ENCLOSURE 12

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 1, 2, AND 3

TECHNICAL SPECIFICATIONS (TS) CHANGES TS-431 AND TS-418 - EXTENDED POWER UPRATE (EPU) - STEAM DRYER EVALUATIONS

CDI TECHNICAL MEMORANDUM NO. 07-26NP, "COMPARISON OF BROWNS FERRY NUCLEAR UNIT 1 AND UNIT 2 MAIN STEAM LINE STRAIN GAGE/PRESSURE READINGS"

(NON-PROPRIETARY VERSION)

Attached is the **Non-Proprietary Version** of CDI Technical Memorandum No. 07-26, "Comparison of Browns Ferry Nuclear Unit 1 and Unit 2 Main Steam Line Strain Gage/Pressure Readings."

This Document Does Not Contain Continuum Dynamics, Inc. Proprietary Information

C.D.I. Technical Memorandum No. 07-26NP

Comparison of Browns Ferry Nuclear Unit 1 and Unit 2 Main Steam Line Strain Gage / Pressure Readings

Revision 0

Prepared by

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

Approved by

Alan J. Bilanin

Prepared by

Milton E. Teske

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Summary

Strain gages on the main steam lines of Browns Ferry Nuclear Unit 1 (BFN1) and Unit 2 (BFN2) recorded pressure levels at Current Licensed Thermal Power (CLTP). This technical memorandum compares these two data sets.

Data Reduction

The main steam lines at BFN1 and BFN2 were instrumented with strain gages so as to infer the pressure in the lines during power operation. The strain gages were located at the positions summarized in Table 1.

Table 1. Main steam line lengths for BFN1 and BFN2. Lengths are measured from the inside wall of the steam dome. BFN1 lengths are approximate.

Main Steam Line	BFN1 and BFN2: Length to First Strain Gage Measurement (ft)	BFN1: Length to Second Strain Gage Measurement (ft)	BFN2: Length to Second Strain Gage Measurement (ft)
A	9.5	41.2	38.1
B	9.5	41.2	39.8
C	9.5	41.2	39.5
D	9.5	41.2	38.2

The data sets were each 120 seconds long (taken at 2500 samples per second) and recorded the strain with 10 volts of excitation to the strain gages (recovering the signals with their background noise). The data sets are identified as shown in Table 2.

Table 2. Strain gage data sets for BFN1 and BFN2.

Unit	Data File Name
BFN1	20070608143544.txt
BFN2	20061128172906.asc

The strain gage signals were converted to pressures by the use of the conversion factors provided in [1] for BFN1 and in [2] for BFN2, as summarized in Tables 3 and 4.

Table 3. Conversion factors from strain to pressure for BFN1 [1]. Channels are averaged to give the average strain.

	Strain to Pressure (psid/μstrain)	Channel Number	Channel Number	Channel Number	Channel Number
MSL A Upper	2.997	1	2	3	4
MSL A Lower	3.027	5	6	7	8
MSL B Upper	3.034	9	10	11	12
MSL B Lower	2.993	13	14	15	16
MSL C Upper	2.912	17	18	19	20
MSL C Lower	2.962	21	22	23	24
MSL D Upper	2.959	25	26	27	28
MSL D Lower	3.007	29	30	31	32

Table 4. Conversion factors from strain to pressure for BFN2 [2]. Channels are averaged to give the average strain; blank sensors indicate that the sensor was inoperative.

	Strain to Pressure (psid/μstrain)	Channel Number	Channel Number	Channel Number	Channel Number
MSL A Upper	3.088	1	2	3	4
MSL A Lower	2.987	5	6	7	8
MSL B Upper	3.070	9		11	
MSL B Lower	3.040	13	14	15	16
MSL C Upper	3.008		18	19	20
MSL C Lower	3.041	21	22	23	24
MSL D Upper	3.017		26	27	28
MSL D Lower	3.022	29	30	31	

Exclusion frequencies were used to remove extraneous signals, as also identified for BFN1 in [1] and a subsequent email, and for BFN2 in [2], and summarized in Tables 5 and 6. The standpipe excitation frequency of 218 Hz was removed in all signals.

