

ENCLOSURE 10

**WESTINGHOUSE REPORT WCAP-17540-NP, REVISION 0
MONTICELLO REPLACEMENT STEAM DRYER PROGRAM
ACOUSTIC LOAD DEFINITION METHODOLOGY**

55 pages follow

Westinghouse Non-Proprietary Class 3

WCAP-17540-NP
Revision 0

May 2012

Monticello Replacement Steam Dryer Program Acoustic Load Definition Methodology



Westinghouse

Monticello Replacement Steam Dryer Program Acoustic Load Definition Methodology

Author

Gianluca Longoni*

Reviewed by

David A. Suddaby*

May 2012

Approved: David R. Forsyth*, Manager
Acoustics and Structural Analysis

*Electronically approved records are authenticated in the electronic document management system.

Westinghouse Electric Company LLC
1000 Westinghouse Drive
Cranberry Township, PA 16066, USA

© 2012 Westinghouse Electric Company LLC
All Rights Reserved

TABLE OF CONTENTS

LIST OF TABLES	iii
LIST OF FIGURES	iv
ACRONYMS	vi
1 EXECUTIVE SUMMARY	1-1
2 ACOUSTIC CIRCUIT MODEL METHODOLOGY	2-1
2.1 NUMERICAL SOLUTION OF THE 3D [] ^{a,c} EQUATION	2-1
2.2 ACOUSTIC CIRCUIT ANALYSIS OF MEASURED MSL PRESSURE FLUCTUATIONS	2-4
3 END-TO-END BENCHMARK OF ACE REV. 1.0 USING MEASURED PLANT DATA	3-1
3.1 MONTICELLO RSD [] ^{a,c} DEVELOPMENT	3-1
3.2 ANALYSIS OF PRESSURE TRANSDUCER DATA MEASURED ON THE STEAM DRYER.....	3-7
3.3 DEVELOPMENT OF THE ACOUSTIC CIRCUIT ENHANCED REV. 1.0 MODELING PARAMETERS	3-14
3.4 END-TO-END COMPARISON OF PREDICTIVE MODELS WITH MEASURED PLANT DATA	3-20
4 DEVELOPMENT OF THE ACOUSTIC LOAD DEFINITION FOR THE MONTICELLO RSD USING ACE REV. 1.0.....	4-1
5 CONCLUSIONS	5-1
6 REFERENCES	6-1

LIST OF TABLES

Table 3-1	Monticello [	]^{a,c} Main Dimensions.....	3-1
Table 3-2	[	]^b	3-3
Table 3-3	[	]^b	3-15
Table 3-4	[	]^b	3-16
Table 3-5	[	]^b	3-16
Table 3-6	[	]^b	3-17
Table 3-7	[	]^b	3-17
Table 3-8	[	]^b	3-18
Table 3-9	[	]^b	3-21
Table 3-10	[	]^b	3-23
Table 4-1	[	]^b	4-1

LIST OF FIGURES

Figure 2-1	Schematic of Pressure Measurement Locations on an MSL.....	2-5
Figure 3-1	Steam Dryer Top View.....	3-2
Figure 3-2	Section A-A from Figure 3-1	3-2
Figure 3-3	[.....] ^{a,c}	3-4
Figure 3-4	Two-Dimensional Cross-Section View at Z=70.9"	3-5
Figure 3-5	Two-Dimensional Cross-Section View at Z=131.1"	3-5
Figure 3-6	Acoustic Model Structure Three-Dimensional Views.....	3-6
Figure 3-7	Monticello RSD Instrumentation Locations – Top View.....	3-7
Figure 3-8	[.....] ^b	3-8
Figure 3-9	[.....] ^b	3-9
Figure 3-10	[.....] ^b	3-10
Figure 3-11	[.....] ^b	3-11
Figure 3-12	[.....] ^b	3-12
Figure 3-13	[.....] ^b	3-12
Figure 3-14	[.....] ^b	3-13
Figure 3-15	[.....] ^b	3-19
Figure 3-16	[.....] ^b	3-20
Figure 3-17	[.....] ^b	3-22
Figure 3-18	[.....] ^{a,c}	3-24
Figure 3-19	[.....] ^b	3-25
Figure 3-20	[.....] ^b	3-26
Figure 3-21	[.....] ^b	3-27
Figure 3-22	[.....] ^b	3-28
Figure 3-23	[.....] ^b	3-29
Figure 3-24	[.....] ^b	3-30
Figure 3-25	[.....] ^b	3-31
Figure 3-26	[.....] ^b	3-32

