

ATTACHMENT 1

PROPOSED TECHNICAL SPECIFICATION CHANGES

8805180368 880506
PDR ADOCK 05000369
P DCD

No changes
This page

REACTOR COOLANT SYSTEM

3/4.4.5 STEAM GENERATORS

LIMITING CONDITION FOR OPERATION

3.4.5 Each steam generator shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With one or more steam generators inoperable, restore the inoperable generator(s) to OPERABLE status prior to increasing T_{avg} above 200°F.

SURVEILLANCE REQUIREMENTS

4.4.5.0 Each steam generator shall be demonstrated OPERABLE by performance of the following augmented inservice inspection program and the requirements of Specification 4.0.5.

4.4.5.1 Steam Generator Sample Selection and Inspection - Each steam generator shall be determined OPERABLE during shutdown by selecting and inspecting at least the minimum number of steam generators specified in Table 4.4-1.

4.4.5.2 Steam Generator Tube Sample Selection and Inspection - The steam generator tube minimum sample size, inspection result classification, and the corresponding action required shall be as specified in Table 4.4-2. The inservice inspection of steam generator tubes shall be performed at the frequencies specified in Specification 4.4.5.3 and the inspected tubes shall be verified acceptable per the acceptance criteria of Specification 4.4.5.4. The tubes selected for each inservice inspection shall include at least 3% of the total number of tubes in all steam generators; the tubes selected for these inspections shall be selected on a random basis except:

- a. Where experience in similar plants with similar water chemistry indicates critical areas to be inspected, then at least 50% of the tubes inspected shall be from these critical areas;
- b. The first sample of tubes selected for each inservice inspection (subsequent to the preservice inspection) of each steam generator shall include:

SURVEILLANCE REQUIREMENTS (Continued)

- 1) All nonplugged tubes that previously had detectable wall penetrations (greater than 20%),
 - 2) Tubes in those areas where experience has indicated potential problems, and
 - 3) A tube inspection (pursuant to Specification 4.4.5.4.a.8) 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.
- c. In addition to the 3% sample, all F* tubes will be inspected.
- d. The tubes selected as the second and third samples (if required by Table 4.4-2) during each inservice inspection may be subjected to a partial tube inspection provided:
- 1) The tubes selected for these samples include the tubes from those areas of the tube sheet array where tubes with imperfections were previously found, and
 - 2) The inspections include those portions of the tubes where imperfections were previously found.

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

<u>Category</u>	<u>Inspection Results</u>
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 (greater than 10%) further wall penetrations to be included in the above percentage calculations.

No changes
this page

REACTOR COOLANT SYSTEM

SURVEILLANCE REQUIREMENTS (Continued)

4.4.5.3 Inspection Frequencies - The above required inservice inspections of steam generator tubes shall be performed at the following frequencies:

- a. The first inservice inspection shall be performed after 6 Effective Full Power Months but within 24 calendar months of initial criticality. Subsequent inservice inspections shall be performed at intervals of not less than 12 nor more than 24 calendar months after the previous inspection. If two consecutive inspections following service under AVT conditions, not including the preservice inspection, result in all inspection results falling into the C-1 category or if two consecutive inspections demonstrate that previously observed degradation has not continued and no additional degradation has occurred, the inspection interval may be extended to a maximum of once per 40 months;
- b. If the results of the inservice inspection of a steam generator conducted in accordance with Table 4.4-2 at 40-month intervals fall in Category C-3, the inspection frequency shall be increased to at least once per 20 months. The increase in inspection frequency shall apply until the subsequent inspections satisfy the criteria of Specification 4.4.5.3a; the interval may then be extended to a maximum of once per 40 months; and
- c. Additional, unscheduled inservice inspections shall be performed on each steam generator in accordance with the first sample inspection specified in Table 4.4-2 during the shutdown subsequent to any of the following conditions:
 - 1) Reactor-to-secondary tubes leaks (not including leaks originating from tube-to-tube sheet welds) in excess of the limits of Specification 3.4.6.2,
 - 2) A seismic occurrence greater than the Operating Basis Earthquake,
 - 3) A loss-of-coolant accident requiring actuation of the Engineered Safety Features, and
 - 4) A main steam line or feedwater line break.