Table 5. Exclusion frequencies for BFN1 strain gage data collected with 10 volts of excitation to the strain gages, as suggested in [1] and a subsequent email. VFD = variable frequency drive. Recirc = recirculation pumps.

Frequency Range (Hz)	Exclusion Cause
0 – 2	Mean
59.8 – 60.2	Line Noise
119.9 – 120.1	Line Noise
179.8 – 180.2	Line Noise
239.9 – 240.1	Line Noise
50.3 – 53.0	VFD (1x)
127.0 – 128.5	Recirc Pumps A, B Speed (5x)
217.5 – 220.0	Standpipe Excitation

Table 6. Exclusion frequencies for BFN2 strain gage data collected with 10 volts of excitation to the strain gages, as suggested in [2]. VFD = variable frequency drive. Recirc = recirculation pumps.

Frequency Range (Hz)	Exclusion Cause
0 – 2	Mean
59.9 – 60.1	Line Noise
119.9 – 120.1	Line Noise
179.9 – 180.1	Line Noise
239.9 – 240.1	Line Noise
44.7 – 46.0	VFD (1x)
90.8 – 91.0	VFD (2x)
136.1 – 136.5	VFD (3x)
181.6 – 181.8	VFD (4x)
227.1 – 227.4	VFD (5x)
112.7 – 113.2	Recirc Pump A Speed (5x)
110.4 – 111.7	Recirc Pump B Speed (5x)
218.5 – 220.0	Standpipe Excitation

Data Comparison and Interpretation

The filtered main steam line pressure signals may be compared by plotting their PSDs, as shown in Figures 1 to 4. Peak and RMS pressures are summarized in Table 7.

From these comparisons it may be seen that the BFN2 signals are for the most part larger than the BFN1 signals, with the exception of the presence of a peak at 55 Hz and 75 Hz in the lower locations on main steam lines B and C (MSL B and C have the dead-headed branches).

