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

July 21, 2016

LICENSEE: Tennessee Valley Authority

FACILITY: Browns Ferry Nuclear Plant, Units 1, 2, and 3

SUBJECT: SUMMARY OF JUNE 23, 2016, CLOSED MEETING WITH TENNESSEE VALLEY AUTHORITY REGARDING THE STRUCTURAL ADEQUACY OF STEAM DRYERS FOR EXTENDED POWER UPRATE LICENSE AMENDMENT REQUEST FOR BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3 (CAC NOS. MF6741, MF6742, AND MF6743)

On June 23, 2016, a Category I closed meeting was held between the U.S. Nuclear Regulatory Commission (NRC), representatives of Tennessee Valley Authority (TVA, the licensee), and TVA's consultants, General Electric – Hitachi (GEH) and Continuum Dynamics, Incorporated (CDI), at NRC Headquarters, One White Flint North, 11555 Rockville Pike, Rockville, Maryland. The purpose of the meeting was to discuss the Browns Ferry Nuclear Plant, Units 1, 2, and 3 (BFN) Extended Power Uprate license amendment request in terms of the structural adequacy of the steam dryers.

The meeting notice and agenda, dated June 15, 2016, are available in the Agencywide Documents Access and Management System (ADAMS) at Accession No. ML16161A064. A list of attendees is enclosed.

Background

By letter dated September 21, 2015, as supplemented by several letters, TVA submitted a license amendment request for the BFN. The proposed amendment would increase the authorized maximum steady-state reactor core power level for each unit from 3,458 megawatts thermal (MWt) to 3,952 MWt. The NRC staff reviewed the licensee's submittals and determined the need for requests for additional information (RAIs).

On June 3, 2016, NRC sent RAIs to the licensee associated with structural adequacy of the steam dryers based on the review by NRC staff from the Mechanical and Civil Engineering Branch (EMCB). These EMCB-RAIs in Enclosure 2 of the NRC letter contained sensitive unclassified non-safeguard information, therefore, Enclosure 2 was withheld from the public. The licensee proposed a closed meeting for 3 hours to discuss initially EMCB-RAIs 14, 15, 16, and 18, associated with safety relief valve (SRV) resonance loading amplitudes. In response to the licensee's request, NRC conducted a closed meeting on June 23, 2016, with the intention of discussing the licensee's proposed RAIs with TVA and its consultants. TVA provided preliminary unverified draft responses received from GEH to these RAIs to NRC prior to the meeting. TVA also sent a white paper received from CDI to NRC associated with EMCB-RAI-15 prior to the meeting. The NRC staff and its consultants reviewed the draft responses, and determined that the draft responses seem to be reasonable, especially for EMCB-RAI-15. As a result, NRC staff came to the conclusion that 3 hours would not be required to discuss only the above EMCB-RAIs, and suggested to include discussions regarding TVA responses dated June 9, 2016 (ADAMS Accession No. ML16166A151), to EMCB-RAIs 10 and 32, and the NRC staff's proposed draft license conditions for all three units.

Highlights of the Meeting Discussion

- The licensee's draft response to EMCB-RAI-14 seems to be reasonable.
- The licensee's draft response to EMCB-RAI-15 also seems to be reasonable, however, a minor cleanup to its response may be needed to delete quarter wave length information due to uncertainties. The white paper presented by CDI providing the basis and application of BFN SRV acoustic load factor is reasonable to NRC.
- The responses to EMCB-RAIs 16 and 18 may simply refer to response for EMCB-RAI-15.
- NRC agreed to provide the followup EMCB-RAI-10 to obtain more detailed information from the licensee in its response.
- NRC agreed to provide the followup EMCB-RAI-24 to obtain the desired information from the licensee in its response.
- For EMCB-RAI-30, NRC informed the licensee that there is no need to expand the frequency range of vibration monitoring. The main steam isolation valves are angle globe-type, which do not have recessed cavities, therefore, they are not susceptible to flow-induced resonance.
- For RAI-32, the licensee will submit a related response to EMCB-RAI-42 that addresses startup testing.
- The licensee will revise draft license conditions 4, 4(b)2 and 4(h).

EMCB-RAIs 14, 15, 16, and 18 can be found in NRC letter dated June 3, 2016 (ADAMS Accession No. ML16144A645). Enclosure 2 contains white paper from CDI related to EMCB-RAI-15. As stated in the licensee's letter dated June 9, 2016 (ADAMS Accession No. ML16166A151), official responses to these RAIs will be provided to NRC by August 26, 2016. TVA will submit the official proposed license conditions later.

Since this was a closed meeting, members of the public were not allowed to participate. Meeting Feedback forms from the participating members were not received. Please direct any inquiries to me at 301-415-1447 or Farideh.Saba@nrc.gov.

