Attachment 3

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Westinghouse Non-Proprietary Class 3

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Revision 0

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South Texas Project Unit 3 Four-Line Subscale Acoustic Test Report

Westinghouse

WCAP-17314-NP
Revision 0

South Texas Project Unit 3
Four-Line Subscale Acoustic Test Report

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TABLE OF CONTENTS

LIST OF TABLES iii

LIST OF FIGURES iv

LIST OF ACRONYMS AND ABBREVIATIONS v

TRADEMARKS vi

1 EXECUTIVE SUMMARY 1-1
2 BACKGROUND AND PURPOSE 2-1
3 INPUTS TO TESTING 3-1
3.1 PLANT GEOMETRY AND OPERATING CONDITIONS 3-1
3.2 ASSUMPTIONS 3-1
3.3 PRE-TEST PREDICTIONS 3-2
4 TESTING METHODOLOGY 4-1
4.1 PHYSICAL TEST SYSTEM 4-1
4.1.1 Plant Scaling and Test Derivation 4-1
4.1.2 Subscale Test Construction and Assembly 4-2
4.2 DATA ACQUISITION AND INSTRUMENTATION 4-9
4.3 PROCEDURAL OVERVIEW 4-10
5 DATA PROCESSING METHODOLOGY 5-1
5.1 DATA FILTERING AND SELECTION 5-1
5.2 EQUATIONS USED IN DATA ANALYSIS 5-2
5.2.1 Derivation of Mach Number 5-2
5.2.2 Frequency Scaling 5-2
5.2.3 Power Spectral Density 5-3
5.2.4 Derivation of RMS Pressures 5-4
5.2.5 Derivation of the Onset Mach Number 5-5
6 DESCRIPTION OF RESULTS 6-1
6.1 TESTING RESULTS 6-1
6.1.1 SRV Natural Frequency 6-3
6.1.2 Evaluation of MSL Acoustic Signature 6-5
7 CONCLUSIONS 7-1
8 REFERENCES 8-1
9 ACKNOWLEDGMENTS 9-1

LIST OF TABLES

Table 3-1 Plant Operating Conditions 3-1
Table 3-2 Sidebranch Natural Frequencies and Onset Velocities 3-2
Table 4-1 Instrumentation Used in Subscale Testing 4-9
Table 4-2 Instrumentation Locations and Channel Nomenclature 4-9
Table 6-1 South Texas Unit 3 Test Matrix Okano SRV 6-1
Table 6-2 Predicted and Measured Natural Frequency 6-4

LIST OF FIGURES

Figure 4-1 Schematic of Subscale System (Not to Scale) 4-3
Figure 4-2 [ ]a,c 4-4
Figure 4-3 [ ]a,c 4-5
Figure 4-4 [ ]a,c 4-6
Figure 4-5 [ ]a,c 4-7
Figure 4-6 [ ]a,c 4-8
Figure 5-1 [ ]a,c 5-1
Figure 6-1 [ ]a,b,c 6-3
Figure 6-2 [ ]a,c 6-6
Figure 6-3 [ ]a,c 6-7
Figure 6-4 [ ]a,c 6-9
Figure 6-5 [ ]a,c 6-10
Figure 6-6 [ ]a,c 6-12

LIST OF ACRONYMS AND ABBREVIATIONS

ABWR	advanced boiling water reactor
CTP	core thermal power
FSO	full scale output
ID	inner diameter
MSL	main steam line
NIST	National Institute of Standards and Technology
PSD	power spectral density
psid	pounds per square inch, dynamic
psig	pounds per square inch, gage
RMS	root mean squared
RPV	reactor pressure vessel
SRV	safety relief valve
STP	South Texas Project
TSV	turbine stop valve
U.S. NRC	United States Nuclear Regulatory Commission

TRADEMARKS

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1 EXECUTIVE SUMMARY

[

]a,c

Current industry experience has shown that acoustic resonance of the safety relief valves (SRVs) may contribute significant energy into the MSL signature. This acoustic energy can propagate upstream into the steam dome and have adverse effects on the structural integrity of the steam dryer in the reactor pressure vessel (RPV).

[

]a,c

[

]a,c

[

]a,b,c

2 BACKGROUND AND PURPOSE

STP is planning on constructing two new reactors at their site, Unit 3 and Unit 4. These units are to be ABWRs.