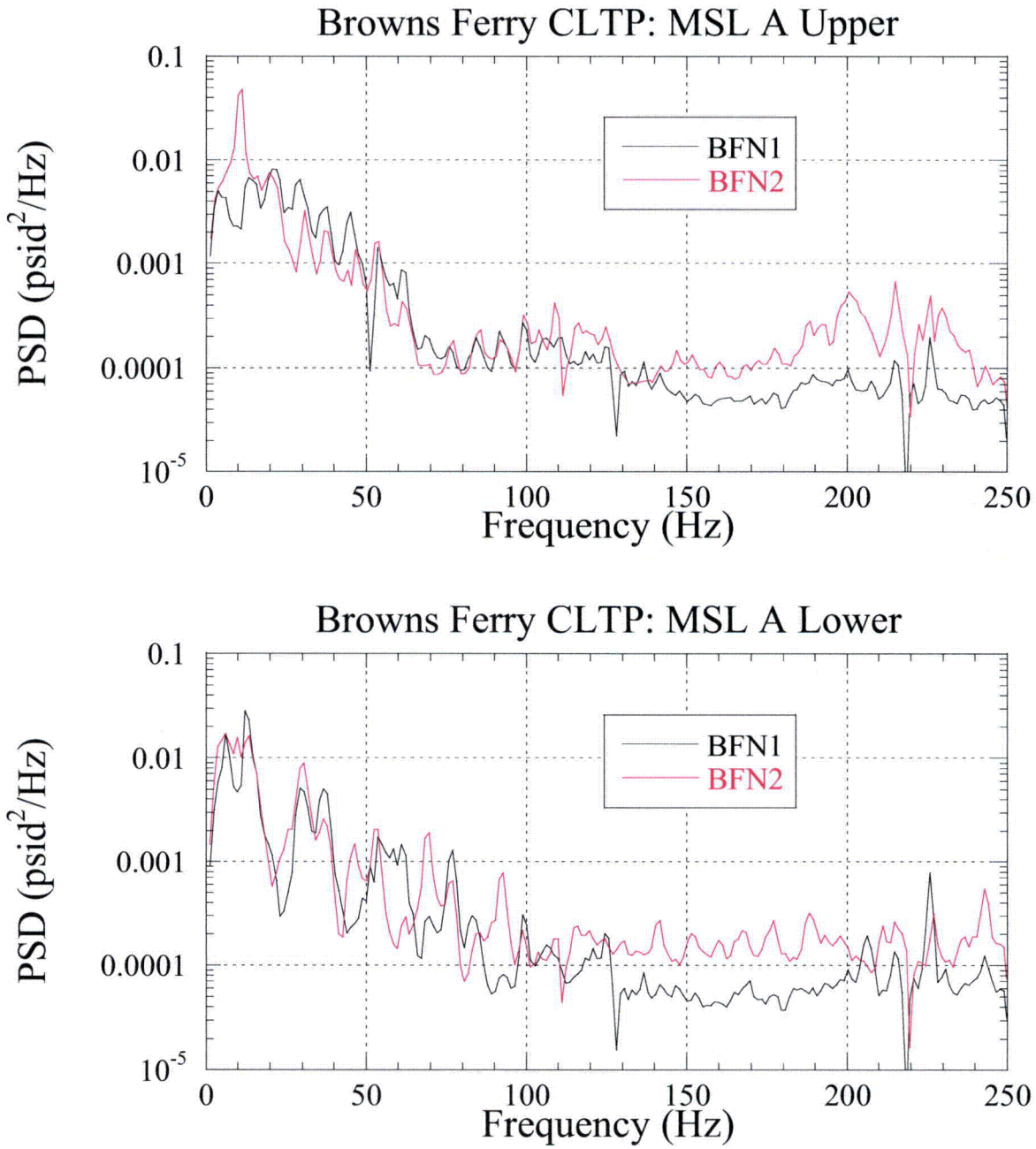

Figure 1. Comparison of BFN1 and BFN2 pressure measurements on main steam line A: upper location (top); lower location (bottom).

