ENCLOSURE 1

Revised GE Non-Proprietary Reports and Specifications

ENCLOSURE 1

ATTACHMENT 1

"Steam Dryer," GE Nuclear Energy, Design Specification, 26A6266, Revision 3, dated April 24, 2005

GE Nuclear Energy

26A6266	SH NO. 1
REV. 3	

EIS IDENT: STEAM DRYER DS

REVISION STATUS SHEET

DOCUMENT TITLE STEAM DRYER

LEGEND OR DESCRIPTION OF GROUPS

TYPE: DESIGN SPECIFICATION

FMF: DRESDEN 2 & 3
QUAD CITIES 1 & 2

MPL NO: B13-D005

| - DENOTES CHANGE

SAFETY-RELATED CLASSIFICATION CODE N

REVISIONS		C
0	RMCN04168	
1	RMCN05778 3/04/2005	
2	RMCN05922 3/30/2005	
3	RMCN06074 4/24/2005	
		PRINTS TO

MADE BY J.K. Sawabe	APPROVALS	GENERAL ELECTRIC COMPANY 175 CURTNER AVENUE SAN JOSE CALIFORNIA 95125
CHKD BY:	ISSUED 12/03/2004	CONT ON SHEET 2

MS WORD (2/98)

1.0 SCOPE

1.1 This document defines the design requirements for a replacement 251-inch BWR/3 Steam Dryer Assembly and for the replacement Steam Dryer Units including initial installation of the replacement Steam Dryer Assembly into the Reactor Pressure Vessel (RPV). The RPV steam dryer support brackets are not addressed in this specification. Disposal of the original steam dryer is not included in this specification.

2.0 APPLICABLE DOCUMENTS, CODES, AND STANDARDS

2.1 The following documents form a part of this specification to the extent specified herein. The applicable revision of these documents will be the latest revision.

2.2 General Electric Company Documents.

2.2.1 Supporting Documents. Supporting Documents are those documents or parts thereof that directly affect the construction (as defined by the American Society of Mechanical Engineers (ASME) code) of a component or appurtenance. Supporting documents to this specification are as follows:

2.2.1.1 Supporting Specifications.

a. Steam Dryer Material Specifications, 26A6273.

b. Steam Dryer Fabrication Specification, 26A6274.

c. Reactor Vessel - Power Uprate Certified Design Specification - Dresden 2 & 3, 26A5587.

d. Reactor Vessel - Power Uprate Certified Design Specification - Quad Cities 1 & 2, 26A5588.

e. Adjustable Dryer and Separator Lifting Device Fabrication Specification, 26A6221.

f. Structural Arc Welds in All-water Environment Process Diagram, P50YP244.

2.2.1.2 Supporting Drawings.

a. Reactor Vessel Specification Control Drawing - Dresden 2 & 3, 885D660.

b. Reactor Vessel Specification Control Drawing - Quad Cities 1 & 2, 886D485.

c. Reactor - Dresden 2 & 3, 104R861.

d. Reactor - Quad Cities 1 & 2, 104R921.

e. Shroud Head and Separator Specification Control Drawing, 718E816.

f. Steam Dryer Guide Rod Specification Control Drawing, 117C1438.

g. Dryer and Separator Lifting Device Assembly Drawing, 124D1216.

h. Reactor Thermal Cycles, 921D265.

i. Steam Dryer Specification Control Drawing, 728E947.

2.3 Codes and Standards.

a. American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code.

(1) Section III, 1998 Edition, and Addenda through the 2000 Addenda.

(2) Section IX, Welding and Brazing Qualifications (latest edition).

(3) ASME Boiler and Pressure Vessel Code Case N-60-5, "Material for Core Support Structures, Section III, Division 1."

(4) Section II Part D, Materials, 1998 Edition and Addenda through 2000 Addenda

2.4 Vendor Documents.

a. Vessel As-Built Dimensions - Dresden 2, VPF 1248-431(2)-01.

b. Vessel As-Built Dimensions - Dresden 3, VPF 2252-172-1.

c. Vessel As-Built Dimensions - Quad Cities 1, Not Available.

d. Vessel As-Built Dimensions - Quad Cities 2, VPF 2752-129-1.

e. Shell Flange Details - Dresden 2, VPF 1248-125-11.

f. Vessel Sub Assembly - Dresden 2, VPF 1248-162-10.

g. Vessel Sub Assembly - Dresden 3, VPF 2252-120-04.

h. Vessel Attachment Details - Dresden 3, VPF 2252-132-.03.

i. Shell Flange Details - Dresden 3, VPF 2252-150-03.

j. Vessel Sub Assembly - Quad Cities 1, VPF 1744-127-07.

k. Vessel Attachment Details - Quad Cities 1, VPF 1744-140-07.

l. Shell Flange Details - Quad Cities 1, VPF 1744-149-04.

m. Vessel Attachment Details - Quad Cities 2, VPF 2752-034-07.

n. Vessel Sub-Assembly Details - Quad Cities 2, VPF 2752-039-11.

2.5 Exelon Supplied Documents.

a. Exelon TODI No. QDC-04-27, "Transmittal of Various Unit 1 and 2 Fuel Pool Floor Drawings to support in Steam Dryer Replacement," dated 7/12/04.

b. Reactor Building Framing Plan EL 690" - 6" West Area - Quad Cities 1, B-219 Rev. AB.

c. Reactor Building Framing Sections & Details, Sheet 3 - Quad Cities 1, B-251 Rev. P.

d. Reactor Building Pool Liner Plan, EL 690'-6" - Quad Cities 1, B-261 Rev. L.

e. Reactor Building Pool Liner Bottom Plan, Sheet 1 - Quad Cities 1, B-262 Rev. S.

f. Reactor Building Pool Sections & Details, Sheet 2 - Quad Cities 1, B-263 Rev. L.

g. Reactor Building Pool Sections & Details, Sheet 3 - Quad Cities 1, B-264 Rev. L.

h. Reactor Building Pool Sections & Details, Sheet 4 - Quad Cities 1, B-265 Rev. L.

i. Reactor Building Framing Plan EL 690' - 6" East Area - Quad Cities 2, B-531 Rev. S.

j. Reactor Building Framing Plan EL 690' - 6" West Area - Quad Cities 2, B-532 Rev. U.

k. Reactor Building Misc. Plans & Details - Quad Cities 2, B-574 Rev. J.

l. Reactor Building Pool Liner Plan EL 690' - 6" - Quad Cities 2, B-575 Rev. D.

m. Reactor Building Pool Liner Plan Sheet 1 - Quad Cities 2, B-576 Rev. K.

n. Reactor Building Pool Sections & Details Sheet 2 - Quad Cities 2, B-577 Rev. C.

o. Reactor Building Pool Sections & Details Sheet 3 - Quad Cities 2, B-578 Rev. B.

p. Reactor Building Pool Sections & Details Sheet 4 - Quad Cities 2, B-579 Rev. D.

q. Floor Loading Diagrams Reactor Bldg EL 690'- 6" and EL 666' - 6 - Quad Cities 1 & 2, B-974 Rev. A.

r. Exelon TODI No. TODI 04-014, "Provide Information for New Spare Steam Dryer Design," dated 10/27/2004.

s. Reactor Building Framing Plan EL. 589'-0" South Area – Dresden 2, B-206 Rev. Q.

t. Reactor Building Framing Plan EL. 589'-0" North Area – Dresden 2, B-207 Rev. K.

u. Reactor Building Framing Plan EL. 613'-0" South Area - Dresden 2, B-208 Rev. S.

v. Reactor Building Framing Plan EL. 613'-0" North Area - Dresden 2, B-209 Rev. N.

w. Reactor Building Framing Section A-A Upper Area - Dresden 2, B-212 Rev. M.

x. Reactor Building Framing Section B-B Upper Area - Dresden 2, B-214 Rev. U.

y. Reactor Building Framing Section G-G Upper Area - Dresden 2, B-224 Rev. M.

z. Reactor Building Framing Section K-K Upper Area - Dresden 2, B-230 Rev. N.

aa. Reactor Building Pool Plan EL. 613'-0" - Dresden 2, B-251 Rev. E.

ab. Reactor Building Pool Sections & Details, Sheet 1 - Dresden 2, B-252 Rev. D.

ac. Reactor Building Pool Sections & Details, Sheet 2 - Dresden 2, B-253 Rev. E.

ad. Reactor Building Pool Sections & Details, Sheet 3 - Dresden 2, B-254 Rev. F.

ae. Reactor Building Pool Sections & Details, Sheet 4 - Dresden 2, B-255 Rev. D.

af. Reactor Building Pool Sections & Details, Sheet 5 - Dresden 2, B-256 Rev. D.

ag. Reactor Building Pool Sections & Details, Sheet 6 - Dresden 2, B-257 Rev. F.

ah. Reactor Building Framing Plan EL. 589'-0" South Area - Dresden 3, B-636 Rev. L.

ai. Reactor Building Framing Plan EL. 613'-0" South Area - Dresden 3, B-638 Rev. H.

aj. Reactor Building Framing Plan EL. 613'-0" North Area - Dresden 3, B-639 Rev. D.

ak. Reactor Building Framing Section A-A Upper Area - Dresden 3, B-642 Rev. C.

al. Reactor Building Framing Section B-B Upper Area - Dresden 3, B-644 Rev. F.

am. Reactor Building Framing Section G-G Upper Area - Dresden 3, B-654 Rev. E.

an. Reactor Building Pool Liner Plan EL 613'-0" - Dresden 3, B-681 Rev. A.

ao. Reactor Building Pool Liner Bottom Plan - Dresden 3, B-682 Rev. A.

ap. Reactor Building Pool Sections and Details, Sheet 1 - Dresden 3, B-683 Rev. 00.

aq. Reactor Building Pool Sections and Details, Sheet 2 - Dresden 3, B-684 Rev. A.

ar. Reactor Building Pool Sections and Details, Sheet 3 - Dresden 3, B-685 Rev. 00.

as. Reactor Building Pool Sections and Details, Sheet 4 - Dresden 3, B-686 Rev. 00.

at. Reactor Building Pool Sections and Details, Sheet 5 - Dresden 3, B-687 Rev. A.

