved in each steam generator shall be reported to the Commission within 15 days.

2. The results of steam generator tube inservice inspections shall be included with the summary reports of ASME Code Section XI inspections submitted within 90 days of the end of each refueling outage. Results of steam generator tube inservice inspections not associated with a refueling outage shall be submitted within 90 days of the completion of the inspection. These reports shall include: (1) number and extent of tubes inspected, (2) location and percent of wall-thickness penetration for each indication of an imperfection and (3) identification of tubes plugged or sleeved.

3. Results of steam generator tube inspections which fall into Category C-3 require notification to the Commission prior to resumption of plant operation, and reporting as a special report to the Commission within 30 days. This special report shall provide a description of investigations conducted to determine cause of the tube degradation and corrective measures taken to prevent recurrence.

4. The results of inspections performed under Specification 4.12.B for all tubes that have defects below the F* or EF* distance, and were not plugged, shall be reported to the Commission within 15 days following the inspection. The report shall include:

   a. Identification of F* and EF* tubes, and

   b. Location and extent of degradation.

5. For implementation of the voltage-based repair criteria to tube support plate intersections, notify the NRC staff prior to returning the steam generators to service should any of the following conditions arise:

   a. If estimated leakage based on the projected end-of-cycle (or if not practical, using the actual measured end-of-cycle) voltage distribution exceeds the leak limit (determined from the licensing basis dose calculation for the postulated main steamline break) for the next operating cycle.

   b. If circumferential crack-like indications are detected at the tube support plate intersections.

   c. If indications are identified that extend beyond the confines of the tube support plate.

   d. If indications are identified at the tube support plate elevations that are attributable to primary water stress corrosion cracking.

   e. If the calculated conditional burst probability based on the projected end-of-cycle (or if not practical, using the actual measured end-of-cycle) voltage distribution exceeds 1×10^{-2}, notify the NRC and provide an assessment of the safety significance of the occurrence.

TABLE TS.4.12-1

STEAM GENERATOR TUBE INSPECTION

1ST SAMPLE INSPECTION			2ND SAMPLE INSPECTION		3RD SAMPLE INSPECTION	
Sample Size	Result	Action Required	Result	Action Required	Result	Action Required
A minimum of S Tubes per S.G.	C-1	None	N/A	N/A	N/A	N/A
	C-2	Repair defective tubes and inspect additional 2S tubes in this S.G.	C-1	None	N/A	N/A
			C-2	Repair defective tubes and inspect additional 4S tubes in this S.G.	C-1	None
					C-2	Repair defective tubes
					C-3	Perform action for C-3 result of first sample
			C-3	Perform action for C-3 result of first sample	N/A	N/A
	C-3	Inspect all tubes in this S.G., Repair defective tubes and inspect 2S tubes in each other S.G. Prompt notification to NRC.	All other S.G.s are C-1	None	N/A	N/A
			Some S.G.s C-2 but no additional S.G. are C-3	Perform action for C-2 result of second sample	N/A	N/A
			Additional S.G. is C-3	Inspect all tubes in each S.G. and repair defective tubes. Prompt notification to NRC.	N/A	N/A

S=3%: When two steam generators are inspected during that outage.
S=6%: When one steam generator is inspected during that outage.

4.12 STEAM GENERATOR TUBE SURVEILLANCE

Bases continued

0.025 inches will have adequate margins of safety against failure due to loads imposed by normal plant operation and design basis accidents (Reference 1). Steam generator tube inspections of operating plants have demonstrated the capability to reliably detect wastage type defects that have penetrated 20% of the original 0.050-inch wall thickness (Reference 2).

Plugging or sleeving is not required for tubes meeting the F* or EF* criteria. Due to the variable effect of tubesheet bow with elevation, the F* criterion applies only below the tubesheet centerline and the EF* criterion is applied no higher than two inches down from the top of the tubesheet.