Figure 3-27 [	] ^b	3-33
Figure 3-28 [	] ^b	3-34
Figure 3-29 [	] ^b	3-35
Figure 4-1 [	] ^b	4-2
Figure 4-2 [	] ^b	4-2
Figure 4-3 [	] ^b	4-3
Figure 4-4 [	] ^b	4-3

ACRONYMS

Acronym	Definition
ACE	acoustic circuit enhanced
ACM	acoustic circuit model
BWR	boiling water reactor
CFD	computational fluid dynamics
CLTP	current licensed thermal power
DAS	data acquisition system
EPU	extended power uprate
FEM	finite element model
IR	inner radius
MNGP	Monticello Nuclear Generating Plant
MSL	main steam line
NRC	Nuclear Regulatory Commission (U.S.)
OEM	original equipment manufacturer
OR	outer radius
PSD	power spectral density
RMS	root mean square
RPV	reactor pressure vessel
RSD	replacement steam dryer
SCF	strain correction factor
SRV	safety relief valve

1 EXECUTIVE SUMMARY

Monticello Nuclear Generating Plant (MNGP) underwent a replacement steam dryer (RSD) program during the spring 2011 refueling outage. MNGP replaced the original equipment manufacturer (OEM) steam dryer with a Westinghouse design. [

] ^a

[

] ^c

[

] ^c

In summary, the modeling features included in ACE Rev. 1.0 are the following:

[

1-2

[

]

c

[

] ^{a,c}

2 ACOUSTIC CIRCUIT MODEL METHODOLOGY

This section describes the theoretical development of the acoustic circuit model methodology. The two steps involved in obtaining the acoustic load definition for the MNGP RSD consist in the following:

[] a,c

2.1 NUMERICAL SOLUTION OF THE 3D []^{a,c} EQUATION

[] a,c

a,c

2.2 ACOUSTIC CIRCUIT ANALYSIS OF MEASURED MSL PRESSURE FLUCTUATIONS

In the acoustic circuit analysis, MSLs are modeled by following parameters:

a,c

Application of the methodology generates solutions in each MSL for:

a,c

Where:

a,c

Where:

a,c

a,c

Figure 2-1 Schematic of Pressure Measurement Locations on an MSL

a,c

a,c

3.1 MONTICELLO RSD []^{a,c} DEVELOPMENT

The geometric model of the steam dryer and surrounding fluid is developed using plant drawings and steam dryer design drawings as outlined in Reference 1. This is an improved model based on:

a,c

Table 3-1 lists the main dimensions used to develop the []^{a,c}.

[illegible]