3.0 DESCRIPTION.

3.1 The steam dryer assembly shall consist of the following major components.

a. Skirt: directs the separator output into the dryer banks.

b. Hold Downs, Supports, and Support Ring: provides attachment to the reactor vessel and support for dryer banks.

c. Dryer Units: removes moisture from the separator output, guides the steam toward the outlet nozzles, and guides the extracted moisture below reactor water level.

4.0 REQUIREMENTS.

4.1 Classification and Code Requirements.

4.1.1 Applicable ASME Code Requirements.

4.1.1.1 There were no Code requirements applicable to the Dresden 2 & 3 and Quad Cities 1 & 2 steam dryers at the time of original construction.

4.1.1.2 ASME Code requirements (2.3.a) shall apply to the steam dryer design to the extent specified herein.

4.1.2 Classification.

4.1.2.1 The steam dryer has no safety function and therefore is a non-safety related item.

4.1.2.2 The steam dryer assembly is classified as an "internal structure" per ASME Boiler and Pressure Vessel Code, Section III, Subsection NG. Therefore, it shall be certified to not affect the core support structure integrity (shroud, top guide, core support and shroud support).

4.2 Performance.

4.2.1 Design Conditions.

a. Reactor Thermal Power	3016 MWt (102.0% of Extended Power Uprate (EPU) condition rated thermal power)
b. RPV steam dome pressure	1020 psia
c. RPV steam dome temperature	Saturated temperature corresponding to RPV steam dome pressure
d. Steam Flow Rate (structural)	11.97 x 10^6 lbm/hr (102.2% of EPU condition rated steam flow)
e. Steam Flow Rate (performance)	11.713 x 10^6 lbm/hr (EPU condition rated steam flow)

4.2.2 Steam Dryer Performance.

4.2.2.1 Moisture carryover at rated steam flow. The steam dryer shall limit moisture carryover to ≤0.1% at rated steam flow at the RPV Main Steam Line (MSL) nozzles. The dryer vane modules (dryer units) shall be 6 feet tall and have the same performance as the BWR/6 6-feet tall dryer vane modules.

4.2.2.2 Drainage system capacity from the steam dryer banks shall be of sufficient capacity to prevent the buildup of water in the dryer vanes.

4.2.2.3 Flow turbulences on the steam dryer shall be minimized to the extent practical.

4.2.2.4 The steam dryer skirt shall have sufficient length (height) to prevent steam from bypassing the steam dryer at the Reactor Pressure Vessel (RPV) Low Water Level 3 setpoint. The RPV Low Water Level 3 Analytical Limit is 503 inches above RPV elevation zero on the outside the steam dryer skirt. The differential pressure between the steam on the inside and on the outside of the steam dryer skirt will require the steam dryer skirt to extend to an elevation below 503 inches above RPV elevation zero.

4.3 Interfaces.

4.3.1 Reactor Pressure Vessel (RPV) and Internals.

4.3.1.1 The steam dryer shall be supported by the existing steam dryer support brackets (Section 2.2.1.2, Paragraphs a and b).

4.3.1.2 The steam dryer shall include a hold-down mechanism using the steam dryer support brackets to prevent the steam dryer from lifting in the event of a Main Steam Line (MSL) break outside the containment (the governing design basis accident for steam dryer design).

4.3.1.3 The steam dryer shall fit within the RPV, accounting for the existing equipment such as the shroud head and steam separator assembly, the RPV flange and the steam dryer guide rods (Section 2.2.1.2, Paragraphs c, d, e, and f, and Section 2.4). Sufficient clearance shall be provided for differential thermal expansion. The original steam dryer (Section 2.2.1.2, Paragraph h) may be used as a guide.

4.3.1.4 The steam dryer shall permit adequate steam flow to the RPV Isolation Condenser (IC) nozzle for those conditions when the IC System is required to function (Dresden 2 & 3 only).

4.3.1.5 Dryer Rocking. The replacement steam dryer design shall include features to prevent impact loading of the RPV steam dryer support brackets from potential dryer rocking during normal operation.

4.3.2 Lifting Strongback.

4.3.2.1 The weight of the steam dryer shall not exceed the capacity of the existing lifting strongback (Section 2.2.1.1, Paragraph e, and Section 2.2.1.2, Paragraph g).

4.3.2.2 The steam dryer shall be designed to interface correctly with the existing lifting strongback.

4.3.3 Dryer Separator Pool.

4.3.3.1 The replacement steam dryer shall be designed for storage, during refueling outages, in the existing dryer separator pool (See Section 2.5, Paragraphs a thru q.). The steam dryer banks are higher than the original design and this new interface shall be confirmed to be acceptable by the plant owner.

4.3.4 Provisions for shipment.

4.3.4.1 The steam dryer assembly shall be delivered in one piece on a suitable shipping fixture.[1]

4.3.5 Provisions for instrumentation.

4.3.5.1 Provisions for instrumentation shall be considered in the design.

4.3.6 Initial installation.

4.3.6.1 The design scope of the replacement steam dryer shall include trial fit up, adjustment, field machining, or field welding as required for the initial dryer installation into the RPV. In the case of the original steam dryer these were adjustment of the leveling screws, adjustment of the hold down subassemblies, and installation of the seismic blocks as specified on the reactor assembly drawings. For the replacement dryer similar initial installation tasks shall be performed on the refuel floor, remotely from the refueling bridge, or by divers. Installation welds may be performed with approved procedures qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX. Underwater welding, in accordance with specification P50YP244 (Section 2.2.1.1, Paragraph f) may be utilized for the initial installation tasks. Previously demonstrated proactive measures shall be taken to prevent loose parts during the initial installation. The design for initial installation shall be done in concert with the design of special installation tooling to minimize installation time and personnel exposure.

4.4 Materials and Fabrication Requirements.

4.4.1 Materials Requirements.

4.4.1.1 The steam dryer materials shall be selected to be resistant to corrosion and stress corrosion cracking in the BWR steam/water environment. See Section 2.2.1.1, Paragraph a, for the specific material requirements.

4.4.1.2 Corrosion allowance for AISI 300 series stainless steel is 0.003 inches for 40 year service. The corrosion allowance for Alloy X-750 is 0.006 inches for 40 year service.

4.4.2 Fabrication Requirements. Fabrication process controls shall be applied to minimize degradation of material properties by forming, cold working, etc. See Section 2.2.1.1, Paragraph b, for the fabrication requirements.

4.5 Steam Dryer Loads.

4.5.1 Differential pressure across the steam dryer during normal and accident conditions. See the Data Sheet for these values.

4.5.2 Seismic Loads.

a. Seismic loads are contained in Appendix 1 of this document.

[1] The Dresden site has yet to confirm that a one-piece dryer assembly is acceptable.

4.5.3 New Loads.

a. New loads (related to containment dynamic phenomena) are not applicable to these BWRs.

4.5.4 Thermal Cycles. Operating conditions (pressure and temperature) as specified below shall be considered in the design of the replacement steam dryer.

a. Dresden 2 & 3: Section 2.2.1.1, Paragraph c, and Section 2.2.1.2, Paragraph h (921D265 as modified by 26A5587, Section 4.4.1).

b. Quad Cities 1 & 2: Section 2.2.1.1, Paragraph d, and Section 2.2.1.2, Paragraph h (921D265 as modified by 26A5588, Section 4.4.1).

4.5.5 Loads Resulting from Rapid Closure of the Main Steam Turbine Stop Valves.

a. Turbine Stop Valve (TSV) closure loads are contained in Appendix 3 of this document. These loads are applicable to Dresden 2 & 3 and Quad Cities 1 & 2.

4.5.6 Flow Induced Vibration (FIV) loads. A document shall be prepared which documents the development and bases of the steam dryer FIV loads. See the Data Sheet for the FIV loads.

4.6 Stress Limits.

4.6.1 Subsection NG "Core Support Structure" stress limits shall be used for the steam dryer design analysis and comparable fabrication and inspection requirements specified, e.g., weld quality factors. Material strength properties shall be obtained from Section II Part D (Section 2.3.a, Paragraph (4)) and Code Case N-60-5 (Reference 2.3.a, Paragraph (3)). Deviations shall be individually justified in the design/stress report and be approved by both GE and the plant owner.

4.6.2 Vibratory loads stress limit. The alternating stress intensity amplitude due to vibratory loads, which are continuously applied (infinite number of cycles) during normal reactor operation, shall be limited to a conservative 10,800-psi fatigue endurance limit. An alternate 13,600-psi criteria, per the ASME Boiler and Pressure Vessel Code, Appendix I, Figure I-9.2.2, Curve C, may be used at specific locations if justified. Locations where postulated fatigue cracking would not result in loose parts may be appropriate for application of the alternate criteria. Justification to apply the alternate criteria shall be individually justified in the design/stress report and be approved by both GE and the plant owner. The (Pm+Pb+Q) stress intensity range shall be less than 27,200 psi for consideration of the alternate criteria. The higher alternate criteria would not be appropriate for outer bank hood, cover plate and associated welds.