The F* and EF* distances will be controlled by a combination of eddy current inspection and/or process control. For a new additional roll expansion, the requirement will be at least 1.2 (1.8 inches for EF*) inches of new hard roll. This is controlled by the 1.25 inch (two inches for EF*) effective length of the rollers. The distance from the original roll transition zone is also controlled by the process in that the lower end of the new roll expansion is located one inch or greater above the original roll expansion. In the case of the new roll, eddy current examination will confirm there are no indications in the new roll region and that there is a new roll region with well defined upper and lower expansion transitions.

When eddy current examination, alone, must determine the F* or EF* distance, such as in the existing hard roll region, or when multiple lengths of additional hard rolls have been added, the eddy current uncertainty is qualified by testing against known standards. That value is expected to be 0.18 inches. Therefore, the F* distance measured by eddy current (sum of 1.07 and 0.18) will be conservatively set at 1.3 inches. The EF* distance measured by eddy current (sum of 1.62 and 0.18) will be conservatively set at 1.9 inches.

When more than one Alternate Repair Criteria are used, the summation of leakage from all tubes left in service by all repair criteria must be less than the allowable leakage for the most limiting of those Alternate Repair Criteria.

Whenever the results of any steam generator tubing in-service inspection fall into Category C-3, these results will be promptly reported to the Commission prior to resumption of plant operation. Such cases will be considered by the Commission on a case-by-case basis and may result in a requirement for analysis, laboratory examinations, tests, additional eddy-current inspection, and revision of the Technical Specifications,if necessary.

Degraded steam generator tubes may be repaired by the installation of sleeves which span the section of degraded steam generator tubing. A steam generator tube with a sleeve installed meets the structural requirements of tubes which are not degraded.

The following sleeve designs have been found acceptable by the NRC Staff:
a. Westinghouse Mechanical Sleeves (WCAP 10757)
b. Westinghouse Brazed Sleeves (WCAP-10820)
c. Combustion Engineering Leak Tight Sleeves (CEN-294-P, for sleeves installed prior to October 1, 1997)

4.12 STEAM GENERATOR TUBE SURVEILLANCE

Bases continued

d. Combustion Engineering Leak Tight Sleeves (CEN-629-P, for sleeves installed after October 1, 1997)

Descriptions of other future sleeve designs shall be submitted to the NRC for review and approval prior to their use in the repair of degraded steam generator tubes. The submittals related to other sleeve designs shall be made at least 90 days prior to use.

Tube Support Plate Repair Limit

The voltage-based repair limits of Specification 4.12.D.4 implement the guidance in Generic Letter 95-05 and are applicable only to Westinghouse-designed steam generators with outside diameter stress corrosion cracking (ODSCC) located at the tube-to-tube support plate intersections. The voltage-based repair limits are not applicable to other forms of steam generator tube degradation nor are they applicable to ODSCC that occurs at other locations within the steam generator. Additionally, the repair criteria apply only to indications where the degradation mechanism is dominantly axial ODSCC with no significant cracks extending outside the thickness of the support plate. Refer to Generic Letter 95-05 for additional description of the degradation morphology.

Implementation of Specification 4.12.D.4 requires a derivation of the voltage structural limit from the burst versus voltage empirical correlation and then the subsequent derivation of the voltage repair limit from the structural limit (which is then implemented by this surveillance).

The voltage structural limit is the voltage from the burst pressure/bobbin voltage correlation, at the 95 percent prediction interval curve reduced to account for the lower 95/95 percent tolerance bound for tubing material properties at 650°F (i.e., the 95 percent LTL curve). The voltage structural limit must be adjusted downward to account for potential flaw growth during an operating interval and to account for NDE uncertainty. The upper voltage repair limit; V_{URL}, is determined from the structural voltage limit by applying the following equation:

$$V_{URL} = V_{SL} - V_{Gr} - V_{NDE}$$

where V_{Gr} represents the allowance for flaw growth between inspections and V_{NDE} represents the allowance for potential sources of error in the measurement of the bobbin coil voltage. Further discussion of the assumptions necessary to determine the voltage repair limit are discussed in Generic Letter 95-05.

