

UNITED STATES NUCLEAR REGULATORY COMMISSION

NORTHERN STATES POWER COMPANY

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

DOCKET NO. 50-282
50-306

REQUEST FOR AMENDMENT TO
OPERATING LICENSES DPR-42 & DPR-60

LICENSE AMENDMENT REQUEST DATED SEPTEMBER 24, 1996

Northern States Power Company, a Minnesota corporation, requests authorization for changes to Appendix A of the Prairie Island Operating License as shown on the attachments labeled Exhibits A, B, C, D, E and F. Exhibit A describes the proposed changes, reasons for the changes, safety evaluation and a significant hazards evaluation. Exhibits B and C are copies of the Prairie Island Technical Specifications incorporating the proposed changes. Exhibits D and E are reports supporting the requested changes. Exhibit F is a Westinghouse Electric Corporation affidavit for withholding of proprietary information.

This letter contains no restricted or other defense information.

NORTHERN STATES POWER COMPANY

By *Roger O. Anderson*
Roger O Anderson
Director
Licensing and Management Issues

On this 24 day of SEPT. 1996 before me a notary public in and for said County, personally appeared Roger O Anderson, Director, Licensing and Management Issues, and being first duly sworn acknowledged that he is authorized to execute this document on behalf of Northern States Power Company, that he knows the contents thereof, and that to the best of his knowledge, information, and belief the statements made in it are true and that it is not interposed for delay.

Mary A. Butts

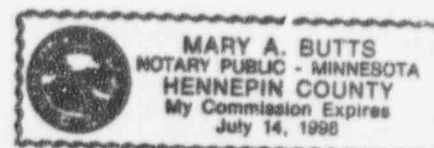


Exhibit A

Prairie Island Nuclear Generating Plant License Amendment Request Dated September 24, 1996

Evaluation of Proposed Changes to the Technical Specifications Appendix A of Operating License DPR-42 and DPR-60

Pursuant to 10 CFR Part 50, Sections 50.59 and 50.90, the holders of Operating Licenses DPR-42 and DPR-60 hereby propose the following changes to Appendix A, Technical Specifications:

Background

This amendment request proposes a change to Technical Specification (TS) 4.12, "Steam Generator Tube Surveillance", to incorporate a revised acceptance criterion for steam generator tubes with degradation in the tubesheet region. This criterion for steam generator tube acceptance was developed by Westinghouse Electric Corporation and is known as EF* ("Elevated F-Star"). This criterion was developed to avoid unnecessary plugging of steam generator tubes.

The purpose for EF* is to provide an alternate repair criterion for the tubesheet region when used with the repair method of additional roll expansion. Previously, the F* criterion was authorized for use at Prairie Island by License Amendment 118, dated May 15, 1995. The F* criterion was applied to the tubesheet region below the centerline of the tubesheet thickness. The proposed EF* criterion applies anywhere in the tubesheet region below two inches from the top of the tubesheet. Either F* or EF* can be used below the centerline (neutral bending axis) of the tubesheet.

For the Prairie Island steam generators, the EF* distance is 1.62 inches (excluding NDE uncertainty). The EF* criterion will be implemented by forming an additional roll expansion joint starting no higher than 2 inches below the top of the tubesheet and extending downwards approximately 2 inches. The EF* criteria is conservative at any lower elevation above or below the centerline of the tubesheet.

The steam generators at Prairie Island are Westinghouse Model 51 steam generators with low temperature mill-annealed Alloy 600 tubing. In the tubesheet region, the tubing has a hard roll expansion only in the lower 2.75 inches.

The F* criterion, with additional roll expansion, was applied in 1995 to 401 tubes in the Prairie Island Unit 2 steam generators and in 1996 to 6 tubes in the Prairie Island Unit 1 steam generators with PWSCC at the roll transition zone or secondary side stress corrosion cracking in the lower tubesheet region. The installation of an additional hard roll expansion, meeting the requirements for EF*, can be used to repair tubes with secondary side degradation which extends higher in the tubesheet region. The EF*

criterion is requested to provide an alternative to plugging or sleeving tubes in the future. Following approval of the EF* criterion, Prairie Island will use the plant modification process (per 10 CFR 50.59) to implement the EF* criterion and the additional roll expansion repair. The additional roll expansion process shall meet the requirements of WCAP-14225, Revision 1.