4.7 Load Combinations and Conditions.

4.7.1 Table 4.7-1 provides the load combinations and load cases to be used in the steam dryer analysis.

Table 4.7-1 Load Combinations

Comb. No.	Service Condition	Load Combination	Remarks/ Notes
A	Normal	DW + DPn ± FIVn	
B1	Upset	DW + DPn + TSV1 ± FIVn	
B2	Upset	DW + DPn + TSV2	2
B3	Upset	DW + DPu ± FIVu	3
B4	Upset	DW + DPn ± OBE ± FIVn	
D1A	Faulted	DW + DPn + $[SSE^2 + \{AC1\ (Hi\text{-}Power)\}^2]^{1/2}$ ± FIVn	1
D1B	Faulted	DW + $[\{DPf1\ (Hi\text{-}Power)\}^2 + SSE^2]^{1/2}$	4
D2A	Faulted	DW + DPn + AC2 (Interlock) ± FIVn	
D2B	Faulted	DW + DPf2 (Interlock)	4

Notes:

1. Loads from independent dynamic events are combined by the square root sum of the squares method.
2. In the Upset B2 combination, FIVn is not included because the reverse flow through the steamlines will disrupt the acoustic sources that dominate the FIVn load component.
3. The relief valve opening decompression wave load (acoustic) associated with an inadvertent or stuck-open relief valve (SORV) opening is bounded by the TSV acoustic load (Upset B1); therefore, the acoustic phase of the SORV load need not be explicitly evaluated or included in the Upset load combination B3.
4. In the Faulted D1B and D2B combinations, FIVn is not included because the level swell in the annulus between the dryer and vessel wall will disrupt the acoustic sources that dominate the FIVn load component.

Definition of Load Acronyms

AC1 Acoustic load due to Main Steam Line Break (MSLB) outside containment, at the Rated Power and Core Flow (Hi-Power) Condition.

AC2 Acoustic load due to Main Steam Line Break (MSLB) outside containment, at the Low Power/High Core Flow (Interlock) Condition.

DW Dead Weight.

DPn Differential 'static' Pressure Load During Normal Operation.

DPu Differential 'static' Pressure Load During Upset Operation (including the effects of stuck-open relief valve (SORV) condition).

DPf1 Differential Pressure Load in the Faulted condition, due to Main Steam Line Break outside containment at the Rated Power and Core Flow (Hi-Power) condition.

DPf2 Differential Pressure Load in the Faulted condition, due to Main Steam Line Break outside containment at the Low Power/High Core Flow (Interlock) condition.

FIVn Flow Induced Vibration Load during Normal Operation.

FIVu Flow Induced Vibration Load during Upset Operation.

OBE Operating Basis Earthquake.

SSE Safe Shutdown Earthquake.

TSV1 The Initial Acoustic Component of the Turbine Stop Valve (TSV) Closure Load. (Inward load on the outermost hood closest to the nozzle)

TSV2 The Flow Impingement Component (following the Acoustic phase) of the TSV Closure Load; (Inward load on the outermost hood closest to the nozzle)

5.0 QUALIFICATION.

5.1 Structural Design.

5.1.1 The structural design of the steam dryer to be confirmed by analysis.

5.2 Performance.

5.2.1 Steam dryer performance to be confirmed by analysis, utilizing previous steam dryer development tests.

5.2.2 Confirmatory testing of the dryer bank assembly is discussed in Appendix 2 of this document.

5.3 Confirmation of Fit-up.

5.3.1 Correct installation fit-up or clearance of the replacement steam dryer shall be demonstrated by a combination of in-reactor visual examinations and selected measurements. The detail requirements shall be developed as a part of the design and specified in the installation specification and the modification/installation drawing. Critical interfaces to be confirmed shall include:

a. steam dryer lifting eyes fit-up with the lifting device,

b. steam dryer assembly clearance, during installation, with the steam dryer guide rods and steam dryer support (RPV) brackets,

c. steam dryer support ring fit-up with the steam dryer support (RPV) brackets,

d. steam dryer hold down sub-assembly fit-up with the steam dryer support (RPV) brackets,

e. steam dryer skirt clearance with the steam separators

5.3.2 Design calculations shall be performed to demonstrate that clearance between the replacement steam dryer and other reactor internal components, including the steam separator, are sufficient. These calculations shall specifically address differential thermal expansion.

6.0 DOCUMENTATION.

6.1 Structural Evaluation.

6.1.1 The design of the replacement steam dryers shall be documented, as a minimum, in the following documents:

a. Detail and Assembly Drawings: Detail and assembly drawings shall document all requirements for construction of the steam dryers.

b. Modification/Installation Drawings: These drawings shall document requirements for initial installation into the RPV including field adjustments, field machining, and welding.

c. Installation Specification: This specification with the Modification/Installation Drawings will complete the documentation of the requirements for the initial steam dryer installation into the RPV.

d. Design Report(s): Design stress report which documents design method, applicable ASME Code Section used in the design, other codes and specifications, calculations, and reference to applicable design drawings.

e. Safety Evaluation: Input shall be provided for a formal safety evaluation that all applicable safety requirements are met.

f. Performance Report: The analysis and test data which demonstrates that the performance requirements will be met.

g. FIV Loading: A report shall be prepared to document the flow induced loading used for steam dryer design and the bases for the development of these loads.

6.2 Testing. Appendix 3 of this document addresses the performance testing of the steam dryer bank assembly.

APPENDIX 1:Seismic Loads

A1.1 Dresden 2 & 3.

A1.1.1 Maximum horizontal acceleration and acceleration response spectra at steam dryer location on RPV for the seismic load case.

A1.1.1.1 Maximum Horizontal OBE Acceleration 0.40 g

A1.1.1.2 Maximum Horizontal SSE Acceleration 0.80 g

A1.1.1.3 The following figures are the horizontal response spectra (at Node 2 of the primary structure model) for OBE (N-S), OBE (E-W) directions for cracked and uncracked shroud conditions. SSE spectra are two times the corresponding OBE spectra.

A1.1.1.4 These loads are identified in eDRF 0000-0029-7776.

A1.1.2 Vertical acceleration.

A1.1.2.1 Vertical OBE Acceleration 0.067 g

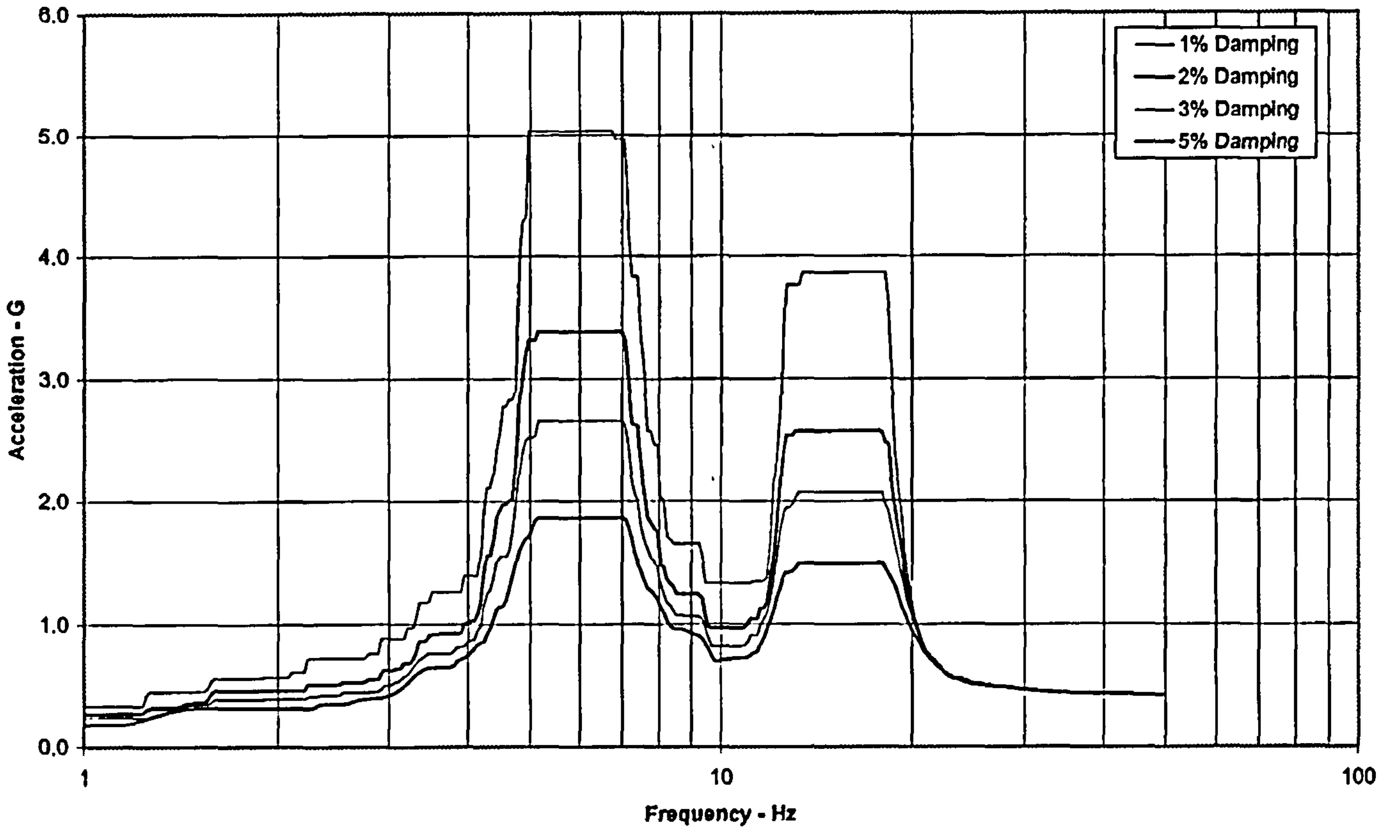
A1.1.2.2 Vertical SSE Acceleration 0.134 g

A1.1.3 Damping.