The mid-cycle equation in Specification 4.12.D.4 should only be used during unplanned inspections in which eddy current data is acquired for indications at the tube support plates.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 137

TO FACILITY OPERATING LICENSE NO. DPR-42

AND AMENDMENT NO. 128 TO FACILITY OPERATION LICENSE NO. DPR-60

NORTHERN STATES POWER COMPANY

PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2

DOCKET NOS. 50-282 AND 50-306

1.0 INTRODUCTION

By letter dated September 24, 1996, as supplemented October 17, 1996, January 3, January 20, and November 10, 1997, and January 9, June 8, and July 20, 1998, the Northern States Power Company (NSP or the licensee) requested amendments to the Technical Specifications (TS) appended to Facility Operating License No. DPR-42 for the Prairie Island Nuclear Generating Plant, Unit 1, and Facility Operating License No. DPR-60 for the Prairie Island Nuclear Generating Plant, Unit 2. The proposed amendments would revise TS 4.12, "Steam Generator Tube Surveillance," to provide Prairie Island with an alternative for dispositioning steam generator tubes with degradation in the tubesheet region. The steam generators at Prairie Island are Westinghouse Model 51 steam generators with mill annealed, Alloy 600 tubing. Prairie Island Units 1 and 2 steam generators were fabricated with a 2.75-inch partial depth roll expansion of the ends of the tubes at the bottom of the tubesheet. The licensee's submittals dated January 3, January 20, and November 10, 1997, and January 9, June 8, and July 20, 1998, provided additional clarifying information within the scope of the original *Federal Register* notice and did not affect the staff's initial no significant hazards consideration determination.

With these amendments steam generator tubes with degradation below the EF* distance in the tubesheet region would not require sleeving or plugging but could be repaired by installation of additional roll expansion to meet the EF* criteria. The proposed changes are intended to provide adequate assurance of steam generator tube integrity because the presence of the tubesheet in conjunction with the hardroll process ensures structural and leakage integrity of the tubes. The presence of the tubesheet provides constraint to the tubes by minimizing the amount of deformation a tube can undergo beyond its expanded outside diameter. The proximity of the tube and tubesheet, due to the hardroll expansion, limits the amount of primary-to-secondary leakage. The EF* criteria provide a similar level of protection for tube degradation in the tubesheet region as that afforded by Regulatory Guide (RG) 1.121, "Bases for Plugging Degraded PWR Steam Generator Tubes," for degradation located outside the tubesheet region.

The licensee supported its request with proprietary and nonproprietary versions of Westinghouse Report WCAP-14225, Revision 1, entitled "F* and Elevated F* Tube Plugging Criteria for Tubes with Degradation in the Tubesheet Region of the Prairie Island, Units 1 and 2 Steam Generators." In support of its repair methodology, the licensee also supplied the results of its test program to verify the adequacy of the reroll process for returning tubes to service. This program is documented in ABB Combustion Engineering Report CEN-620-P, Revision 05-P, "Series 44 & 51 Design Steam Generator Tube Repair Using a Tube Re-Rolling Technique (Proprietary and nonproprietary versions available)."

2.0 BACKGROUND

General Design Criterion (GDC) 14 of Appendix A to 10 CFR Part 50 requires that the reactor coolant pressure boundary be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture. RG 1.121 provides guidance on an acceptable method for establishing the limiting safe conditions of tube degradation of steam generator tubing. Technical Specification 4.12, "Steam Generator Tube Surveillance," assures the continued integrity of the steam generator tubes that are a part of the primary coolant pressure boundary. If a tube is found to be defective, the existing TS requires that the tube be removed from service by plugging, or repaired by sleeving or by utilizing F* in the lower region of the tubesheet.