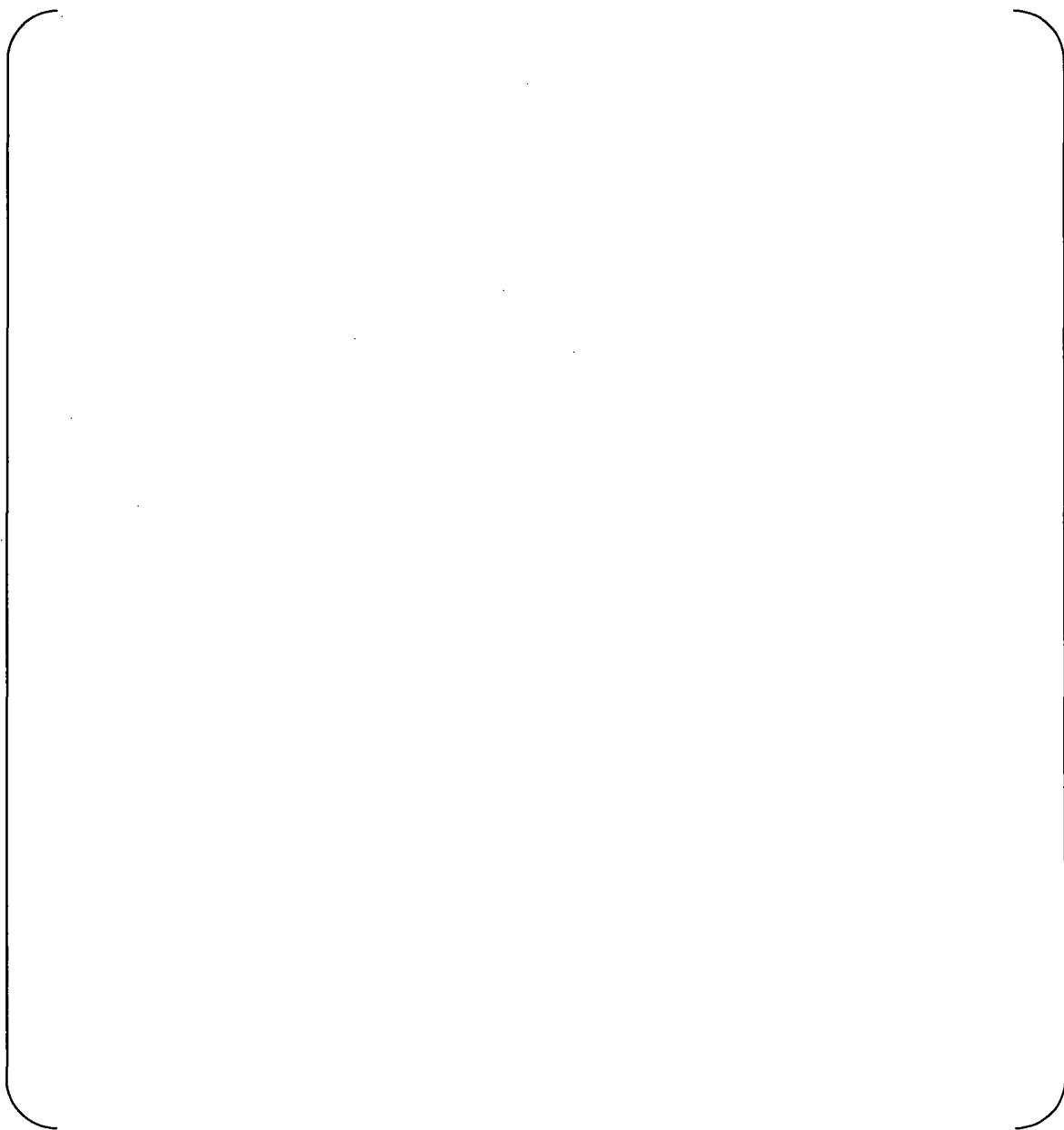
Figure 3-1 Steam Dryer Top View



Figure 3-2 Section A-A from Figure 3-1

[illegible]

a,c



a,c

Figure 3-3 [

]^{a,c}



Figure 3-4 Two-Dimensional Cross-Section View at Z=70.9"



Figure 3-5 Two-Dimensional Cross-Section View at Z=131.1"