A1.1.3.1 OBE Damping 2%

A1.1.3.2 SSE Damping 2%

Dresden 2&3 RPV Node 2 OBE Spectra - EW - Uncracked Shroud



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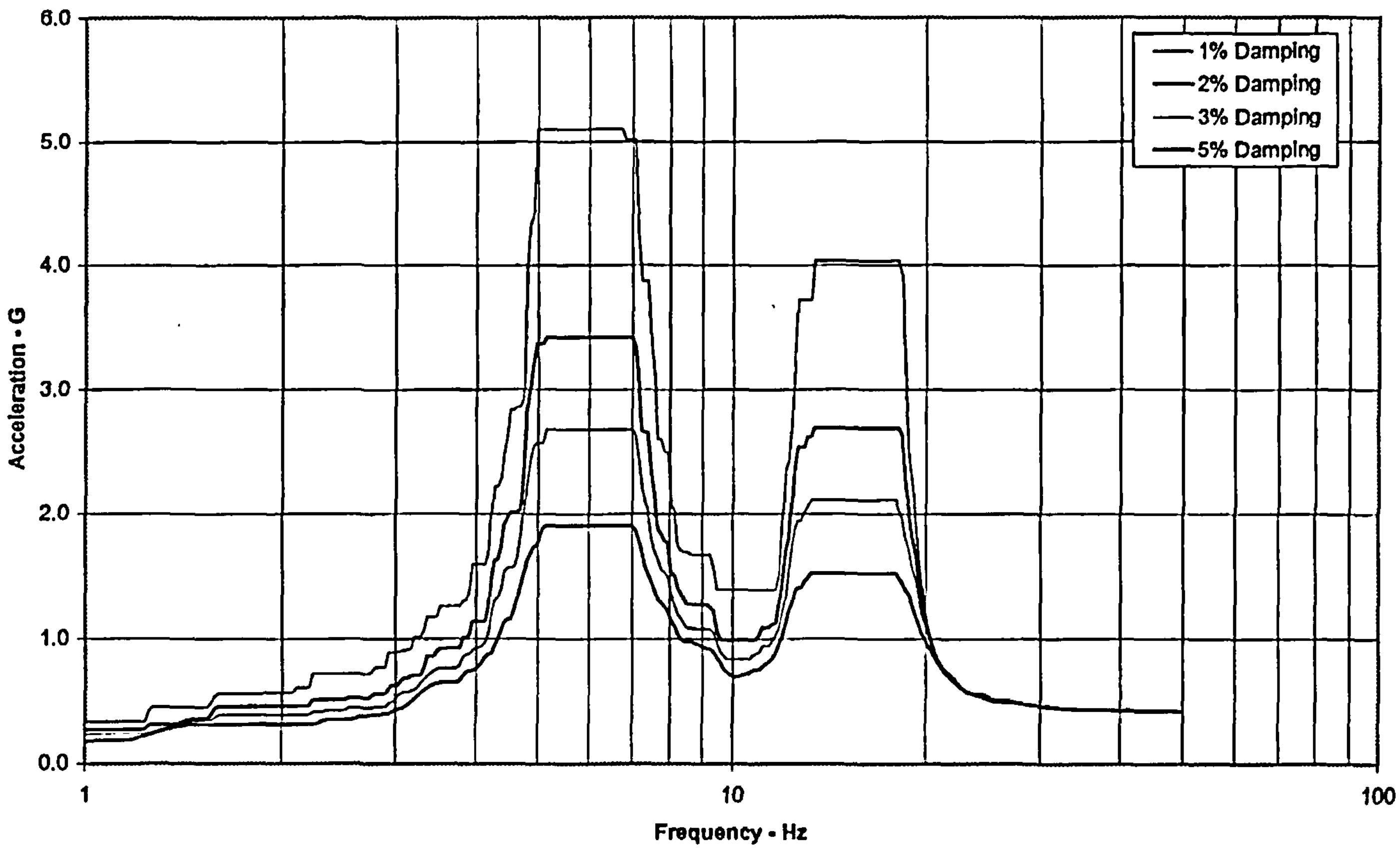
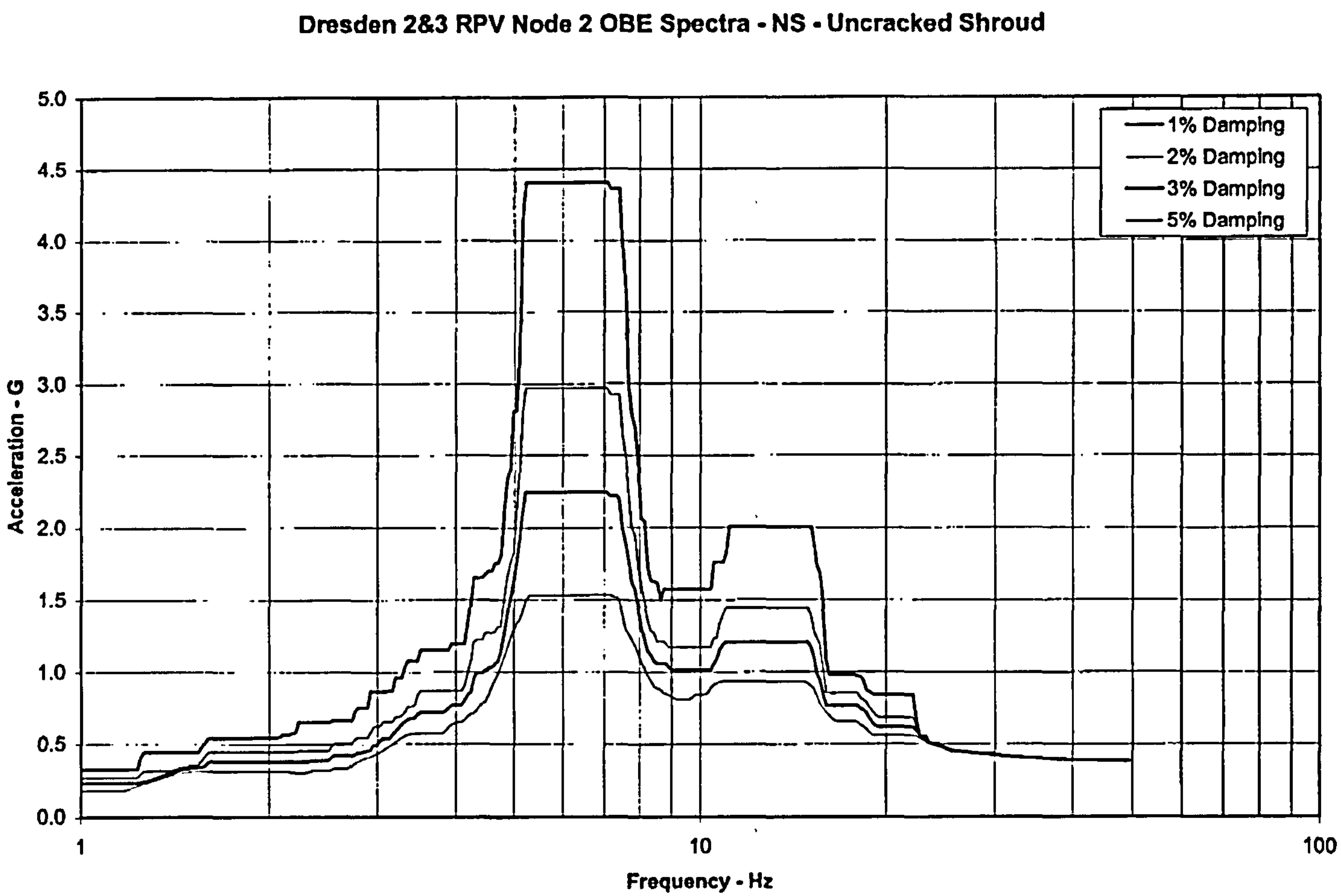
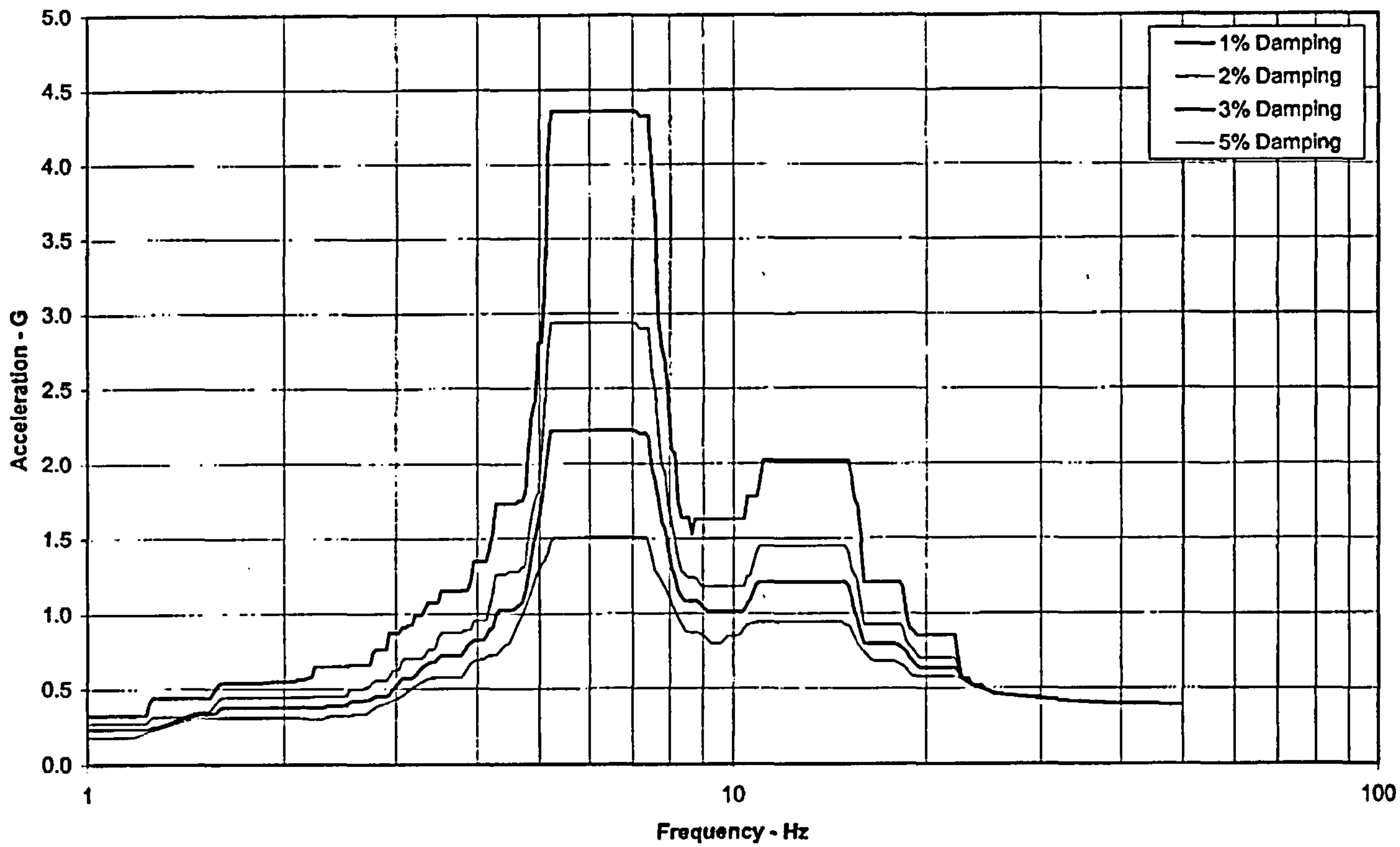
Dresden 2&3 RPV Node 2 OBE Spectra - EW - Cracked Shroud