REACTOR COOLANT SYSTEM

SURVEILLANCE REQUIREMENTS (Continued)

4.4.5.4 Acceptance Criteria

a. As used in this specification:

- 1) 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;
- 2) Degradation means a service-induced cracking, wastage, wear or general corrosion occurring on either inside or outside of a tube;
- 3) Degraded Tube means a tube containing imperfections greater than or equal to 20% of the nominal wall thickness caused by degradation;
- 4) % Degradation means the percentage of the tube wall thickness affected or removed by degradation;
- 5) Defect means an imperfection of such severity that it exceeds the plugging limit. A tube containing a defect is defective;
- 6) Plugging Limit means the imperfection depth at or beyond which the tube shall be removed from service and is equal to 40% of the nominal tube wall thickness. This definition does not apply to the area of the tubesheet region below the F* distance provided the tube is not degraded (i.e., no indications of cracking) within the F* distance.
- 7) 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 as specified in 4.4.5.3c, above;
- 8) 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; and

~~NOTE 1: The application of F* expires at the end of the fifth fuel cycle for each respective unit.~~

REACTOR COOLANT SYSTEM

SURVEILLANCE REQUIREMENTS (Continued)

- 9) Preservice Inspection means an inspection of the full length of each tube in each steam generator performed by eddy current techniques prior to service to establish a baseline condition of the tubing. This inspection shall be performed after the field hydrostatic test and prior to initial POWER OPERATION using the equipment and techniques expected to be used during subsequent inservice inspections.
 - 10) F* Distance is the distance into the tubesheet from the top face of the tubesheet or the top of the last hardroll, whichever is lower (further into the tubesheet) that has been conservatively chosen to be 2 inches.
 - 11) F* TUBE is a tube with degradation equal to or greater than 40% below the F* distance and not degraded (i.e., no indications of cracking) in the F* distance.
- b. The steam generator shall be determined OPERABLE after completing the corresponding actions (plug all tubes exceeding the plugging limit and all tubes containing through-wall cracks) required by Table 4.4-2.

4.4.5.5 Reports

- a. Within 15 days following the completion of each inservice inspection of steam generator tubes, the number of tubes plugged in each steam generator shall be reported to the Commission in a Special Report pursuant to Specification 6.9.2;
- b. The complete results of the steam generator tube inservice inspection shall be submitted to the Commission in a Special Report pursuant to Specification 6.9.2 within 12 months following the completion of the inspection. This Special Report 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.
- c. The results of inspections of F* tubes shall be reported to the Commission ~~in a report to the Director, ONRR, prior to the restart of the unit following the inspection.~~ This report shall include:
per the requirements of SECTION 4.4.5.5 part a.
 - 1) Identification of F* tubes, and
 - 2) Location and size of the degradation.

TABLE 4.4-1

MINIMUM NUMBER OF STEAM GENERATORS TO BE INSPECTED DURING INSERVICE INSPECTION

Preservice Inspection	No			Yes		
	Two	Three	Four	Two	Three	Four
No. of Steam Generators per Unit				One	Two	Two
First Inservice Inspection	All			One	Two	Two
Second & Subsequent Inservice Inspections	One ¹			One ¹	One ²	One ³

Table Notation:

1. The inservice inspection may be limited to one steam generator on a rotating schedule encompassing 3 N % of the tubes (where N is the number of steam generators in the plant) if the results of the first or previous inspections indicate that all steam generators are performing in a like manner. Note that under some circumstances, the operating conditions in one or more steam generators may be found to be more severe than those in other steam generators. Under such circumstances the sample sequence shall be modified to inspect the most severe conditions.
2. The other steam generator not inspected during the first inservice inspection shall be inspected. The third and subsequent inspections should follow the instructions described in 1 above.
3. Each of the other two steam generators not inspected during the first inservice inspections shall be inspected during the second and third inspections. The fourth and subsequent inspections shall follow the instructions described in 1 above.