The EF* distance 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 1.8 inches of new hard roll. This is controlled by the length of the rollers (at least 1.8 inch effective length). Eddy current uncertainty will be addressed by the plant modification process. The current methodology being developed is the use of a special eddy current probe containing two sets of coils, a rotating coil and a bobbin coil, with a known distance between the coils to reduce axial position uncertainties. In the absence of demonstrated uncertainty measurements, an uncertainty of 0.4 inches will be used. Uncertainty in the eddy current measurement of the EF* distance is being evaluated for the ZETEC combination probe and will be provided upon completion of testing.

The existing Technical Specification tube repairing and plugging criteria apply throughout the tube length, but do not take into account the reinforcing effect of the tubesheet on the external surface of the tube in the roll expansion region. The presence of the tubesheet will constrain the tube and will complement its integrity in that region by precluding tube deformation beyond its expanded outside diameter. The resistance to both tube rupture and tube collapse is significantly strengthened by the tubesheet. In addition, the proximity of the tubesheet significantly affects the leak behavior of throughwall tube cracks in this region. The EF* criterion is based on determining the length of hardroll engagement necessary to resist tube pullout forces during normal operation, test, upset, and faulted conditions. No significant leakage relative to plant Technical Specification limits is to be expected from application of the EF* criterion.

Under previous qualification testing (ABB CE Report CEN-620-P, discussed below), leakage testing was done for an effective roller length of 1.25 inches. Following 22,500 load cycles, the maximum leakage observed was 6.87×10^{-4} gal/hr in coupons which had hard sludge present. This leakage would total .08 GPM if all steam generator tubes in both steam generators contained additional roll expansions. Tubes without hard sludge did not leak. Similar results are expected with longer hard rolls.

The EF* methodology and determination of the EF* distance are included in 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". This report, prepared by Westinghouse Electric Corporation, is contained in Exhibit D. A non-proprietary version of the report is included in Exhibit E.

Combustion Engineering Report CEN-620-P Rev 00 was previously submitted to the NRC by NSP letter dated March 22, 1995. This report, "Series 44 & 51 Design Steam Generator Tube Repair Using a Tube Re-rolling Technique" documented the qualification of the reroll process for rerolling in the lower region of the tubesheet. A revision to this document which addresses rerolling in the upper region of the tubesheet will be submitted to the NRC by October 31, 1996

Proposed Changes

Technical Specification 4.12, "Steam Generators Tube Surveillance", describes the inservice inspection program used to demonstrate steam generator operability. In order to utilize the EF* repair criterion, several items in Technical Specification 4.12 must be revised. A brief description of the proposed revisions is provided below. The specific wording changes to the Technical Specifications are shown in Exhibits B and C.

1. Proposed Changes to Technical Specification 4.12.B.3

References to the EF* criterion and EF* regions are added to the existing references to the F* criterion and regions.

2. Proposed Changes to Technical Specification 4.12.D.1.f

References to the EF* criterion are added to the existing references to the F* criterion.

3. Proposed Changes to Technical Specification 4.12.D.1.(j)

Clarification is added that the F* criterion applies below the mid plane of the tubesheet.

4. Proposed New Technical Specifications 4.12.D.1.(l) and (m)

New Specifications 4.12.D.1.(l) and 4.12.D.1.(m) provide definitions for the EF* distance and an EF* tube.

5. Proposed Changes to Technical Specification 4.12.D.2

A reference to EF* tubes is added to the existing reference to F* tubes

6. Proposed Changes to Technical Specification 4.12.E.4

References to the EF* criterion are added to the existing references to the F* criterion.

7. Proposed changes to Technical Specification Table TS.4.12-1

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

8. Proposed changes to Technical Specification Bases for TS.4.12

The Bases for Specification 4.12 are revised in accordance with the changes made in the specification as discussed above. The changes to the bases are shown in Exhibit B.

Justification

Using Technical Specification tube plugging criteria in place prior to the implementation of the F* repair criterion (approved by License Amendment 118), many tubes experiencing only minor degradation's would have to be repaired or removed from service. The analyses supporting the F* criterion, which applies only to the lower tubesheet region, showed that tube plugging or repair is not required in many cases to maintain tube bundle integrity. With the analyses described in this submittal for EF* and WCAP-14225, Revision 1, it is also shown that plugging and repair are not required for defects higher in the tubesheet (up to 2 inches from the top of the tubesheet) in order to maintain tube bundle integrity. WCAP-14225, Revision 1, was developed by Westinghouse specifically for Prairie Island and provides EF* criterion for the Prairie Island steam generators.