Farideh E. Saba

Farideh E. Saba, Senior Project Manager
Plant Licensing Branch II-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-259, 50-260, 50-296

Enclosures:
1. List of Attendees
2. CDI White Paper

cc w/encl: Distribution via Listserv

LIST OF ATTENDEES

JUNE 23, 2016, CLOSED MEETING WITH TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3

STRUCTURAL ADEQUACY OF STEAM DRYERS ASSOCIATED WITH

EXTENDED POWER UPRATE LICENSE AMENDMENT REQUEST

Name	**Organization**
C. Basavaraju	Nuclear Regulatory Commission (NRC)
Farideh Saba	NRC
Siva P. Lingam	NRC
Steve Hambric	NRC Consultant
Dan Green	Tennessee Valley Authority (TVA)
Pete Donahue	TVA
Gerard J. Doyle	TVA
Eric Frevold	TVA
Jamie Carneal	General Electric - Hitachi (GEH)
Dan Pappone	GEH
Alexander Boschitsch	Continuum Dynamics, Incorporated
Vic Shah*	NRC Consultant
Samir Ziada*	NRC Consultant
Scott Bowman*	GEH
David Spaulding*	GEH
Don Sampson*	GEH
Zhichao Wang*	GEH
Abbas Selmane*	GEH
Michael Heger*	GEH
Michael Kiernan*	GEH
Wei Ren*	GEH

*Participated by phone

Enclosure 1

CDI WHITE PAPER ASSOCIATED WITH EMCB-RAI-15

Enclosure 2

CDI White Paper No. 16-11

Basis and Application of Browns Ferry SRV Acoustic Load Factor

Revision A

Prepared by

Continuum Dynamics, Inc.
34 Lexington Avenue
Ewing, NJ 08618

Prepared under Purchase Order No. 2104480 for

TVA / Browns Ferry Nuclear Plant
Shaw & Nuclear Plant Road
Athens, AL 35611

Prepared by

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Alan J. Bilanin

Reviewed by

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June 2016

Narrative

Standpipes on a main steam line may lock into acoustic resonance whereby the resonance of a standpipe is enhanced or amplified by the presence of other standpipes. In establishing a load definition for Browns Ferry steam dryers at EPU conditions during standpipe resonance, use is made of measured data on the Quad Cities Unit 2 steam dryer. A question has been raised as to whether sufficient SRV standpipe resonances were occurring at Quad Cities to establish a conservative load definition for the Browns Ferry steam dryer. This report documents an approach which can be used to establish a conservative Browns Ferry EPU steam dryer acoustic load definition, and which addresses questions regarding lock-in effects as well as concerns over directly estimating plant dryer loads from scaled test measurement data.

Approach

As a result of a plant being licensed to a given power level it is normally not possible to run the plant at a higher power level to obtain data. To get around this problem it is possible to use subscale testing as described in the Reference 1 to develop scaling factors to apply to plant data at one power level to estimate the data that is expected at the higher power level.

The process would be to measure main steam line pressure data at CLTP conditions in the plant. Then subscale tests would be conducted at CLTP and EPU conditions to develop bump up factors that can be applied to the plant CLTP data to estimate the loads at EPU conditions. In this manner, subscale data is not used in an absolute sense but as a ratio. Errors in magnitude that result from subscale testing occur at both power levels in approximately equal ways. Hence, by ratioing measurements , these errors effectively cancel.

Subscale tests of the Browns Ferry Units 1 and 2 main steam system have been carried out at approximately one-eighth scale. The locations of the safety valve steam pipes are shown in Figure 1 and the complete geometry is described in Reference 1. Photos of the subscale steam delivery system are shown in Figure 2 and 3.

Pressure transducers are located along the main steam lines at the exact scaled distances of the transducers in the plant. The scaled flows in the subscale facility correspond to CLTP and EPU conditions.

The bump-up factor is calculated as a function of frequency, converted from subscale to full scale, with the equation:

$$\text{Bump-Up Factor} = \sqrt{\frac{PSD_{EPU}}{PSD_{CLTP}}}$$

This involves dividing the EPU PSD at each frequency by the CLTP PSD at that frequency, and taking the square root. This equation is used for each of the eight strain gage locations in the frequency interval from 100 Hz to 120 Hz, thereby encompassing the anticipated standpipe/valve excitation frequency interval. Outside this interval, a velocity-squared bump-up factor of 1.35, based on anticipated and actual in-plant flow rate at BFN1 and BFN2, is used. The resulting bump-up factors are plotted in Figure 4.