3-6

a,c

Figure 3-6 Acoustic Model Structure Three-Dimensional Views

a,c

3.2 ANALYSIS OF PRESSURE TRANSDUCER DATA MEASURED ON THE STEAM DRYER

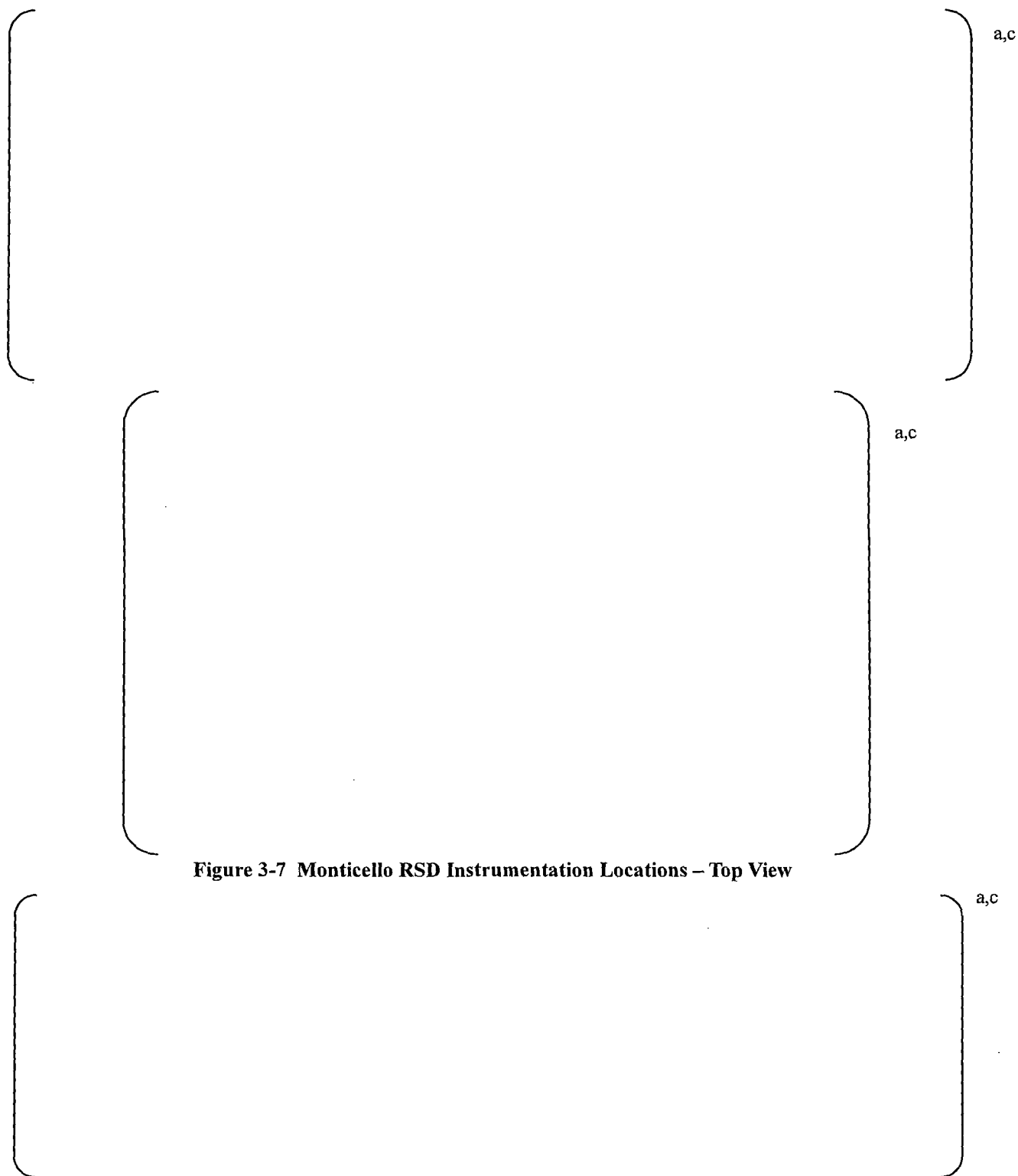


Figure 3-7 Monticello RSD Instrumentation Locations – Top View

Figure 3-8 [

]^b

b

Figure 3-9 [

] ^b

b

Figure 3-10 [

]^b

3-11

b

Figure 3-11 [

]^b

a,c



Figure 3-12 [



Figure 3-13 [

] ^b

a,c

] ^b

a,c

Figure 3-14 [

a,c

3.3 DEVELOPMENT OF THE ACOUSTIC CIRCUIT ENHANCED REV. 1.0 MODELING PARAMETERS

a,c

[illegible]

Where:

a,c

Table 3-4 [] ^b	
[
	]^b

[

]^{a,c}

Table 3-5 [] ^b		
[
		]^b

[

]^{a,c}

[

]^{a,c}

Table 3-6 [] ^b		
[
		]^b

Table 3-7 [] ^b		
[
		]^b

[] a.c

[illegible]

The application of the total uncertainties listed in Table 3-8 to the predicted pressure loads is compared with the measured data as shown in Figures 3-15 and 3-16.