No changes
this page

TABLE 4.4-2

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	Plug defective tubes and inspect additional 2S tubes in this S. G.	C-1	None	N/A	N/A
			C-2	Plug defective tubes and inspect additional 4S tubes in this S. G.	C-1	None
					C-2	Plug defective tubes
			C-3	Perform action for C-3 result of first sample	N/A	N/A
	C-3	Inspect all tubes in this S. G., plug defective tubes and inspect 2S tubes in each other S. G.	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 plug defective tubes.	N/A	N/A

$S = 3 \frac{N}{n} \%$ Where N is the number of steam generators in the unit, and n is the number of steam generators inspected during an inspection

*No changes
 this page*

ATTACHMENT 2

JUSTIFICATION AND SAFETY ANALYSIS

I. Purpose

The purpose of this document is to present the justification for permanently including the F* criterion in Technical Specification (TS) 3/4.4.5, "Steam Generators" for McGuire Units 1 and 2. Authorization to apply the F* criterion currently expires at the end of the fifth fuel cycle for each unit.

II. Introduction

The F* criterion was developed to permit steam generator tubes to remain in service when degradation has been detected in the full depth hard roll expanded portion of the tube in the tube sheet below the "F*" distance (2"). If the F* criterion were not in use for McGuire Units 1 and 2, defects below the F* distance would require the affected tubes to be plugged. Based on technical considerations, such plugging is not necessary. The presence of the tube sheet constrains the tube and complements its integrity in the hard rolled region by precluding tube deformation beyond its expanded outside diameter. The resistance to both tube rupture and tube collapse is significantly strengthened by the tube sheet. In addition, the intimate contact between the tube and the tube sheet affects the leak behavior of throughwall tube cracks in this region. No significant leakage relative to plant technical specification allowables has been experienced.

The technical basis for establishing the F* criterion has been presented previously in Westinghouse Reports WCAP 11224 and 11225. The F* criterion identifies a distance below the top of the tube sheet designated F*, below which tube degradation of any extent does not necessitate plugging. To date, the F* criterion has been utilized twice at McGuire Unit 1 during the EOC 3 and EOC 4 outages and once at McGuire Unit 2 during the EOC 3 outage. The information presented below is considered to justify continuing the application of the F* criterion for the life of the plant.

III. Approach

As noted in Section II, the technical justification for use of the F* criterion has been demonstrated previously. To date, no new test data or information has been presented by the developer of the F* criterion which influences the original technical justification for the F* criterion. In addition, no adverse effects of the application of the F* criterion at McGuire or any other plant have been identified to date. Accordingly, the originally submitted justification is considered to still be applicable and to provide justification for continued use of the F* criterion. In addition, the following approaches have been used to provide further evidence that continued use of the F* criterion at McGuire Units 1 and 2 is justified:

1. Review of McGuire Data - Eddy current inspection results, tube plugging data, and tube leakrate data were reviewed to determine the effect, if any, of the F* criterion on tube plugging requirements and leakage rates. Inspection results were also utilized to determine actual trends in tube degradation since implementation of the F* criterion, as well as predicted trends in degradation had the F* criterion not been utilized. The concurrent effects of tube sheet shot peening were also considered.

2. Review of Industry Data - Eddy current inspection results and related data from other units incorporating the F* criterion or a similar approach were reviewed for their applicability to the McGuire units. These results are used to further understand the effects of the F* criterion on tube plugging requirements and leakage rates.

In addition, this document discusses the changes required in the text of TS 3/4.4.5 which are to be incorporated into the permanent version of the F* criterion.