The basis for steam generator tube surveillance and plugging/repair is to ensure that the structural integrity of the tubes is maintained. The EF* criterion was developed to allow for an alternative to tube plugging or sleeving for indications which occur in the tubesheet area. The EF* criterion was premised on the fact that the tubesheet provides reinforcement of the expanded portion of the tube, provides resistance to tube rupture and collapse, and limits leakage of through wall cracks. The EF* criterion length of undegraded expanded tube in the tubesheet has been found by testing to be sufficient to maintain any potential leakage (resulting from cracks occurring further down in the tubesheet) to well below the Technical Specification limit and Safety Analysis assumptions. WCAP-14225, Revision 1, describes in detail the analysis and testing performed to demonstrate acceptability of the EF* criterion.

The proposed Technical Specification change is requested to provide Prairie Island with an alternative for dispositioning steam generator tubes degraded in the tubesheet region. The proposed amendment offers several benefits including:

1. Reduced occupational radiation exposure that would otherwise be incurred by plant workers involved in tube plugging or sleeving operations.

2. Minimizing the loss of margin in the reactor coolant flow through the steam generator in LOCA analyses.
3. Avoiding loss of margin in reactor coolant system flow and therefore assisting in assuring that minimum flow rates are maintained in excess of that required for operation at full power.
4. Reduction in the length of plant outages and the time that the steam generators are open to the containment environment during an outage as a result of the reduction in the amount of tube plugging or sleeving required.
5. Less complex eddy current inspections because of fewer sleeved tubes.
6. Reduced tube plugging and sleeving will contribute to longer steam generator life.

Safety Evaluation

Introduction

The amendment has been proposed to address eddy current indications of tube degradation which can occur in the tubes within the tubesheet in the steam generators at Prairie Island Units 1 and 2. These steam generators were fabricated with a 2.75 inch partial depth roll expansion in the tubesheet. Interpretation of eddy current data and metallurgical examination of pulled tubes from the Prairie Island Units and similar plants has shown a potential for primary water stress corrosion cracking (PWSCC) within the roll expanded and roll transition regions of the tube in the tubesheet and secondary side intergranular attack/stress corrosion cracking (IGA/SCC) in the remainder of the tubesheet region. Using existing Technical Specification tube repair criteria within the tubesheet region, tubes with indications are sleeved, repaired utilizing F* in the lower region of the tubesheet or removed from service by plugging.

The EF* criterion will be implemented by forming an additional roll expansion joint up to two inches below the top of the tubesheet. The additional hard roll expansion will be about two inches long. The EF* distance when applied below two inches from the top of the tubesheet, has been determined to be 1.62 inches (excluding NDE uncertainty) for the Prairie Island steam generators. The difference between the F* and EF* criteria is that EF* must consider the effect of tubesheet bowing above the neutral bending axis of the tubesheet.

It can be shown that tube plugging or sleeving is not required in many such cases to maintain steam generator tube integrity. The proposed amendment would revise Technical Specification Section 4.12 specifying an EF* distance of additional roll expansion within the tubesheet below which indications of degradation would have no impact on the determination of integrity of a steam generator tube. As a result, 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* criterion. The proposed change will provide adequate assurance of steam generator tube integrity because the presence of the tubesheet in conjunction with the hardroll process significantly reduces the potential for tube failure and/or leakage within the tubesheet area when compared to the free span portion of the tube. The presence of the tubesheet provides for constraint of the tube, and the tubesheet complements the integrity of the tube 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* criterion provides a similar level of protection for tube degradation in the tubesheet region as that afforded by Regulatory Guide 1.121, "Bases for Plugging Degraded PWR Steam Generator Tubes", for degradation located outside the tubesheet region.

The use of the EF* criterion will reduce the amount of tube plugging or sleeving required and thus would reduce occupational radiation exposure that would otherwise be incurred by plant workers involved in steam generator tube repair. The proposed amendment would also avoid loss of margin in reactor coolant system flow and therefore assist in assuring that minimum flow rates are maintained in excess of that required for operation at full power.

The possibility of tube repair by sleeving should not be considered a reason to exclude use of this proposed tubesheet plugging criterion, but should be considered one of the options used to address degradation in the tubesheet region of the tube.