The industry experience has shown that defects have developed between the mid-thickness of the tubesheet and the top of the tubesheet. The staff believes that tubes having degradation in the tubesheet region may remain in service provided the degradation is below a specified distance from the bottom of the roll transition, and the undegraded portion of the tube in the tubesheet can maintain adequate structural and leakage integrity under loading from normal operations, anticipated operational occurrences, and postulated accident conditions. RG 1.121 recommends that the margin of safety against tube rupture (or pullout) under normal operating conditions should not be less than a factor of three at any tube location where defects have been detected. For postulated accidents, RG 1.121 recommends that the margin of safety against failure be consistent with the margin of safety determined by the stress limits in NB-3225 of Section III of the Boiler and Pressure Vessel Code of the American Society of Mechanical Engineers (ASME). Structural loads imposed on the tube-to-tubesheet joint primarily result from the differential pressure between the primary and secondary sides of the tubes. The peak postulated loading occurs during a main steam line break due to a lowering of the secondary side pressure. However, normal operating loads, cyclic loading from transients (e.g., startup/shutdown), and potential thermal expansion loads can also be significant. The analysis supporting the EF* criteria should address all loading conditions necessary to maintain adequate integrity of the tube-to-tubesheet joint.

The elastic preload between the tube and tubesheet not only prevents pullout of the tube from the tubesheet, but also provides a leak tight barrier minimizing the potential for primary-to-secondary coolant leakage. With sufficient length of hardroll, the tube-to-tubesheet joint will limit leakage under normal and faulted conditions. If a through-wall crack is present in the joint, primary coolant may leak to the secondary side. Under the proposed EF* criteria, licensees must demonstrate that leakage integrity of the joint is maintained under all analyzed conditions.

3.0 EVALUATION

3.1 EF* Engagement Distance Determination

The application of the EF* criteria applies to those tubes where an additional roll expansion is performed above the mid-plane of the tubesheet. The EF* criteria are based on determining the length of hardroll engagement necessary to resist tube pullout forces during normal operation, test, upset, and faulted conditions. The necessary engagement length (as discussed below, this measurement is 1.62 inches) applicable to the Prairie Island steam generators was determined based on a semi-empirical method of quantifying the axial load bearing capability of the rolled joint, resulting from the radial contact preload pressure and the associated friction between the tube and the tubesheet. A test program was conducted by Westinghouse to quantify the degree of interference fit between the tube and the tubesheet provided by the hardrolling operation. The calculation of the value of the EF* distance is based on determining the length of hardroll necessary to offset the applied loads (i.e., rolling process preload, thermal expansion preload, pressure preload tubesheet bow loss, and the axial pullout forces) during the maximum normal operating conditions or faulted conditions, whichever provides the largest value. The applied loads are balanced by the load-carrying ability of the hardrolled tube as calculated using an empirically derived coefficient of friction at the tube-to-tubesheet interface.

The EF* criteria will be implemented by forming an additional roll expansion joint up to 2 inches below the top of the tubesheet. The EF* distance when applied below 2 inches from the top of the tubesheet, considering the loads discussed above including the effects of tubesheet bowing above the neutral bending axis of the tubesheet, has been determined to be 1.62 inches (excluding NDE [nondestructive examination] uncertainty) for the Prairie Island steam generators.

Limitation of Primary-To-Secondary Leakage

Under the proposed repair criterion, tubes containing throughwall flaws may be allowed to remain in service provided the indications are located below a specified length of tube-to-tubesheet hardroll (i.e., EF* distance). The presence of a hardroll above any tube cracking provides significant resistance to primary-to-secondary (or secondary-to-primary) leakage through such flaws. Operating experience with the F* repair criteria approved for Prairie Island Unit 2 indicates that rerolled tubing has a higher potential for leakage than originally determined in leak rate qualification testing of simulated tubesheet hardroll expansions. In the 1997 Prairie Island Unit 2 refueling outage, secondary side hydrostatic pressure testing identified several F* tubes as the possible source of primary-to-secondary leakage measured prior to plant shutdown. The licensee quantified the maximum leak rate from the F* tubes through in-situ pressure testing. Based on the results of the inspection findings and the in-situ pressure testing, the licensee determined a bounding leak rate for a single steam generator assuming all tubes had been repaired by rerolling. The calculated leak rate is lower than the site allowable leak rate limit of 1 gallon per minute.