The bump-up factor at each strain gage location would be used to multiply the strain gage readings at that location in the plant at CLTP conditions, on a frequency-by-frequency basis, to obtain the estimated main steam line strain gage readings at that location in the plant at EPU conditions. The subsequent dryer loads developed from the acoustic circuit model would be provided to a finite element model of the dryer for stress predictions at EPU conditions.

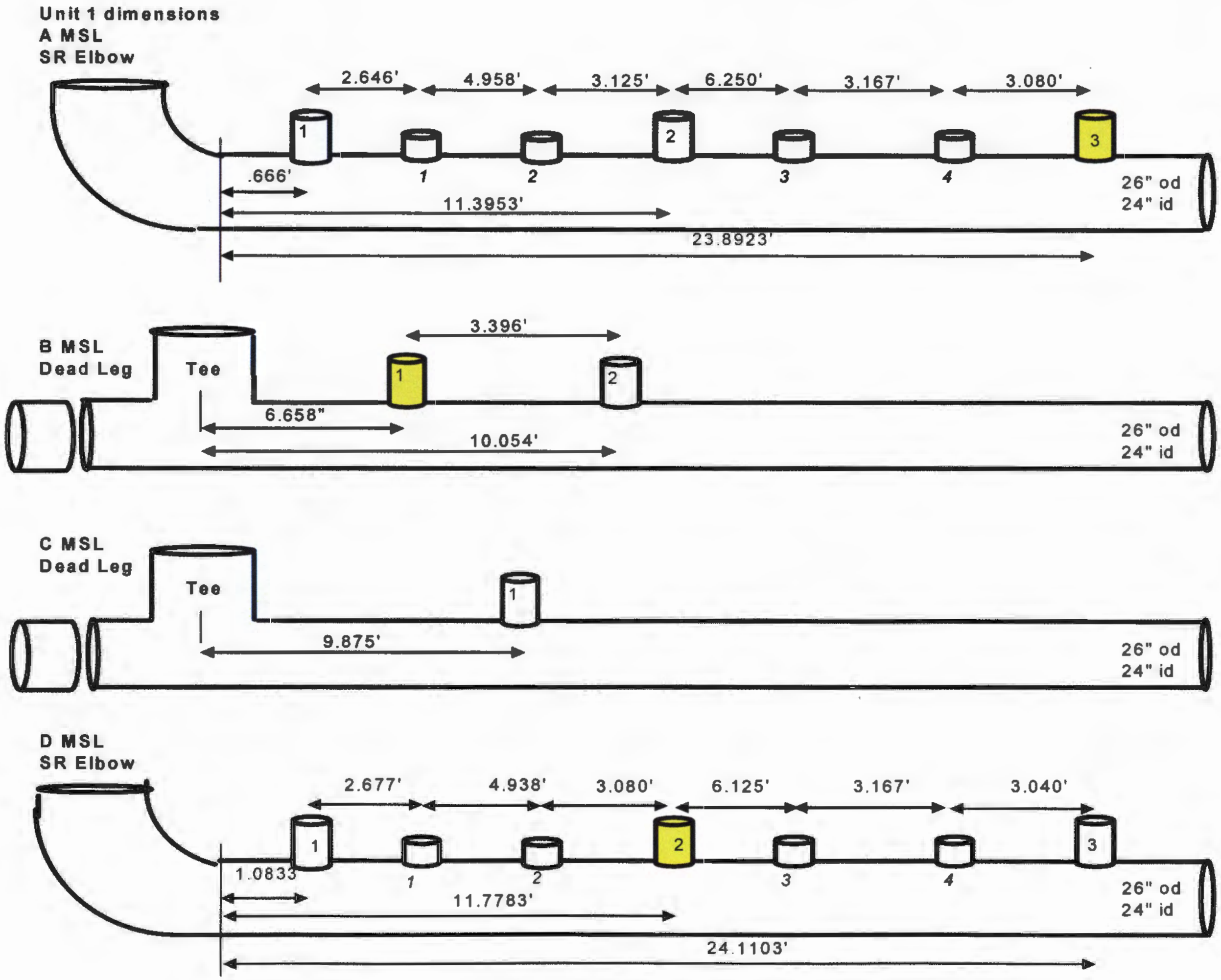

Figure 1. Schematic of the four main steam lines at BFN1. (Ref. 1).

Figure 2. Photographs of the steam delivery system at nominal one-eighth scale. (Ref. 1).