Evaluation

Tubes can be expanded in the steam generator tubesheet by a hardrolling process which expands the tube to bring the outside surface into intimate contact with the tubesheet hole. The roll process and roll torque are specified to result in a metal-to-metal interference fit between the tube and the tubesheet. Tubes with hard sludge present were demonstrated in Combustion Engineering Report CEN-620-P to not move during load cycling and push tests, but did leak at a maximum value of 6.87×10^{-4} gallons per hour. Qualification testing of the elevated additional roll expansion will be provided in the revised Combustion Engineering report.

When the tubes have been hardrolled into the tubesheet, any axial loads developed by pressure and/or mechanical forces acting on the tubes are resisted by frictional forces developed by the elastic preload that exists between the tube and the tubesheet. For some specific length of engagement of the hardroll, no significant axial forces will be transmitted further down the tube, and that length of tubing, the EF* distance, will be sufficient to anchor the tube in the tubesheet. In order to determine the EF* distance for application in Westinghouse Model 51 steam generators, a testing program was conducted to measure the elastic preload of the tubes in the tubesheet.

The proposed EF* distance provides for sufficient engagement of the tube-to-tubesheet hardroll such that pullout forces that could be developed during normal or accident operating conditions would be successfully resisted by the elastic preload between the tube and tubesheet.

An axial length of roll expansion equal to the EF* distance provides sufficient structural integrity to preclude pull out of the tube due to pressure effects, even after assuming that the tube has experienced a complete circumferential separation at or below the bottom of the EF* distance. This same axial length of roll expansion of the tube into the tubesheet provides a barrier to leakage during all plant conditions for through wall cracking of the tube in the expanded region below EF*.

The proposed change designates a portion of the tube below which tube degradation does not necessitate remedial action. As noted above, the area subject to this change is in an additional expanded portion of the tube within the tubesheet of the steam generators. The EF* length has been determined to be 1.62 inches (not including eddy current uncertainty). Sound roll expansion of 1.62 inches will satisfy all applicable recommendations of Regulatory Guide 1.121, with regard to tube burst capability.

As described above, the EF* criterion requires a minimum length of hardroll engagement below the bottom of the roll transition. For Prairie Island, an EF* distance of 1.62 inches has been proposed. The presence of the elastic preload presents a significant resistance to flow of primary-to-secondary or secondary-to-primary water for degradation which has progressed fully through the thickness of the tube wall. In effect, no leakage would be expected if a sufficient length of hardroll is present. Because of the difficulty in accurately sizing stress corrosion crack indications, the proposed Technical Specifications require that no indications of cracking can be present within the EF* distance in tubes to which the EF* criterion is applied. This requirement has the effect of preventing the start of a leak path.

The issue of leakage within the EF* region up to the top of the roll transition includes the consideration of postulated accident conditions. The relationship between the tubesheet region leak rate at most limiting postulated accident (feedline break) conditions relative to that for normal plant operating conditions has been assessed. For the postulated leak source within the roll expansion, increasing the differential pressure on the tube wall increases the driving head for the leak; however, it also increases the tube to tubesheet loading. For an initial location of a leak source a distance greater than EF* below the bottom of the roll transition, the feedwater line break pressure differential results in an insignificant leak rate relative to that which could be associated with normal plant operation. This is a result of the increased tube to tubesheet loading associated with the increased differential pressure. Thus, for a circumferential indication below the EF* region, any leakage under accident conditions would be less than that experienced under normal operating conditions. Therefore, any

leakage under accident conditions would be less than the existing Technical Specification leakage limit which is consistent with accident analysis assumptions.

Steam generator tube integrity must be maintained under the postulated loss of coolant accident condition of secondary-to-primary differential pressure. Based on tube collapse strength characteristics, the constraint provided to the tube by the tubesheet gives a margin between the tube collapse strength and the limiting secondary-to-primary differential pressure condition, even in the presence of circumferential or axial indications.

Conclusions

In conclusion, Northern States Power believes there is reasonable assurance that the health and safety of the public will not be adversely affected by the proposed Technical Specification changes.

Determination of Significant Hazards Considerations

The proposed changes to the Operating License have been evaluated to determine whether they constitute a significant hazards consideration as required by 10 CFR Part 50, Section 50.91 using the standards provided in Section 50.92. This analysis is provided below:

1. The proposed amendment will not involve a significant increase in the probability or consequences of an accident previously evaluated.