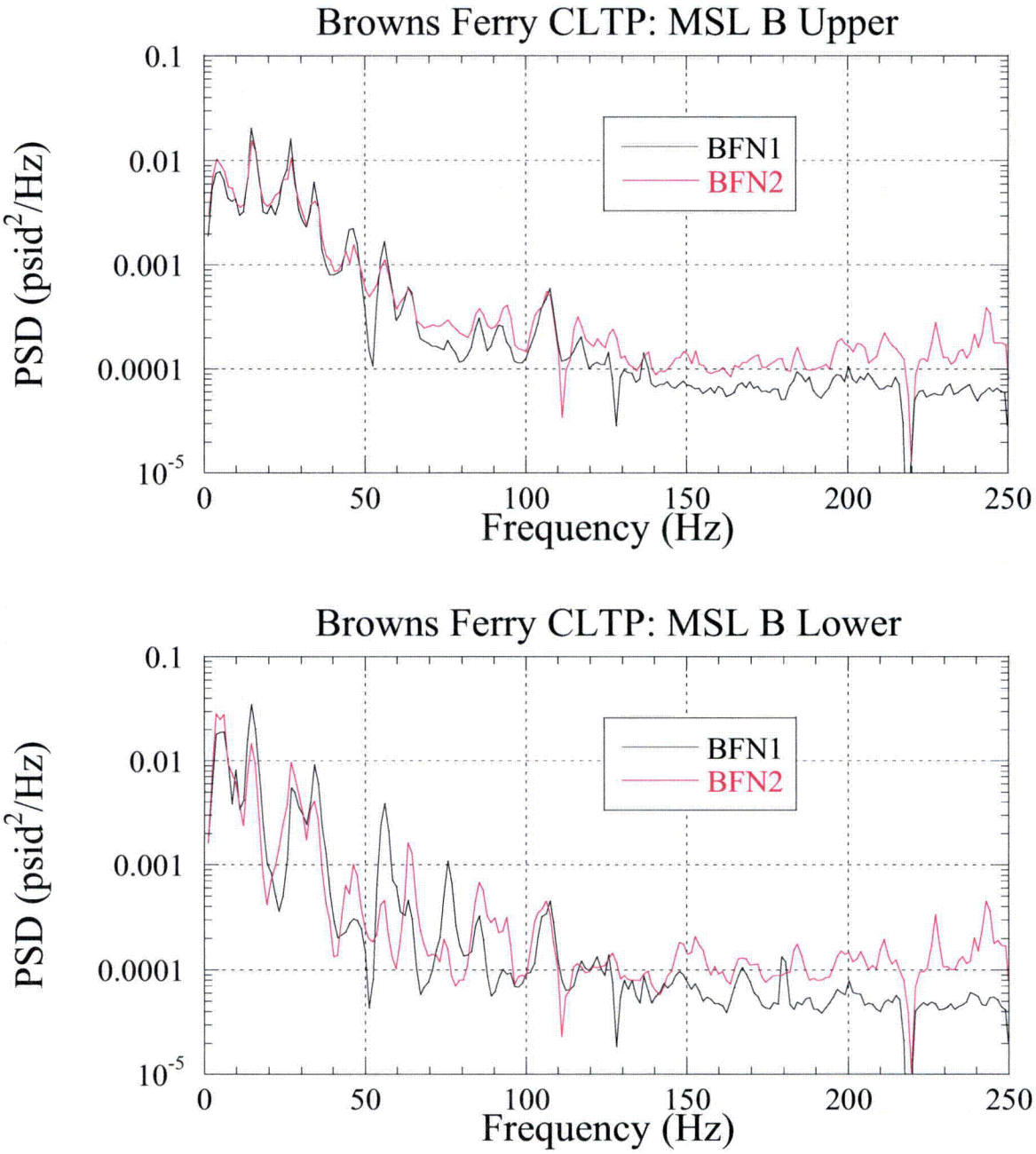

Figure 2. Comparison of BFN1 and BFN2 pressure measurements on main steam line B: upper location (top); lower location (bottom).