Figure 3-15 [

] ^b



Figure 3-16 [

] ^b

[

] ^{a,c}

3.4 END-TO-END COMPARISON OF PREDICTIVE MODELS WITH MEASURED PLANT DATA

[

] ^{a,c}

Table 3-9 [] ^b	
[]	
	] ^b

[]

] ^{a,c}



Figure 3-17 [

]^b

[

]^{a,c}

Table 3-10				

b

Figure 3-18 [

]^{a,c}

b

Figure 3-19 [

] ^b

b

Figure 3-20 [

] ^b



Figure 3-21 [

]ᵇ



Figure 3-22 [

]^b

b

Figure 3-23 [

]^b



Figure 3-24 [

]^b

b

Figure 3-25 [

] ^b

b

Figure 3-26 [

] ^b

b




Figure 3-27 [

]^b



Figure 3-28 [

]^b



Figure 3-29 [

]^b

4 **DEVELOPMENT OF THE ACOUSTIC LOAD DEFINITION FOR
THE MONTICELLO RSD USING ACE REV. 1.0**

[

]^{a,c}

Table 4-1 [] ^b		
[
		]^b



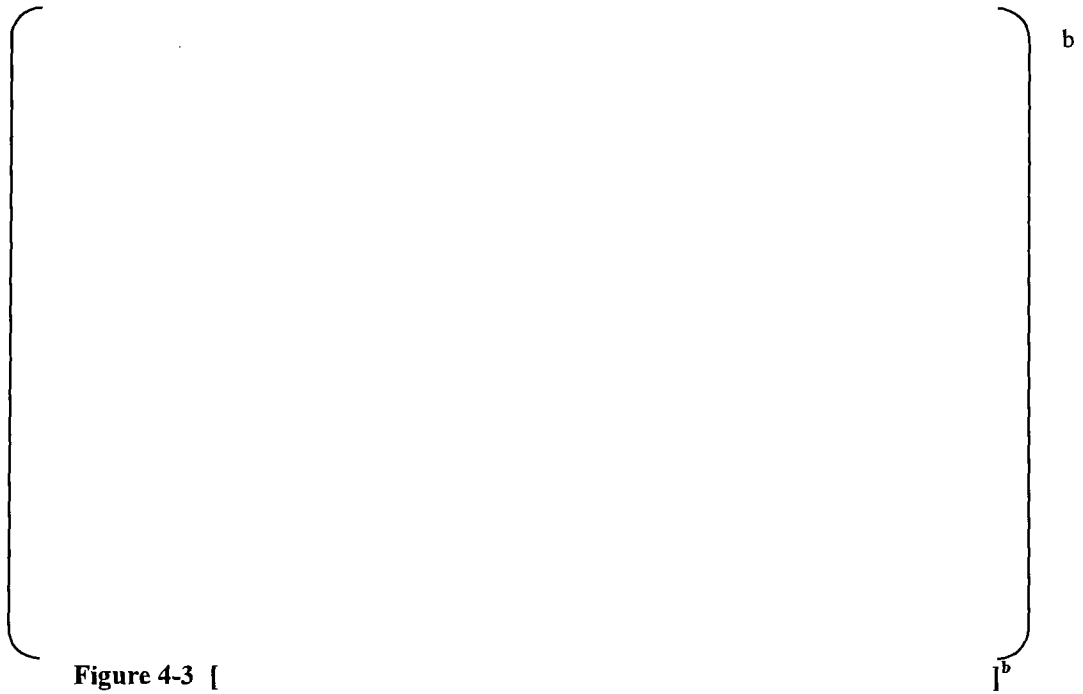
Figure 4-1 [

] ^b
b



Figure 4-2 [

] ^b



5 CONCLUSIONS

[

] ^{a,c}

6 REFERENCES

1. [

] ^{a,c}

2. [

] ^{a,c}

3. [

] ^{a,c}