The supporting technical and safety evaluations of the subject criterion demonstrate that the presence of the tubesheet will enhance the tube integrity in the region of the hardroll by precluding tube deformation beyond its initial expanded outside diameter. The resistance to both tube rupture and tube collapse is strengthened by the presence of the tubesheet in that region. The results of hardrolling of the tube into the tubesheet is an interference fit between the tube and the tubesheet. Tube rupture cannot occur because the contact between the tube and tubesheet does not permit sufficient movement of tube material. The radial preload developed by the rolling process will secure a postulated separated tube end within the tubesheet during all plant conditions. In a similar manner, the tubesheet does not permit sufficient movement of tube material to permit buckling collapse of the tube during postulated LOCA loadings.

The EF* length of roll expansion is sufficient to preclude tube pullout from tube degradation located below the EF* distance, regardless of the extent of the tube degradation. The existing Technical Specification leakage rate requirements and accident analysis assumptions remain unchanged in the unlikely event that significant leakage from this region does occur. As noted above, tube rupture and

pullout is not expected for tubes using the EF* criterion. Any leakage out of the tube from within the tubesheet at any elevation in the tubesheet is fully bounded by the existing steam generator tube rupture analysis included in the Prairie Island Plant USAR. For plants with partial depth roll expansion like Prairie Island, a postulated tube separation within the tube near the top of the roll expansion (with subsequent limited tube axial displacement) would not be expected to result in coolant release rates equal to those assumed in the USAR for a steam generator tube rupture event due to the limited gap between the tube and tubesheet. The proposed plugging criterion does not adversely impact any other previously evaluated design basis accident.

Leakage testing of roll expanded tubes indicates that for roll lengths approximately equal to the EF* distance, any postulated faulted condition primary to secondary leakage from EF* tubes would be insignificant.

2. The proposed amendment will not create the possibility of a new or different kind of accident from any accident previously analyzed

Implementation of the proposed EF* criterion does not introduce any significant changes to the plant design basis. Use of the criterion does not provide a mechanism to initiate an accident outside of the region of the expanded portion of the tube. Any hypothetical accident as a result of any tube degradation in the expanded portion of the tube would be bounded by the existing tube rupture accident analysis. Tube bundle structural integrity will be maintained. Tube bundle leaktightness will be maintained such that any postulated accident leakage from EF* tubes will be negligible with regard to offsite doses.

3. The proposed amendment will not involve a significant reduction in the margin of safety.

The use of the EF* criterion has been demonstrated to maintain the integrity of the tube bundle commensurate with the requirements of Reg Guide 1.121 (intended for indications in the free span of tubes) and the primary to secondary pressure boundary under normal and postulated accident conditions. Acceptable tube degradation for the EF* criterion is any degradation indication in the tubesheet region, more than the EF* distance below the bottom of the transition between the roll expansion and the unexpanded tube. The safety factors used in the verification of the strength of the degraded tube are consistent with the safety factors in the ASME Boiler and Pressure Vessel Code used in steam generator design. The EF* distance has been verified by testing to be greater than the length of roll expansion required to preclude both tube pullout and significant leakage during normal and postulated accident conditions. Resistance to tube pullout is based upon the primary to secondary pressure differential as it acts on the surface area of the tube, which includes the tube wall cross-section, in addition to the inner diameter based area of the tube. The leak testing acceptance criteria are based on the primary to

secondary leakage limit in the Technical Specifications and the leakage assumptions used in the USAR accident analyses.

Implementation of the tubesheet plugging criterion will decrease the number of tubes which must be taken out of service with tube plugs or repaired with sleeves. Both plugs and sleeves reduce the RCS (reactor coolant system) flow margin; thus, implementation of the EF* criterion will maintain the margin of flow that would otherwise be reduced in the event of increased plugging or sleeving.

Based on the above, it is concluded that the proposed change does not result in a significant reduction in margin with respect to plant safety as defined in the USAR or the Technical Specification Bases.

Based on the evaluation described above, and pursuant to 10 CFR Part 50, Section 50.91, Northern States Power Company has determined that operation of the Prairie Island Nuclear Generating Plant in accordance with the proposed license amendment request does not involve any significant hazards considerations as defined by NRC regulations in 10 CFR Part 50, Section 50.92.

Environmental Assessment

Northern States Power has evaluated the proposed changes and determined that:

1. The changes do not involve a significant hazards consideration,
2. The changes do not involve a significant change in the types or significant increase in the amounts of any effluents that may be released offsite, or
3. The changes do not involve a significant increase in individual or cumulative occupational radiation exposure.

Therefore, the proposed Technical Specification changes would not result in a significant radiological environmental impact.