IV. Justification

1. Review of McGuire Data

A. Review of Eddy Current (EC) Inspection Data

A review of EC inspection results shows that a total of 229 tubes in McGuire Unit 1 were allowed to remain in service based on the F* criterion during the 1986 and 1987 outages (see Table 1). At McGuire Unit 2, a total of 99 tubes were allowed to remain in service based on the F* criterion during the 1987 outage (see Table 2). No problems such as subsequent abnormal EC indications or primary to secondary leaks associated with these tubes left in service have been noted.

Duke's submittals dated June 17, 1987 and October 8, 1987 document inspection results on F* tubes. While crack growth may occur, the crack would be arrested at the end of the "skip roll" region where the residual stresses are relieved. Additionally, as EC techniques and technology improve, some indications previously identified (conservatively) as cracks are being determined not to be cracks.

B. Review of Tube Leakage Data

A review of primary coolant leakrates for McGuire Units 1 and 2 from approximately December, 1986 through February, 1988 indicates that leakrates have remained well below the limits specified by the plant technical specifications. In addition, the leakrate data indicates that no significant increases, transients, or abnormalities in the leakrates have been associated with the tubes which have remained in service due to the F* criterion.

C. Other Possible Effects of the F* Criterion

A review of the ECT data for the McGuire units and other related plants indicates no adverse effects on tube sheet integrity caused by degraded tubes remaining in service below the F* region. However, if degraded tubes were to leak and cause degradation of the tube sheet material, corrosion products would result in constriction of the tube within the tube sheet at that location. No evidence of such tube constriction has been identified in any operating plant.

2. Review of Industry Data

A. Review of EC Inspection Data

Several other operating plants in the U.S.A. and overseas are presently utilizing alternate plugging criteria similar to the F* criteria being used at McGuire Units 1 and 2. These units are in general similar in design and operation to the McGuire units (Westinghouse Model D steam generators). A review of EC inspection results for these plants indicates that the impact of the alternate criteria on tube plugging status has been approximately equal to the impact of the F* criterion at the McGuire units. To date, no abnormal Eddy Current indication or primary to secondary leaks associated with the tubes left in service due to the alternate criteria at these other units have been noted.

B. Review of Tube Leakrate Data

A review of tube leakrate data from other plants presently utilizing alternate plugging criteria for tube sheet region degradation indicates that no significant increases, transients, or abnormalities in leakrates have been associated with the tubes which have remained in service due to the alternate plugging criterion.

3. Impact of F* Criterion on Steam Generator Plugging Status

A. Impact of F* to Date

As noted previously, use of the F* criterion has been of significant benefit in limiting the number of tubes plugged due to degradation in the tube sheet region in the McGuire Units 1 and 2 steam generators. The 229 tubes left in service using F* criteria at McGuire Unit 1 represented 58% of the potentially pluggable tubes identified in 1986 and 1987. To date, degradation of tubes in the tube sheet region has resulted in a cumulative plugging of 0.92% in these steam generators. If the F* criterion had not been implemented, cumulative plugging due to degradation in this area would currently be 2.17% (see Table 1). Similarly in the McGuire Unit 2 steam generators, the 99 tubes left in service using F* criteria represented 41% of the potentially pluggable tubes identified in 1987. Presently, tube sheet degradation has resulted in a cumulative plugging of 0.80% in these steam generators. If the F* criterion had not been implemented, cumulative plugging due to tube sheet degradation would currently be 1.34% (see Table 2).

In addition, if the F* criterion had not been implemented on both McGuire units the total personnel exposure would have been higher. Plugging of steam generator tubes is now performed by the Babcock and Wilcox robot ROGER. While this results in substantially lower personnel doses per tube plugged (40 mRem with ROGER versus approximately 310 mRem before ROGER), this dose can quickly accumulate considering hundreds of tubes are presently involved, with the potential for more as time progresses.