Dresden 2&3 RPV Node 2 OBE Spectra - NS - Uncracked Shroud
Acceleration - G
Frequency - Hz
1% Damping
2% Damping
3% Damping
5% Damping
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
10
100

Dresden 2&3 RPV Node 2 OBE Spectra - NS - Cracked Shroud



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A1.2 Quad Cities 1 & 2.

A1.2.1 Maximum horizontal acceleration and acceleration response spectra at steam dryer location on RPV for the seismic load case.

A1.2.1.1 Maximum Horizontal OBE Acceleration 1.00 g

A1.2.1.2 Maximum Horizontal SSE Acceleration 2.00 g

A1.2.1.3 The following figures are the horizontal response spectra (at Node 2 of the primary structure model) for OBE (N-S), OBE (E-W) directions for cracked and uncracked shroud conditions. SSE spectra are two times the corresponding OBE spectra.

A1.2.1.4 These loads are identified in eDRF 0000-0029-7777.

A1.2.2 Vertical accelerations.

A1.2.2.1 Vertical OBE Acceleration 0.08g

A1.2.2.2 Vertical SSE Acceleration 0.16g

A1.2.3 Damping.

A1.2.3.1 OBE Damping 2%

A1.2.3.2 SSE Damping 2%

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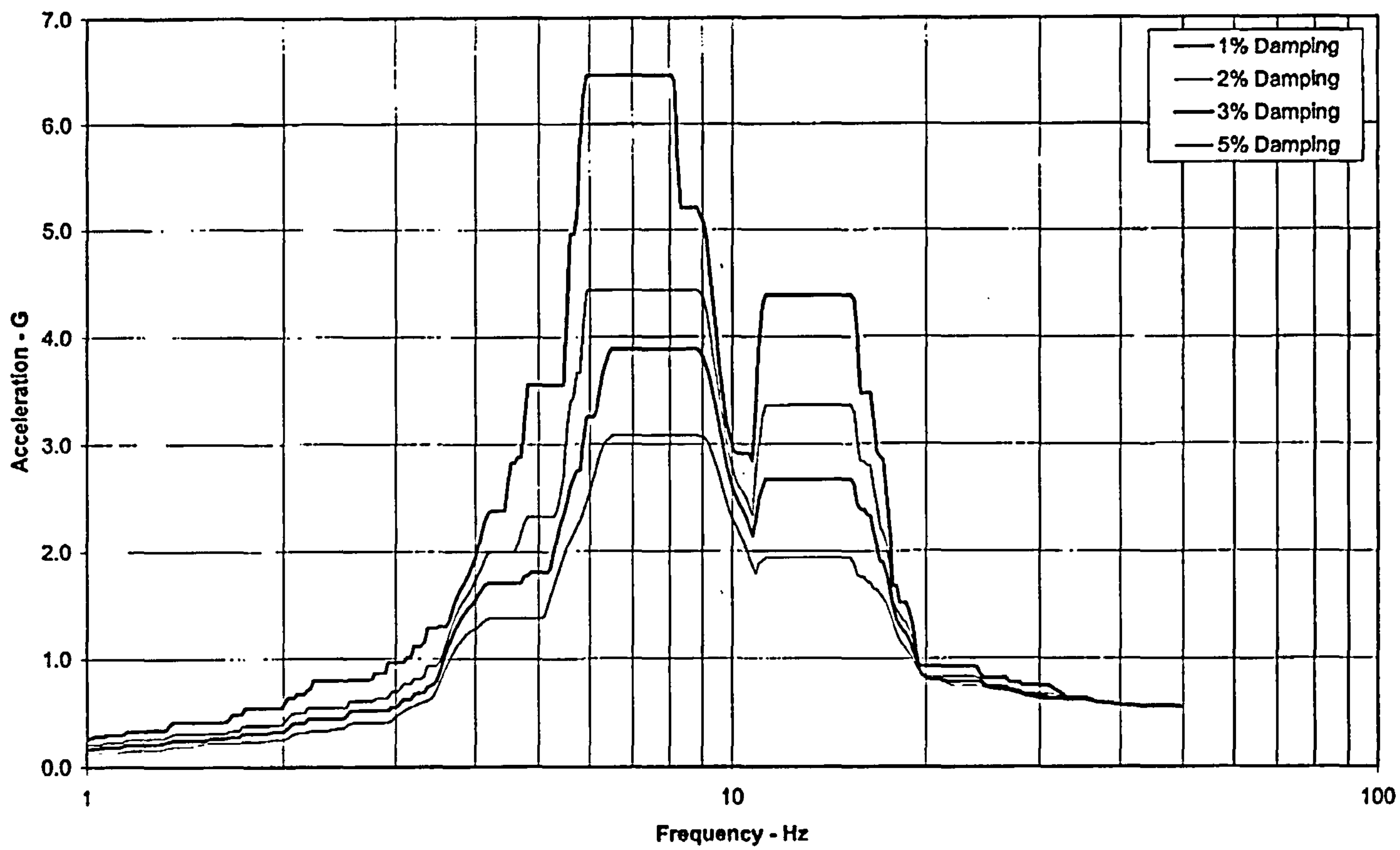
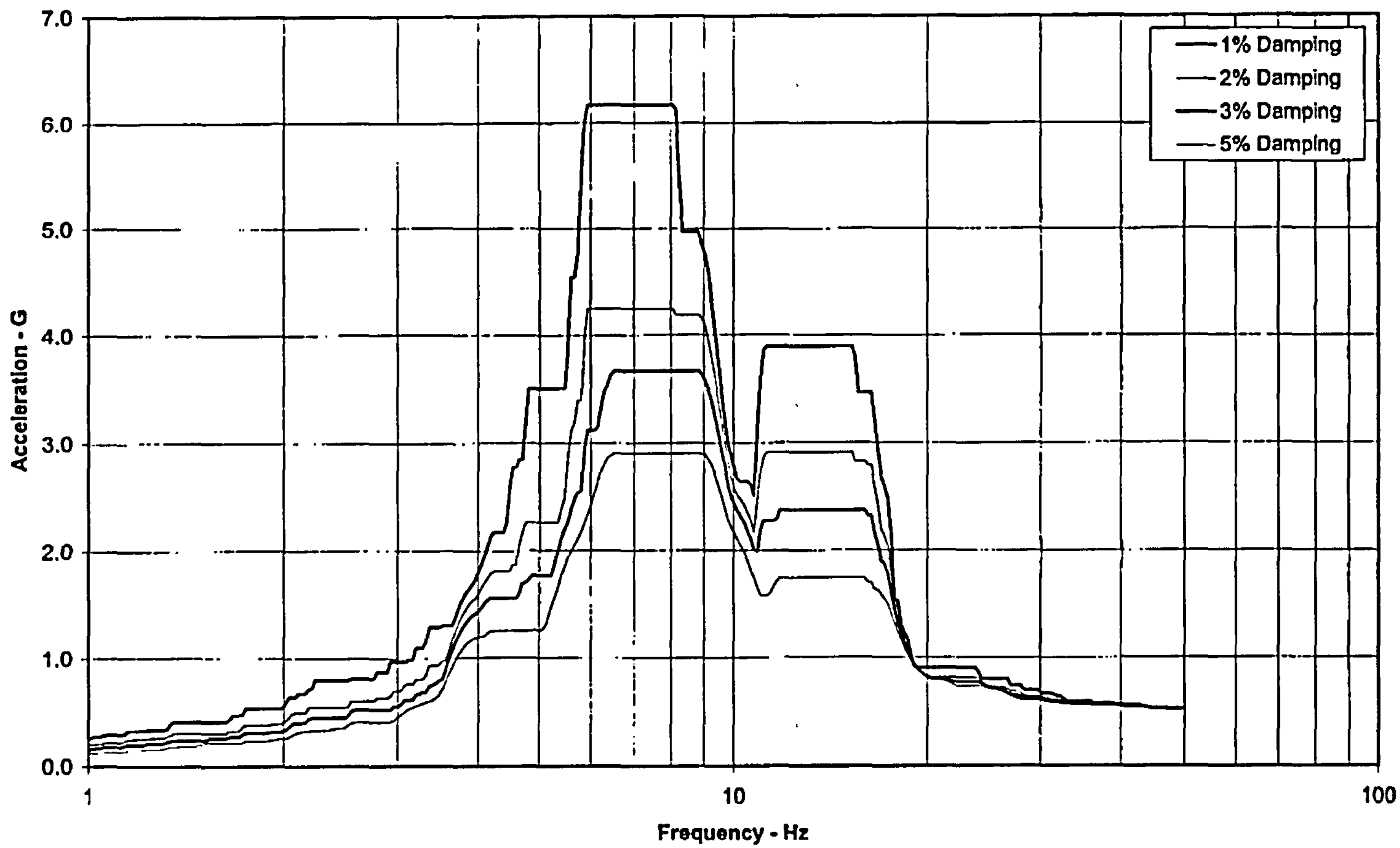
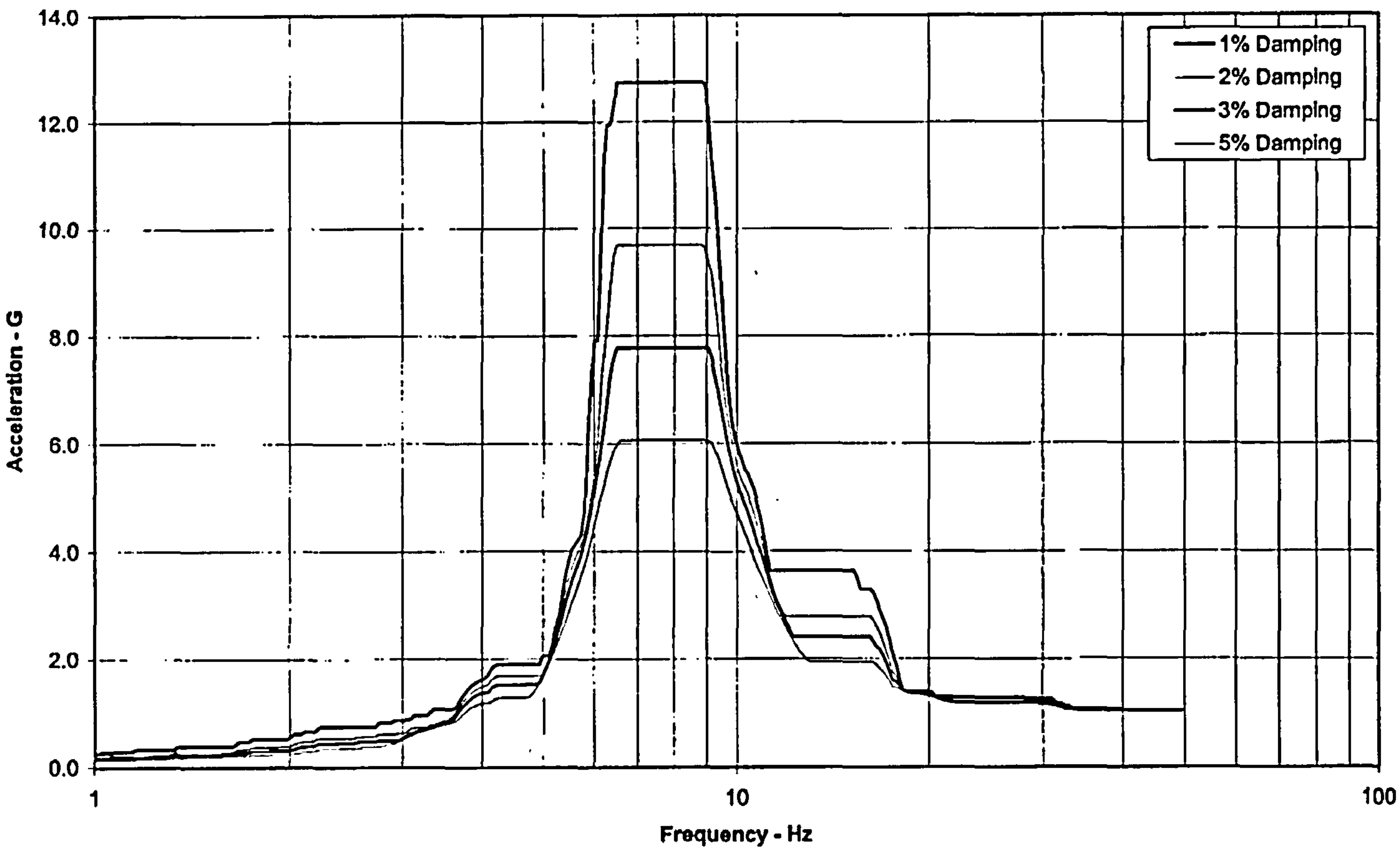
Quad Cities 1&2 RPV Node 2 OBE Spectra - EW - Cracked Shroud



Quad Cities 1&2 RPV Node 2 OBE Spectra - EW - Uncracked Shroud



Quad Cities 1&2 RPV Node 2 OBE Spectra - NS - Cracked Shroud



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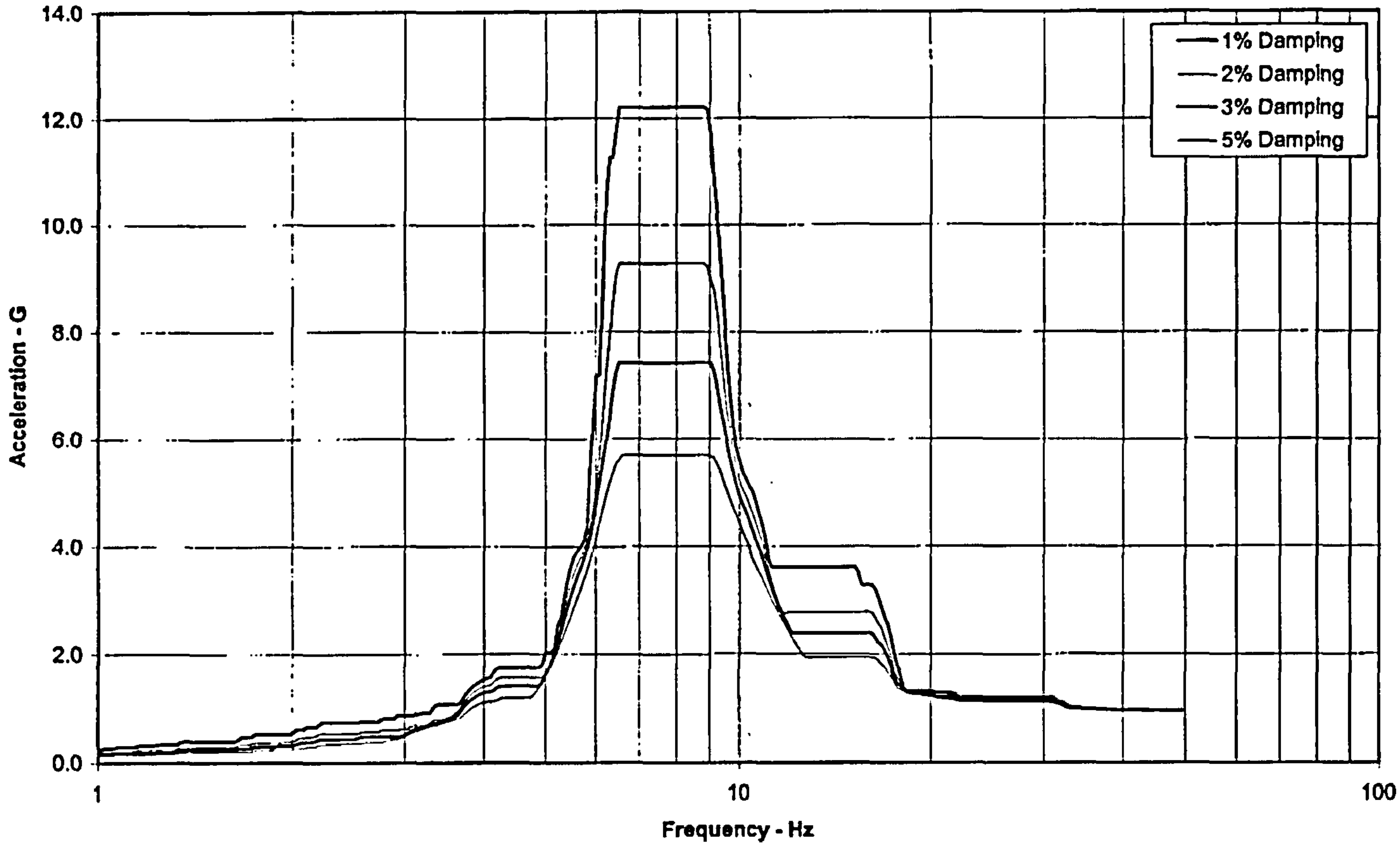
Quad Cities 1&2 RPV Node 2 OBE Spectra - NS - Uncracked Shroud



