BAW-10236
DECEMBER 1999

ADDENDUM

FOR

DAVIS-BESSE REPAIR ROLL

UTS EXCLUSION ZONES

FTI NON-PROPRIETARY

FRAMATOME TECHNOLOGIES
P.O. BOX 10935
LYNCHBURG, VA 24506-0935

FRAMATOME
TECHNOLOGIES

This document is the non-proprietary version of the proprietary document BAW-10236P-00. In order for this document to meet the non-proprietary criteria, certain blocks of information were withheld. The basis for determining what information to withhold was based on the three criteria listed below. Depending upon the applicable criteria, the criteria code, (b), (c), or (d), represents the withheld information.

(b) The information reveals data or material concerning FTI research or development plans or programs of present or potential competitive advantage to FTI.

(c) The use of the information by a competitor would decrease his expenditures, in time or resources, in designing, producing or marketing a similar product.

(d) The information consists of test data or other similar data concerning a process, method or component, the application of which results in a competitive advantage to FTI.

RECORD OF REVISION

Revision	Date	Section	Description
0	12/16/99	All	Original Issue

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

Toledo Edison Company has implemented a steam generator tube repair roll program at Davis-Besse Unit 1. One of the current design requirements of the repair roll is that it not slip under any normal operating or accident loading conditions. This document evaluates the recently determined Davis-Besse specific MSLB and SBLOCA conditions against the load carrying capability of the repair roll in order to revise the exclusion zones for the repair roll. The new UTS exclusion zones for repair roll installation are listed in Table 2 and replace the exclusion zones listed in Reference 2.1.

The evaluation is performed by comparing [ ][(d)] of the postulated tube load (based on transient analysis) to the maximum load carrying capability of the repair roll. These comparisons are performed as a function of radius and elevation within the tubesheet. The scope of this work is limited to the upper tubesheet due to the current limitation of the repair roll to the upper tubesheet.

Based on the large exclusion zones resulting for a single repair roll subjected to an SBLOCA, a [ ][(b)] repair roll is also considered. This length of roll is achieved by installing two overlapping rolls.

2.0 REFERENCES

1. FTI Document No. (BAW) 43-2303P-03, "OTSG Repair Roll Qualification Report", 10/97 [FTI Proprietary].

2. ASME Boiler and Pressure Vessel Code, Section III, Table N-427, 1968 Edition with Addenda thru Summer 1968.

3.0 ABBREVIATIONS AND ACRONYMS

1. ID – Inner Diameter
2. MSLB – Main Steam Line Break
3. OD – Outer Diameter
4. OTSG – Once Through Steam Generator
5. SBLOCA – Small Break Loss of Coolant Accident

4.0 METHODOLOGY

The load carrying capability of the repair roll is a function of the amount of contacting surface area, the coefficient of friction, and the contact pressure between the tube and the tubesheet. When comparing room temperature test conditions to various OTSG operating conditions, changes in surface area and coefficient of friction are considered insignificant when compared to the change in contact pressure.

The load testing summarized in Section 5.2 of Reference 2.1 was performed in tubesheet mockups with "as fabricated" bore diameters. In this condition, the contact pressure between the tube and tubesheet is derived from the amount of springback in the tube.

Springback is the term given to the radial interference between the unstressed OD of a rolled tube and the ID of the surrounding tubesheet bore. It is produced by the radial and circumferential deformation caused by the roll expansion process. From testing, it was determined that the average amount of springback due the repair roll process is [ ][(d)] inches [Ref. 2.1, page 5-11] and results in a 95% 1-sided lower tolerance limit load carrying capability of [ ][(d)] lbs [Ref. 2.1, page 5-10].

During certain operating conditions, temperature and pressure changes may reduce the contact pressure between the tube and tubesheet, resulting in less load carrying capability. Changes in contact pressure are a direct result of changes in the amount of net radial interference. Differential dilation is therefore defined as the average change in the relative difference in the dilation between the tube OD and the tubesheet bore ID. Zero differential dilation refers to the condition where the tube-to-tubesheet joint is in the "as installed" condition, which means the only component affecting load carrying capability is the [ ][(d)] inch tube average springback. The differential dilation is equal to the tubesheet bore dilation due to tubesheet bowing and free thermal growth minus the dilation of the tube due to internal pressure and free thermal growth.

The average differential dilations and axial tube loads associated with the most limiting SBLOCA are utilized in this evaluation. The load carrying capability of the repair roll is calculated by first reducing the test load carrying capability [ ][(d)] to account for the effect of the elevated temperature on the tube modulus of elasticity. This load carrying capability is then reduced proportionally to the amount of differential dilation. Because the repair roll installation results in [ ][(d)] of springback, the load carrying capability is reduced [ ][(b)] for every [ ][(d)] of differential dilation. It is assumed that a differential dilation of [ ][(d)] results in no load carrying capability.

The load carrying capability is computed as a function of the tube centerline radial position and the distance below the primary face of the upper tubesheet. If the calculated load carrying capability is greater than the predicted axial tube load due to the postulated SBLOCA, then the repair roll is considered acceptable. The evaluation focuses on placing the repair roll from [ ][(b)] below the primary face of the upper tubesheet.

5.0 EVALUATION

The repair roll load carrying capability is evaluated for the Davis-Besse specific MSLB and SBLOCA transients in this section. The evaluation is performed utilizing the method discussed in section 4, and considers the cases where the steam generators are 0% and 25% plugged.