B. Impact of F* Criterion on Future Tube Plugging Requirements

Hot leg tube sheet degradation is expected to decline from present rates because of shot peening but the ratio of tubes plugged to F* tubes should remain the same as the degradation rates decline. Therefore F* will continue to be effective in preventing unnecessary tube plugging.

In addition, it is expected that degradation in the cold leg tube sheet region may be detected in the McGuire steam generators after 5-10 EFPYs of operation. The same mechanism is at work on the cold leg tube sheet region, however the reduced temperature significantly slows the process. Shot peening of the cold leg tube sheet region is currently planned for EOC 6 for Unit 1 (1990) and EOC 5 for Unit 2 (1989). It is anticipated that the F* criterion applied to the cold leg tube sheet region will significantly reduce the number of tubes which will require plugging due to degradation in this region.

C. Impact of Tube Sheet Peening on Tube Plugging Status

Available plant data indicates that peening is expected to have a significant mitigating effect by two cycles after peening has been implemented. Each unit's steam generator hot leg tubesheet regions were shot peened at the EOC 3 (Unit 1 - 1986, Unit 2 - 1987). It is expected that the number of tubes requiring plugging due to tube sheet degradation will continue to decline for the life of the plant as a result of tube sheet peening.

V. Summary

From the information presented in Section IV, the following conclusions can be made regarding the implementation and use of the F* criterion at McGuire Units 1 and 2:

- A. Use of the F* criterion at McGuire has had no adverse impact on any aspect of steam generator operability. No significant change in primary to secondary coolant leakrates have been observed, and no degradation of tubesheet material has been identified as a result of the F* criteria.
- B. Other plants similar in design and operation to the McGuire units have successfully implemented alternate plugging criterion such as F* with no adverse effects on steam generator operability.
- C. The F* criterion has had, and is expected to continue to have, a significant positive impact on overall tube plugging status in the McGuire steam generators.

- D. It is considered that these findings represent sufficient justification for including the F* criterion as a permanent part of TS 3/4.4.5, "Steam Generators". In addition, it is considered that the information presented in Section IV represents sufficient evidence that the F* criterion is functioning safely and effectively, and therefore, that reporting requirements for tubes affected by the F* criterion should be the same as for tubes plugged during the plant outage.
- E. The F* criterion has had and will have a positive impact on the reduction of personnel radiation exposure for the life of the plant.

VI. Changes Required in Technical Specification

A number of changes in the text of Technical Specification 3/4.4.5 are proposed for making the F* criterion a permanent part of the technical specification. These changes are outlined below:

- A. Change: Delete Note 1. page 3/4.4-14.

Basis: It is considered that the information presented in Section IV provides sufficient justification for making the F* criterion a permanent part of TS 3/4.4.5, and therefore eliminating an expiration time for its applicability.

- B. Change: Change Section 4.4.5.5, part c, page 3/4 4-15, to read: "The results of inspections of F* tubes shall be reported to the Commission per the requirements of Section 4.4.5.5 part a. The reported data shall include:

- 1) Identification of F* tubes, and
- 2) Location and size of the degradation."

Basis: It is considered that the information presented in Section IV provides sufficient evidence that the F* criterion is functioning safely and effectively, and therefore, that reporting requirements for tubes affected by the F* criterion should be the same as for tubes plugged during the plant outage.