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APPENDIX 2: Steam Dryer Bank Performance Testing

A2.1 Test Method and Configuration.

A2.1.1 A test shall be performed on a dryer bank assembly to benchmark the differential pressure across the dryer bank assembly and to confirm that the velocity profile at the exit of the dryer bank is uniform. This test does not have to be performed with steam/water or air/water. An air test would be sufficient.

A2.1.2 The dryer bank configuration tested should be representative of the steam flow path from the inlet at the base of the steam dryer to the exit at the top of the steam dryer (i.e., the inlet hood, dryer vane module, outlet perforated plates, and the flow path out the top of the steam dryer).

A2.2 Parameters to be Measured.

A2.2.1 The differential pressure across the dryer bank assembly (i.e., the differential pressure between the inlet at the base of the steam dryer to the exit at the top of the steam dryer) shall be measured. This value shall be used to benchmark the differential pressure.

A2.2.2 The velocity profile at the exit of the perforated plates shall be measured. The velocity should be measured at a minimum every six inches along the vertical length of the steam dryer bank.

A2.3 Flow Rate.

A2.3.1 The flow rate shall be sufficient enough that the instrumentation can measure the differential pressure across the steam dryer bank assembly and the velocity profile at the outlet of the perforated plates can be measured.

A2.3.2 At least three different flow rates should be used.

A2.4 Acceptance Criteria.

A2.4.1 The uniformity of the velocity leaving the perforated plates shall not differ by more than 10%.

Basis for Steam Dryer Bank Performance Testing Requirements
(information only):

The air only test requirement is based on the 2001 Dresden/Quad Cities dryer modification experience. Existing test data and facts, which will be used in describing the basis for air only testing, follow:

(1) There is already steam-water test data for the dryer vanes that will be used for the new dryers (NEDE-133391, "Performance of a Development Steam Dryer with Delta P, Inc., Vanes and three AS-2B Steam Separators Simulating BWR/6," by S. Wolf, August 1974, Class II). BWR/6 steam dryers use the same dryer vanes.

(2) The steam dryer moisture separation performance improves as the vertical velocity profile in the dryer cross section becomes more uniform.

(3) Given the dryer geometry and the dryer vanes, the vertical velocity profile is the main parameter that affects the performance of the steam dryer.

(4) The steam dryer breakthrough test data is correlated as Steam Separator moisture carryover (CO) at the point of moisture breakthrough as a function of the steam dryer average velocity through the vane section. The breakthrough CO in the dryer vane depends on the velocity passing through the vane.

The basis for establishing the air only testing requirement follows:

(1) The CFD analysis of the vertical velocity profiles in the vane bank will be performed as a part of design analysis for the new steam dryer design and the BWR/6 standard design to demonstrate that the velocity profile of the new steam dryer is more uniform than that of the BWR/6 dryer.

(2) By the combination of the air test and the CFD analysis, it will be demonstrated that the vertical velocity profile in the steam dryer is more uniform than that of the BWR/6 steam dryer. This will ensure that applying the BWR/6 steam dryer performance curve is conservative.

(3) The BWR/6 steam dryer performance curve may be applied for steam dryer conservatively.

(4) BWR/6 dryer performance curve may be modified in the future if necessary based on the comparison of the vertical velocity profiles of the BWR/6 steam dryer and the new steam dryer. This option will not be used at this time because there is a sufficient design margin for moisture separation using BWR/6 dryer performance curve, but will be preserved for potential future use in case a further improved dryer performance is required in the future.

APPENDIX 3: Turbine Stop Valve (TSV) Closure Loads.

A3.1 Introduction.

A3.1.1 This appendix presents the loads on the Dresden and Quad Cities new steam dryer design in an event of turbine stop valve (TSV) closure. This event is the most limiting event in the upset backward flow category. The steam dryer cover plates experience two types of loads in the event of TSV closure: Steam Hammer Load (acoustic loads) and Impingement Load (flow-induced loads).

A3.2 Results.

A3.2.1 Acoustic loads on the dryer hood (TSV1).

A3.2.1.1 The acoustic loads on the dryer hood at EPU power level is calculated as follows:

$P_{hood}(x,y,t) = (2.92\ \text{psid})^* ((\Delta P/\Delta P_{vessel})$ from Figures A3-1 – A3-5 Equation 1

Where,

- x = Horizontal distance from the vessel centerline between the two steam line nozzles on one side of the pressure vessel (ft).
- y = Vertical distance above the dryer cover plate (ft).
- t = Time in milliseconds

A3.2.1.2 The maximum acoustic loads distribution on the vertical cover plate at EPU power level is summarized in Table A3-1. The maximum acoustic loads distribution is obtained by applying the Steam Hammer pressure of 2.92 psid to the peak local normalized pressure distribution.

Table A3-1. Maximum Acoustic Load on the Vertical Cover Plate at EPU

y, Dryer Vertical Centerline	Pressure Differential(1) (psid)					
7.5 ft	1.20	0.66	0.68	0.67	0.62	
6.0 ft	5.88	5.26	4.66	4.24	3.53	
4.5 ft	8.78	8.32	8.13	7.20	6.06	
3.0 ft	11.70	11.50	11.25	10.26	8.49	
1.5 ft	13.58	14.08	15.37	13.05	10.65	
0.0 ft	15.34	15.96	16.94	14.90	11.64	
Coordinate (x,y)	0.00 ft	1.642 ft	3.284 ft	4.926 ft	6.568 ft	X, Lower Horizontal Cover Plate

(1) The pressure differential of 2.92 psid in Equation 1 is included in the results.

A3.2.2 Upset flow induced load on the vertical coverplate (TSV2).

A3.2.2.1 The upset flow-induced load on the vertical cover plate at EPU is 20.3 psid. This is the peak load on the vertical cover plate that is directly opposite from the steam line nozzle (the projected area of the steam line nozzle on to the vertical cover plate).

A3.3 References.

1. eDRF 0000-0029-5121/0000-0039-3844, "Updated TSV Acoustic Loads."

2. GE-NE-0000-0031-5681-R0, "Turbine Stop Valve Closure Loads for Dresden and Quad Cities New Steam Dryer Design," 8/18/04.