The licensee will implement changes in the rerolled tube acceptance criteria from the process used under the F* repair criterion. These changes should improve the resistance to leakage of repaired tubing to that afforded by the installation procedures utilized in previous applications of

the F* repair criterion. The licensee has also demonstrated by analysis that the postulated leak rate from all tubes repaired by rerolling is within acceptable limits. The staff concludes that the proposed rerolling repair process will provide adequate leakage integrity to those tubes returned to service using the EF* repair criterion.

Tube Integrity Under Postulated LOCA Conditions

The licensee must also demonstrate tube integrity under secondary-to-primary differential pressure loading during a postulated loss-of-coolant accident (LOCA). A review of tube collapse strength characteristics indicates that the constraint provided to the tube by the tubesheet gives a significant margin between tube collapse strength and the limiting secondary-to-primary differential pressure condition, even in the presence of circumferential or axial indications.

Inspection of EF* Tubes

The EF* criteria are based on determining the length of hardroll engagement necessary to resist tube pullout forces and/or leakage within the tubesheet area. The necessary engagement distance was determined to be 1.62 inches. An eddy-current examination is performed to determine the acceptability of the reroll. This examination, as noted below, verifies the presence of the reroll as well as the location. Since the rerolling tool used results in a 2-inch roll in previously unexpanded tubing, this examination verifies the existence of the necessary engagement. Accordingly, addressing eddy-current measurement uncertainty is unnecessary. Rerolled joints will be subject to a bobbin coil profilometry examination to verify the adequacy of the installed joint. Data from the profilometry inspection will be used to confirm that the roller forces were sufficient to fully expand tubes into the tubesheet bore consistent with the repair requirements for EF* tubes.

The proposed TS require that all tubes that have had the EF* criteria applied will be inspected in the EF* regions of the roll expanded regions. The region of these tubes below the EF* regions may be excluded from the plugging criteria of the TS. The requirement to inspect all EF* tubes during each TS inspection is acceptable to the staff.

Repair Methodology

In support of the proposed EF* amendment, the licensee submitted ABB Combustion Engineering Report CEN-620-P, Revision 05-P, "Series 44 and 51 Design Steam Generator Tube Repair Using a Re-Rolling Technique." This report details the analyses and testing completed to verify the structural and leakage integrity of the repair hardroll introduced in the rerolling process. To return steam generator tubes to service with confirmed degradation below the EF* distance in the tubesheet region, the licensee will implement a field rerolling process that expands tubes into the tubesheet over a 2-inch length located up to within 2 inches of the tubesheet secondary face. Field-installed hardrolls will be inspected to verify that (1) the new expanded tube region is free from defects over the EF* distance, (2) the hardroll is in the proper location, and (3) the tube was adequately expanded into the tubesheet.

One factor that could affect the integrity of the repair is the presence of sludge between the outer tube wall and the tubesheet bore. In the qualification test program, the vendor modeled and evaluated the adverse effects of crevice sludge on the tube-to-tubesheet joint. Tubes were hardrolled into a tubesheet collar for testing with both wet and dry conditions. Several different tests were conducted to verify acceptability of EF* tubes. These tests included static and cyclic loading in addition to leak resistance testing. Based on the results of the test program, the licensee concluded that the field-installed hardrolled joints would have adequate structural integrity. The leakage was also shown to be well within acceptable limits.

Recent operating experience at Prairie Island Unit 2 has indicated that field-installed hardrolled joints for tubes repaired under the F* criterion have lower resistance to leakage than demonstrated in the qualification testing for the rerolling process. To address this issue, the licensee implemented several changes in the F* repair procedure that are similarly applied to the EF* repair process that will minimize the potential for returning tubes to service by rerolling with unacceptably low resistance to leakage. As described in CEN-620-P, Revision 05-P, the licensee will perform bobbin coil profilometry to ensure a minimum expansion level was achieved in the rerolling process. The revised repair procedure will also add an additional roll expansion over the original roll transition zone. A third change includes the performance of a secondary side hydrostatic test to verify the leakage integrity of newly installed rerolls. These measures provide assurance that tubes returned to service via the EF* repair criterion will have adequate leakage integrity during normal operating and postulated accident conditions.