[

]a,c

[

]a,c

[

]a,c

[

]a,c

[

]a,c

3 INPUTS TO TESTING

3.1 PLANT GEOMETRY AND OPERATING CONDITIONS

[

]b

Table 3-1 Plant Operating Conditions		
Condition	**Mach Number**	**% CTP**

b

3.2 ASSUMPTIONS

[

]a,b

[

]a,c

a,c

(3-1)

Where

[

]a, c

[

]a,c

[

]a,c

[

]a,c

[

]a,c

[

]a,c

[

]a,c

3.3 PRE-TEST PREDICTIONS

[

]a

Table 3-2 Sidebranch Natural Frequencies and Onset Velocities

Description	Predicted Natural Frequencies (Hz)		Onset Mach Number		Onset Power Levels (% CTP)	
	Plant	Subscale	Single Vortex	Double Vortex	Single Vortex	Double Vortex

a,b,c

4 TESTING METHODOLOGY

4.1 PHYSICAL TEST SYSTEM

4.1.1 Plant Scaling and Test Derivation

[

]a,c

[

]a,c

[ ]a,b,c

[

]a,c

[

]a,b,c

[ ]a,b,c

[

]a,b,c

[ ]a,b,c

[

]a,c

4.1.2 Subscale Test Construction and Assembly

[

]a,c

[

]a,c

[

]a,c

[

]a,c

[

]a,c

[

]a,c

A schematic of the testing system is shown in Figure 4-1.

a,b,c

Figure 4-1 Schematic of Subscale System (Not to Scale)

[ ]a

a,c

Figure 4-2 [ ]a,c

[

] a,c

a,c

Figure 4-3 [ ][a,c]

a,c

Figure 4-4 [ ]a,c

[

]a,c

a,c

Figure 4-5 [ ][a,c]

a,c

Figure 4-6 [ ]a,c

4.2 DATA ACQUISITION AND INSTRUMENTATION

[

]a,c

Table 4-1 Instrumentation Used in Subscale Testing

Type	Manufacturer	Model Number	Rating

a,c

The instrumentation locations and channel numbers for the tests are shown in Table 4-2.

Table 4-2 Instrumentation Locations and Channel Nomenclature

Channel Number	Transducer Type	Location	S/N	Coeff

a,c

[

]a,c

[

]a,c

4.3 PROCEDURAL OVERVIEW

[ ]a,c

[

]a,c

[

]a,c

[

]a,c

[

]a,c

[

]a,c

[

]a,c

[

]a,c

5 DATA PROCESSING METHODOLOGY

All data processing was performed with custom functions in MATLAB R2010a, based on the equations described herein. These methods and equations are the same as have been applied during subscale data analysis for previous power uprate license submittals.

5.1 DATA FILTERING AND SELECTION

[

]a,c

a,b,c

Figure 5-1 [ ]a,c

[

]a,c

5.2 EQUATIONS USED IN DATA ANALYSIS

5.2.1 Derivation of Mach Number

[

]a,c

[

]a,c

$$\left[\qquad \right]^{a,c} \tag{5-1}$$

Where

$$\left[\qquad \right]^{a,c}$$

5.2.2 Frequency Scaling

[

]a,c

[ ]a,c

(5-2)

Where

[ ]a,b,c

[

]a,b,c

5.2.3 Power Spectral Density

[

]a,c

[

]a,c

[

]a,c

[ ]a,c

(5-3)

Where

[ ]a,c

[

]a,c

[ ]a,c (5-4)

Where

[ ]a,c

5.2.4 Derivation of RMS Pressures

[

]a,c

[ ]a,c (5-5)

Where

[ ]a,c

[

]a,c

[ ]a,c (5-6)

Where

[ ]a,c

5.2.5 Derivation of the Onset Mach Number

[

]a,c

[ ]a,c (5-7)

Where

[ ]a,c

[

]a,b,c

6 DESCRIPTION OF RESULTS

6.1 TESTING RESULTS

[

]a,c

Table 6-1 South Texas Unit 3 Test Matrix Okano SRV

Table 6-1 South Texas Unit 3 Test Matrix Okano SRV

a,c

a,b,c

6.1.1 SRV Natural Frequency

[

]a,c

b

Figure 6-1 [ ]a,b,c

[

]a,b,c

[

]a,b,c

[ ]a,c

Table 6-2 Predicted and Measured Natural Frequency

Description	Predicted Natural Frequency (Hz)	Measured Natural Frequency (Hz)	% Difference

a,b,c

[

]a,c

6.1.2 Evaluation of MSL Acoustic Signature

[

]a,c

[

]a,c

[

]a,c

a,b,c

Figure 6-2 [ ]a,c

[

]a,b,c

a,b,c

Figure 6-3 [ ][a,c]

[

]a,b,c

[

]a,b,c

a,b,c

Figure 6-4 [ ]a,c

[

]a,b,c

[

]a,c

a,b,c

Figure 6-5 [ ]a,c

[

]a,b,c

[

]a,b,c

[

]a,b,c

a,b,c

Figure 6-6 [ ][a,c]

[

]a,b,c

[

]a,b,c

[

]a,c

7 CONCLUSIONS

[

]a,c

[

]a,b,c

[

]a,b,c

[

]a,b,c

8 REFERENCES

1. [ ]a,c

2. [ ]a,c

3. [ ]a,c

4. [ ]b

5. [ ]a,c

6. [ ]a,c

9 ACKNOWLEDGMENTS

The author would like to thank Mr. Jens Conzen, Mr. Scott Farrar, and Mr. Samad Erogbogbo for their help in completing the scale model testing.