5.1 MAIN STEAM LINE BREAK

The load carrying capability of the repair roll over the span [ ][(b)] from the primary face of the tubesheet is plotted as a function of radius. This span is chosen because it represents the current "default" position of the repair roll. The purpose of these plots is to present a visual comparison of the predicted load carrying capability versus the predicted transient design load. These calculations are performed by first calculating the average differential dilation over the [ ] (b) span and then using that dilation to determine the load carrying capability of the repair roll. The transient design loads are then calculated by decreasing the predicted transient loads by [ ] (d) in order to account for the compressive load imparted by the rolling process [Reference 2.1, page 5-16], and then multiplying the difference by [ ](d) in order to include a design margin. These design transient loads are added to the plot in order to determine where the roll is calculated to be able to carry the transient load [ ](d).

Figure 1 shows that the repair roll is predicted to be able to carry the design transient loads at all locations for both the 0% and 25% plugged conditions. The repair roll load carrying capability [ ] (d) is a constant due to the average differential dilations being compressive at all radial locations over the [ ] (b) span.

This same methodology is applied to the entire upper tubesheet region and the results shown in Figure 2. The shaded regions represent the locations where the repair roll load carrying capability is less than the transient design load. [

](d)

Figure 1 Default Roll Position Load Comparison - MSLB

(d)

Figure 2 UTS Exclusion Zones - MSLB

(d)

5.2 SMALL BREAK LOSS OF COOLANT

The load carrying capability of the repair roll over the span [ ] (b) from the primary face of the tubesheet is plotted as a function of radius. This span is chosen because it represents the current "default" position of the repair roll. The purpose of these plots is to present a visual comparison of the predicted load carrying capability versus the predicted transient design load. These calculations are performed by first calculating the average differential dilation over the [ ] (b) span and then using that dilation to determine the load carrying capability of the repair roll. The transient design loads are then calculated by decreasing the predicted transient loads by [ ] (d) in order to account for the compressive load imparted by the rolling process [Reference 2.1, page 5-16], and then multiplying the difference by [ ] (d) in order to include a design margin. These design transient loads are added to the plot in order to determine where the roll is calculated to be able to carry the transient load [ ] (d).

Figure 3 shows that effect of plugging tubes is relatively small. [

] (d)

This same methodology is applied to the entire upper tubesheet region and the results shown in Figure 4. [

] (d)

Figure 3 Default Roll Position Load Comparison - SBLOCA

(d)

Figure 4 UTS Exclusion Zones - SBLOCA

(d)

In accordance with Reference 2.1, a double overlapping roll can be used to form the new pressure boundary. This roll consists of [

] (b) The double overlapping repair roll proposed for use at Davis Besse will be utilized for tubes that are located within the exclusion area for the [ ] (b) repair roll. The length of the [ ](d) rolls is determined by the physical length of the mechanical roll expanders. The overall length of the double roll is determined by the use of mechanical "hard stops" during the installation process.

The load carrying capability of the double repair roll is calculated by multiplying the load carrying capability of a single roll by [ ] (b). The double roll default location is in the span [ ] (b) from the primary face of the upper tubesheet. These calculations are performed by first calculating the average differential dilations over the span [,](b) and then using them in the SBLOCA equation. The transient design load is added to the results shown in Figure 5 in order to determine where the roll is calculated to be able to carry the SBLOCA load.

Figure 5 Default Double Roll Position Load Comparison - SBLOCA

(c)

Figure 5 shows that the [ ] (b) roll meets the design at all tube radial positions. In other words, overlapping rolls installed [ ] (b) below the primary face of the tubesheet are acceptable from a slippage standpoint for all tubes.

This same methodology is now applied to the entire upper tubesheet region and the results shown in Table 1. These results are not shown pictorially due to the fact that the regions for the repair roll overlap each other.

Table 1 Double Roll SBLOCA Exclusion Zones

(d)

Note: "x" refers to the radial position of the tube within the steam generator.

6.0 . RESULTS AND CONCLUSIONS

The purpose of this calculation package is to evaluate the effects of the Davis-Besse specific MSLB and SBLOCA transients on the load carrying capability of the repair roll. In Reference 2.1, the exclusion zones for Davis-Besse were based on a generic MSLB transient analysis. The exclusion zones for installing repair rolls in the upper tubesheet region of the Davis-Besse steam generators are now revised to be based on their site specific transient data.

Table 2 presents the repair roll installation exclusion zones as a function of distance from the primary face of the upper tubesheet. A location is excluded if the repair roll load carrying capability is predicted to be less than [ ](d) of the transient tube load. [

](b)

It may be necessary to place the repair roll at a position other than what is listed in Table 2. In this case, the two positions that the roll would span should both be considered acceptable based on Table 2. For cases where a double roll is to be installed, the exclusion zones are presented in Table 1.

Table 2 Repair Roll UTS Exclusion Zones

(c)

Note: "x" refers to the radial position of the tube within the steam generator and "New Topical Locations" refers to the resulting new exclusion zones based on the other 3 columns.

Docket Number 50-346
License Number NPF-3
Serial Number 2634
Enclosure 3

COMMITMENT LIST

The following list identifies those actions committed to by the Davis-Besse Nuclear Power Station (DBNPS) in this document. Any other actions discussed in this document represent intended or planned actions by the DBNPS. They are described only for information and are not regulatory commitments. Please notify the Manager - Regulatory Affairs (419-321-8466) at the DBNPS of any questions regarding this document or any associated regulatory commitments.

COMMITMENTS	DUE DATE
None	N/A