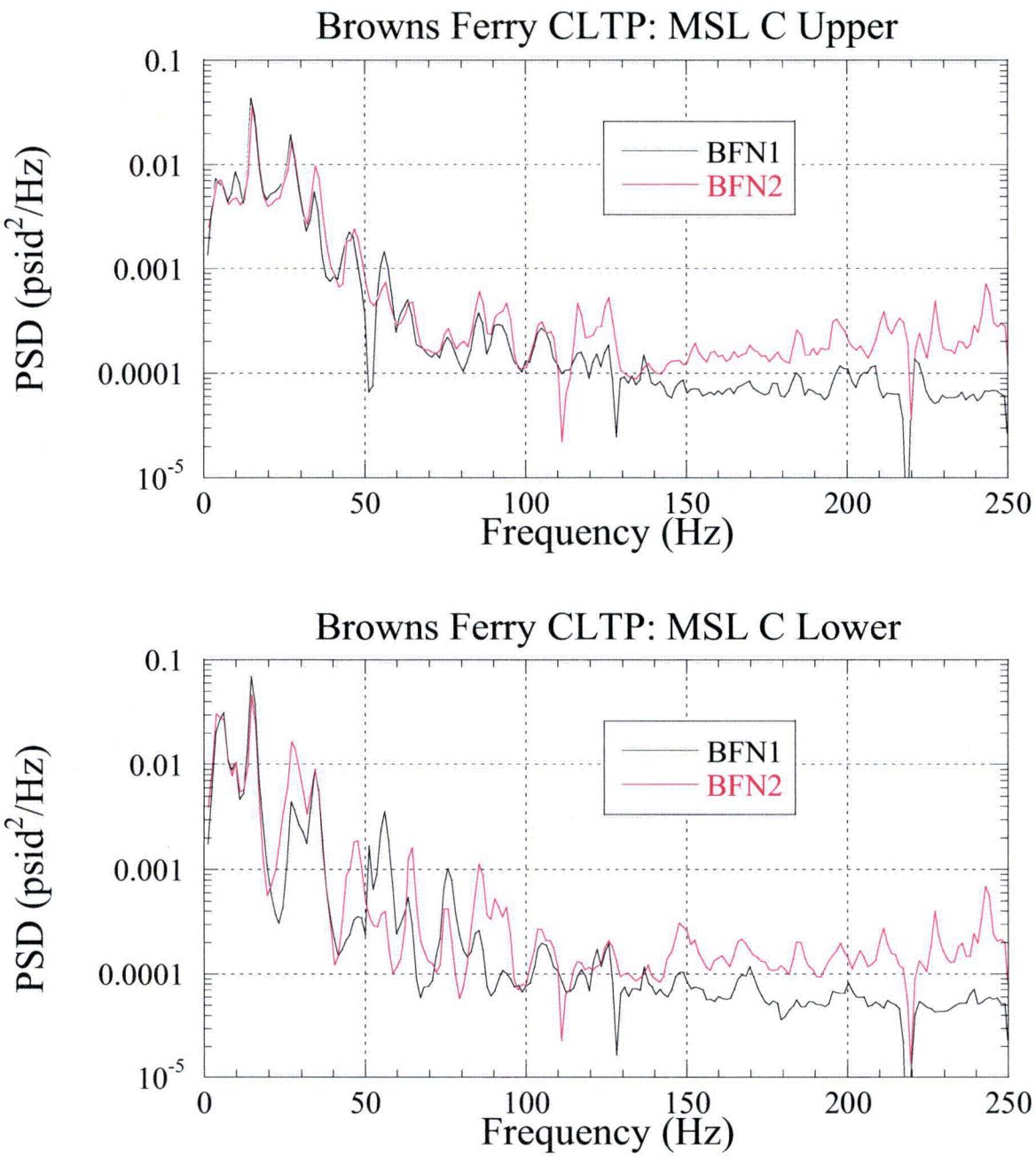

Figure 3. Comparison of BFN1 and BFN2 pressure measurements on main steam line C: upper location (top); lower location (bottom).