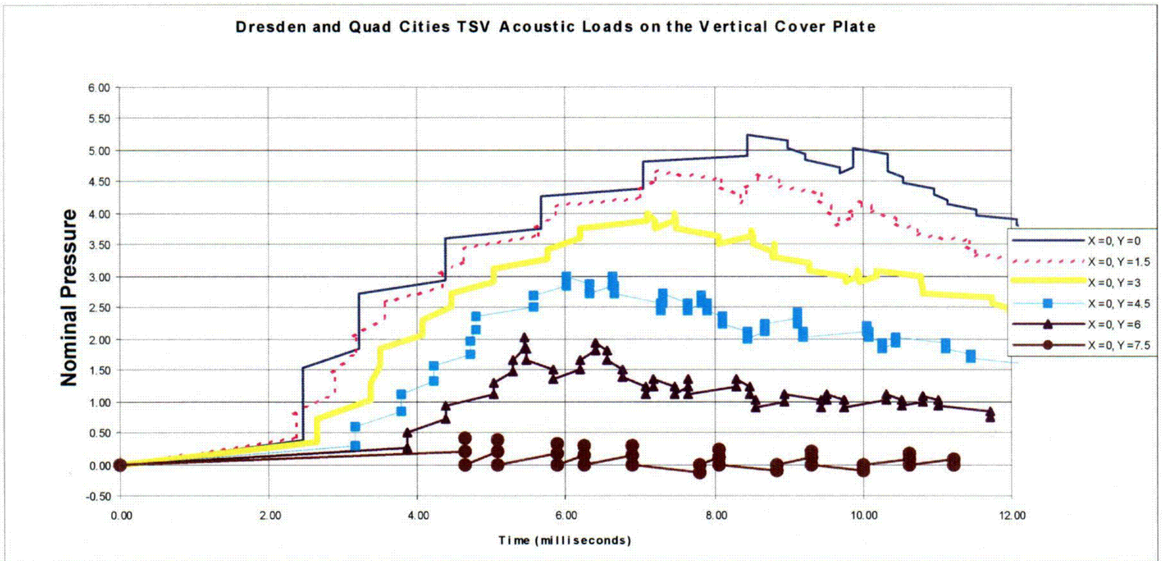

Figure A3-1: Base Load x=0 and Y=1.5, 3.0, 4.5, 6.0, and 7.5

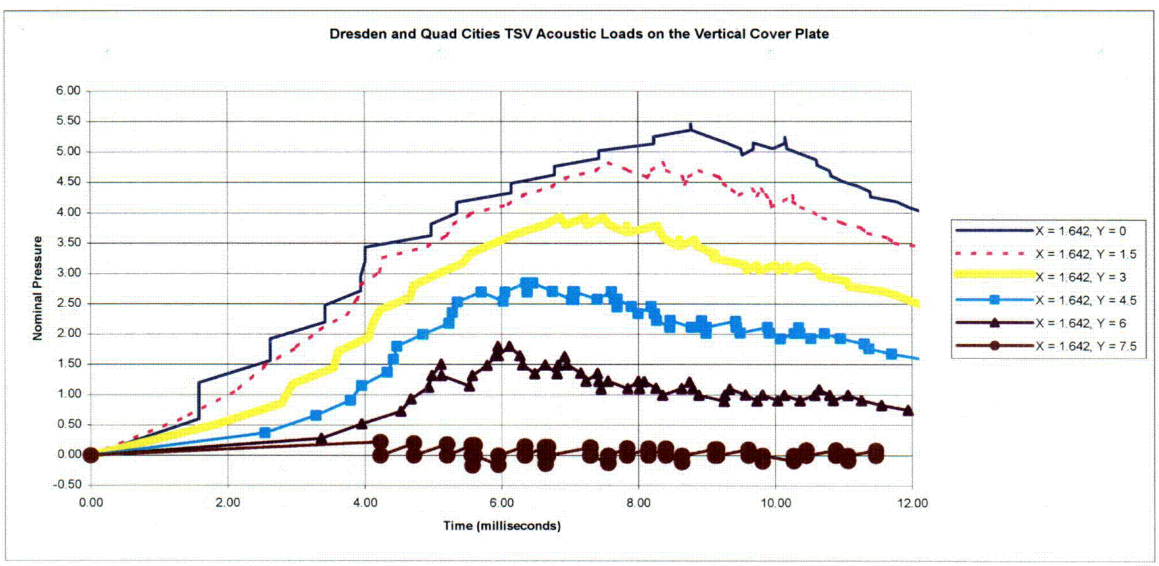

Figure A3-2: Base Load x=1.642 and Y=1.5, 3.0, 4.5, 6.0, and 7.5

C01

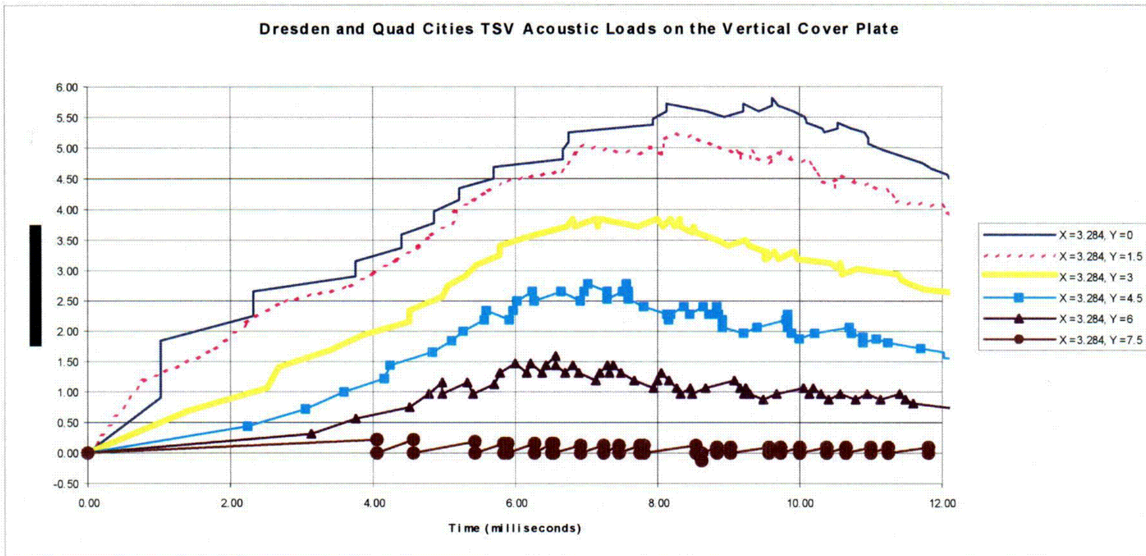

Figure A3-3: Base Load x=3.284 and Y=1.5, 3.0, 4.5, 6.0, and 7.5

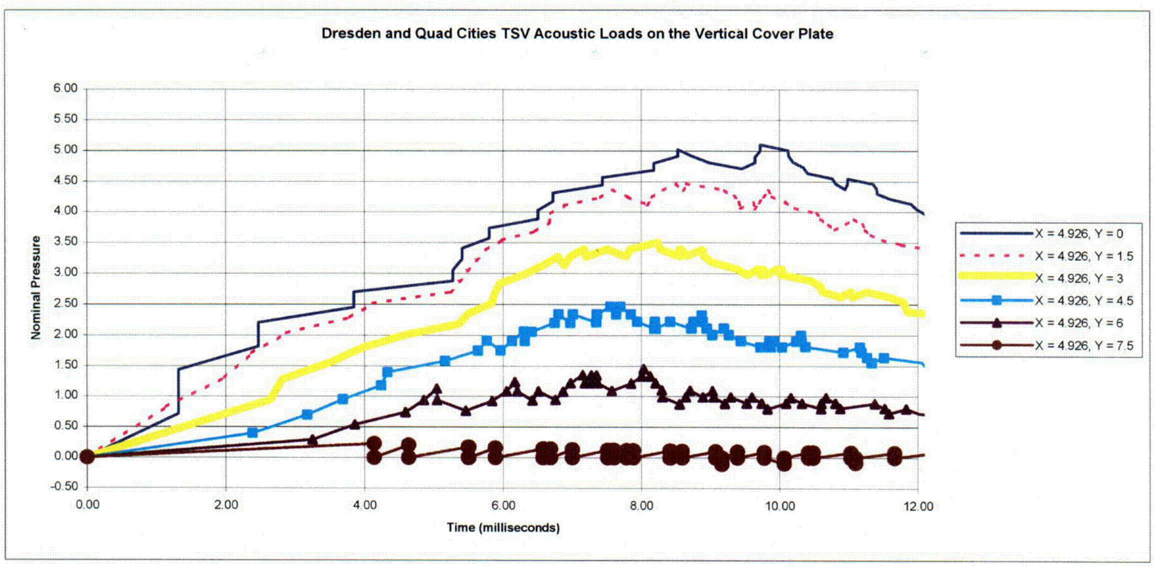

Figure A3-4: Base Load x=4.926 and Y=1.5, 3.0, 4.5, 6.0, and 7.5

C02

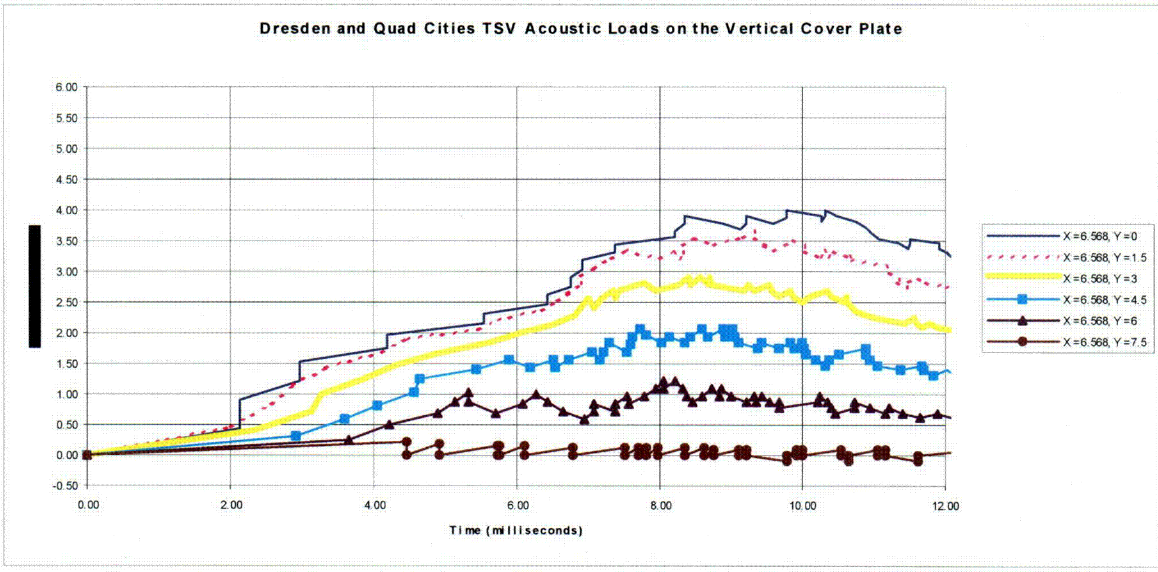

Figure A3-5: Base Load x=6.568 and Y=1.5, 3.0, 4.5, 6.0, and 7.5

C03