3.2 Evaluation of Proposed TS Changes

The licensee proposed the following changes to the TS to implement the EF* repair criteria.

1. TS 4.12.B.3 "Steam Generator Tube Sample Selection and Inspection"

   The existing TS is modified to state the following:

   In addition to the sample required in Specification 4.12.B.2.a through c, all tubes which have had the F* or EF* criteria applied will be inspected in the F* and EF* regions of the roll expanded regions. The region of these tubes below the F* and EF* regions may be excluded from the requirements of 4.12.B.2.a.

2. TS 4.12.D.1.(f)

   The definition of Repair Limit is modified to state that the definition does not apply to the portion of the tube in the tubesheet below the F* or EF* distance provided the tube is not degraded (i.e., no indications of cracks) within the F* or EF* distance for F* or EF* tubes.

3. TS 4.12.D.1.(j)

   The definition of F* Distance is modified to clarify that the F* distance applies to roll expanded regions below the midplane of the tubesheet.

4. Proposed New TS 4.12.D.1.(l)

   The following new TS is added to provide the definition of EF* distance.

   EF* distance is the distance from the bottom of the upper hardroll transition toward the bottom of the tubesheet that has been conservatively determined to be 1.62 inches (not including eddy current uncertainty). EF* distance applies to roll expanded regions when the top of the additional roll expansion is 2.0 inches or greater down from the top of the tubesheet.

5. Proposed New TS 4.12.D.1.(m)

   The following new TS is added to provide the definition of EF* tube.

   EF* tube is a tube with degradation, below the EF* distance, equal to or greater than 40%, and not degraded (i.e., no indications of cracking) within the EF* distance.

6. TS 4.12.D.2 "Acceptance Criteria"

   The existing TS is modified to state the following:

   The steam generator shall be determined OPERABLE after completing the corresponding actions (plug or repair by sleeving all tubes exceeding the repair limit and all tubes containing through-wall cracks or classify as F* or EF* tubes) required by Table TS.4.12-1.

7. TS Table 4.12-1 "Steam Generator Tube Inspection"

   The existing TS Table is modified to state the following:

   The words "plug or sleeve" in the action required columns for the three sample inspections are replaced with the word "repair."

8. TS 4.12.E.4 "Reports"

   The existing TS is modified to state the following:

   The results of inspections performed under Specification 4.12.B for all tubes that have defects below the F* or EF* distance, and were not plugged, shall be reported to the Commission within 15 days following the inspection. The report shall include:

   a. Identification of F* and EF* tubes, and

   b. Location and extent of degradation

9. Table TS 4.12-1 "Steam Generator Tube Inspection"

   The words "plug or sleeve" are changed to "repair" to acknowledge the variety of repair criteria.

10. Proposed Revision to Bases Section

    The Bases for TS Section 4.12 have been revised to address changes to the TS.

The staff has reviewed the TS changes and finds that they incorporate the EF* criteria consistent with the safety evaluation as discussed above and will provide adequate assurance of steam generator tube integrity. Therefore, the proposed changes are acceptable.

3.3 Conclusion

Based on its review of the licensee's proposal, the staff has determined that the proposed changes will provide adequate assurance of steam generator tube integrity because (1) the presence of the tubesheet in conjunction with the hardroll process significantly reduces the potential for tube failure and/or leakage from tubes returned to service through the application of EF* repair criteria, (2) the presence of the tubesheet provides for constraint to the tube by minimizing the amount of deformation a tube can undergo beyond its expanded outside diameter, and (3) the proximity of the tube and tubesheet, due to the hardroll expansion, limits the amount of primary-to-secondary leakage. Therefore, the staff concludes that tubes can be left in service with eddy-current indications of pluggable magnitude that are below the EF* distance, provided the tube is not degraded within the EF* distance.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Minnesota State official was notified of the proposed issuance of the amendments. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendments change a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendments involve no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration and there has been no public comment on such finding (61 *FR 64388*). Accordingly, the amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributor: P. Rush

Date: August 13, 1998