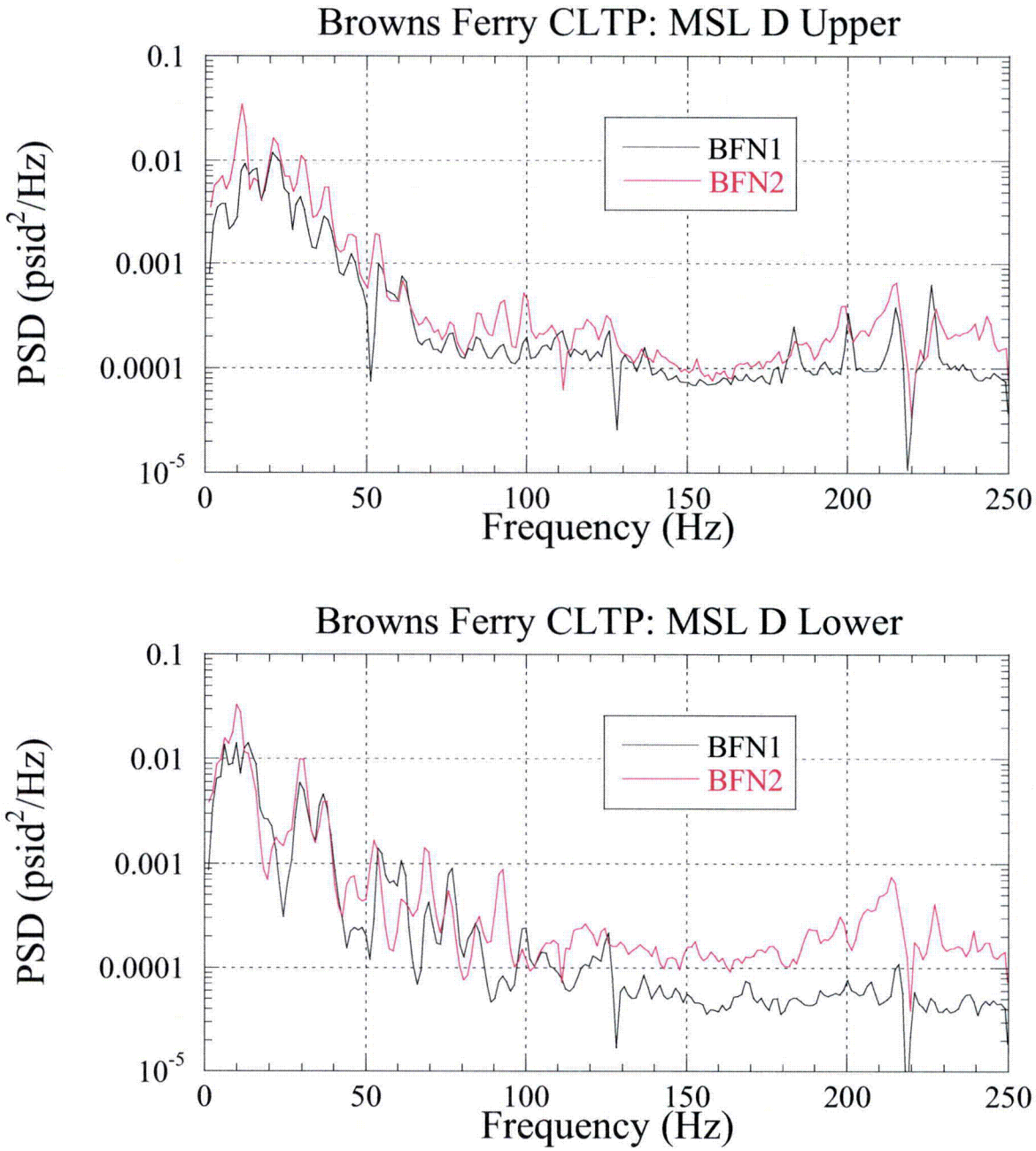

Figure 4. Comparison of BFN1 and BFN2 pressure measurements on main steam line D: upper location (top); lower location (bottom).

Table 7. Comparison of Peak and RMS values for BFN1 and BFN2.

Location	BFN1 Peak Pressure (psid)	BFN2 Peak Pressure (psid)	BFN1 RMS Pressure (psid)	BFN2 RMS Pressure (psid)
MSL A Upper	1.925	3.417	0.454	0.568
MSL A Lower	2.144	2.422	0.504	0.546
MSL B Upper	2.145	2.198	0.510	0.519
MSL B Lower	2.374	2.817	0.551	0.538
MSL C Upper	2.643	2.624	0.588	0.584
MSL C Lower	2.866	3.650	0.633	0.650
MSL D Upper	2.098	2.888	0.473	0.627
MSL D Lower	2.410	2.613	0.481	0.573

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Conclusion

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References

1. Structural Integrity Associates, Inc. 2007. Browns Ferry Unit 1 Main Steam Line 100% CLTP Strain Data Transmission. SIA Letter Report No. KKF-07-012.

2. Structural Integrity Associates, Inc. 2006. Main Steam Line 100% CLTP Strain Data Transmission. SIA Letter Report No. GSZ-06-017.

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Figure 5. Predicted loads on the low-resolution grid representing BFN1 (black curves) and BFN2 (red curves), as developed by the Modified Bounding Pressure acoustic circuit model, to 250 Hz. Low-numbered nodes are on the C/D side of the dryer, while high-numbered nodes are on the A/B side of the dryer.