Figure 3. Additional photographs of the steam delivery system at nominal one-eighth scale. (Ref. 1)

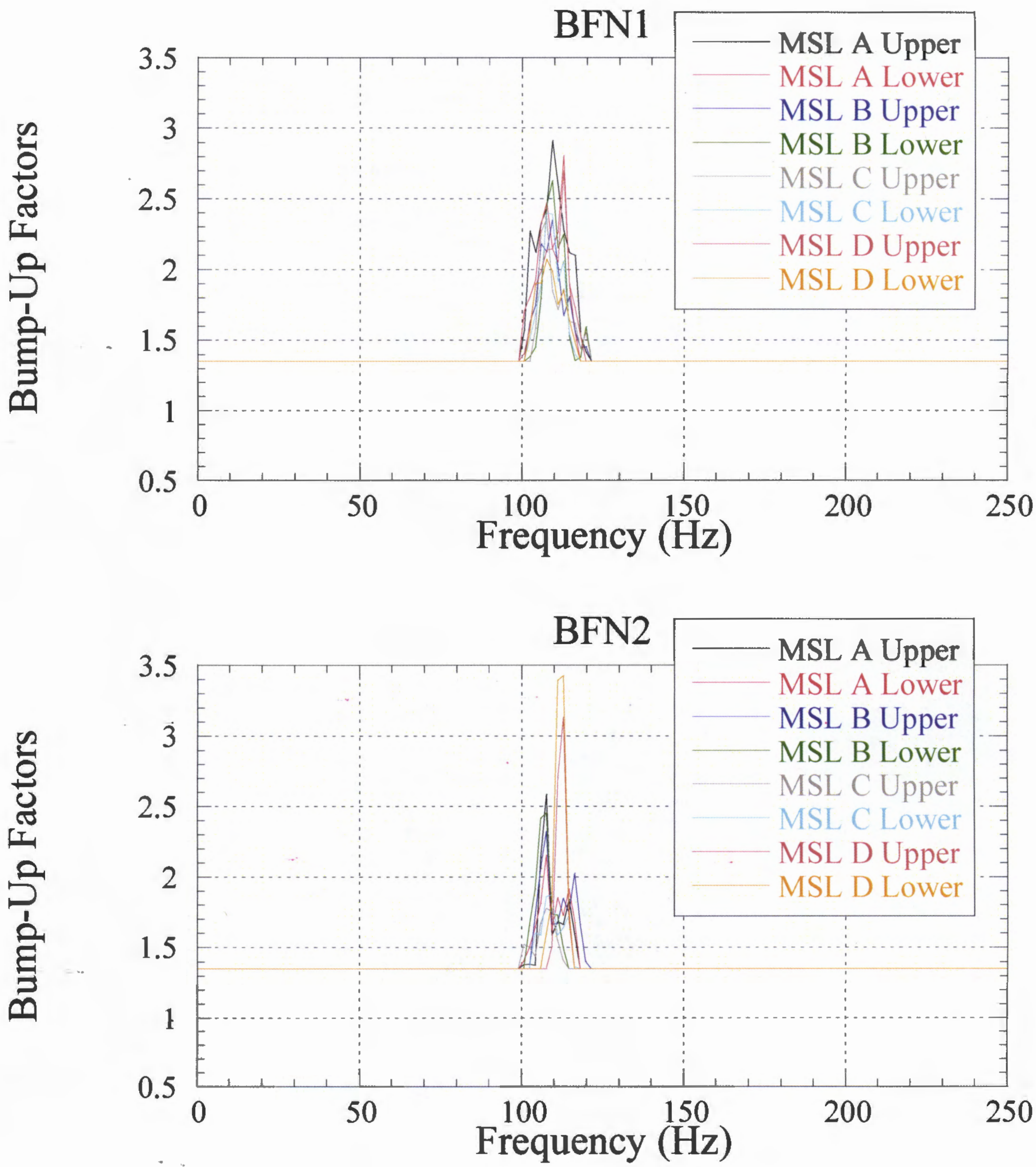

Figure 4. Bump-up factors developed from BFN1 (top) and BFN2 (bottom) subscale data. The eight locations are shown by the eight pressure transducer identifiers. (Ref. 1)

Conclusions

Using measured in plant Main Steam Line CLTP pressure data and bump up factors, an estimate of the Main Steam Line pressure at EPU conditions can be obtained. Based on the subscale model testing documented in Reference 1, and summarized in this report, a 3.5 bump up factor applied to CLTP data would conservatively bound EPU conditions. For example, a conservative application of the method would be to show that dividing the limiting dryer stress ratio at CLTP conditions by the maximum bump up factor of 3.5 still yields an acceptable stress ratio. It is noted that this bump up factor implicitly accounts for any acoustic resonance interaction from multiple in-line SRV standpipes.

References

1. Continuum Dynamics, Inc. 2008 Flow-Induced Vibration in the Main Steam Lines at Browns Ferry Nuclear Units 1 and 2, With and Without Acoustic Side Branches, and Resulting Steam Dryer Loads, C.D.I. Report No. 08-14P, Revision 0.

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Farideh E. Saba, Senior Project Manager **/RA/**
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DATE	07/14/16	07/20/16	07/21/16

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