McGUIRE-1 TUBE SHEET PWSCC STATUS

Inspection	1985 (EOC 2)	1986 (EOC 3)	1987 (EOC 4)
Tubes Inspected	2485	6105	18180 ¹
Tubes with Indications	2	140	312
Tubes Plugged	2	37	128
Pluggings Avoided Using F* Criteria	-	103	126
Repeat F* Indications	-	-	58
Cumulative Plugged (%)	0.08	0.69	0.92
Cumulative Plugged (%) If No F* Criteria	0.08	1.24	2.17

1 Represents 100% inspection of tubes remaining in-service

TABLE 1

McGUIRE-2 TUBE SHEET PWSCC STATUS

Inspection	1986 (EOC 2)	1987 (EOC 3)
Tubes Inspected	2887	18234 ¹
Tubes with Indications	3	240
Tubes Plugged	3	141
Pluggings Avoided Using F* Criteria	-	99
Repeat F* Indications	-	-
Cumulative Plugged (%)	0.10	0.80
Cumulative Plugged (%) If No F* Criteria	0.10	1.34

¹ Represents 100% inspection of tubes remaining in-service

ATTACHMENT 3

ANALYSIS OF SIGNIFICANT HAZARDS CONSIDERATIONS

Analysis of Significant Hazards Considerations

Pursuant to 10CFR 50.91, this analysis provides a determination that the proposed amendment does not involve any significant hazards considerations as defined by 10CFR 50.92.

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

As documented in the previous submittals, WCAPs, and Attachment 2, the utilization of the F* criterion does not impact the operability of the steam generators. The restraining action of the tubesheet upon the tubes precludes tube rupture or collapse for F* tubes, and the tubes to tubesheet interface restricts any leakage to small amounts relative to Technical Specification limits.

The prevention of tube rupture by the tubesheet assures the probability of this accident is unaffected, while the restriction of leakage as discussed above assures that the consequences of any accident are not significantly affected by the application of F*.

The proposed changes to the reporting requirements are an administrative matter to allow Duke slightly more time to assimilate the required information and to combine the two reports (number of tubes plugged and F* report) into one document for submittal. Since F* tubes have behaved as expected, the immediacy of the F* report as originally conceived has been determined to be unnecessary. The same information will be submitted to the Commission, just on a slightly different required schedule. The data is not of immediate safety concern as it does not affect the probability or consequences of an accident. In practice, these two reports (tubes plugged and F* tubes) have been combined on two previous occasions: June 17, 1987 for McGuire 2 EOC3 and October 8, 1987 for McGuire 1 EOC4.

- 2) The proposed amendment would not create the possibility of a new or different kind of accident previously evaluated.

The proposed changes continue to ensure the integrity of the steam generator tubes and the tubesheet. With the integrity of the steam generator maintained, and no other potential hardware or procedural changes, no new accident scenarios may be created.

The proposed change to the reporting requirements is strictly an administrative change of no safety significance and does not change the information provided the Commission, merely the timing of the submittal.

- 3) The proposed amendment would not involve a significant reduction in a margin of safety.

The proposed changes would extend the F* criteria, currently in use, for the life of the station. Testing as documented in support of the original amendment (Amendments 59 and 40 for Units 1 and 2, respectively) and operational experience have revealed that the tubes behaved as expected (remained restrained by the tubesheet, no significant leakage) and do not present a safety concern.

The proposed change in the reporting requirements is an administrative matter as previously discussed and does not affect any margins of safety.

Additionally, the Commission has previously found the F* criteria to be acceptable at McGuire, pending confirmation of tube behavior thru two cycles of operation. (Reference Amendments 59 and 40 to NPF-9 and NPF-17, respectively, for McGuire Nuclear Station, Units 1 and 2, respectively, dated August 19, 1986.) As detailed in Attachment 2 of this proposal, the behavior of F* tubes has been as expected. The shot peening of the hot leg tubesheet region and the planned shot peening of the cold leg tubesheet region will serve to arrest the primary water stress corrosion cracking (PWSCC) in the tubes. With the degradation of the tubesheet region of the steam generators essentially arrested, the integrity of the generators is assured, thus the F* criteria may be extended for the life of the plant without decreasing plant safety.

Based upon the preceding analysis, Duke Power concludes, in accordance with 10CFR 50.91, that the proposed changes do not involve any significant hazards considerations as defined by 10CFR 50.92.