Attachment 9

**Redacted TVA calculation WCGACQ0766, Revision 1, "
Required Response Spectra for Evaluation of Radiation Monitoring Equipment"
(Letter Item 6)**

NPG CALCULATION COVERSHEET/CCRIS UPDATE

REV 0 EDMS/RIMS NO.	EDMS TYPE:	EDMS ACCESSION NO (N/A for REV. 0)
T93110407002	calculations(nuclear)	T93120113002

Calc Title:
REQUIRED RESPONSE SPECTRA FOR EVALUATION OF RADIATION MONITORING EQUIPMENT

CALC ID	TYPE	ORG	PLANT	BRANCH	NUMBER	CUR REV	NEW REV	REVISION APPLICABILITY
CURRENT	CN	NUC	WBN	CEB	WCGACQ0766	000	001	Entire calc ☒
NEW	CN	NUC						Selected pages ☐

ACTION	NEW ☐ REVISION ☒	DELETE ☐ RENAME ☐	SUPERSEDE ☐ DUPLICATE ☐	CCRIS UPDATE ONLY ☐ (Verifier Approval Signatures Not Required)	No CCRIS Changes ☐ (For calc revision, CCRIS been reviewed and no CCRIS changes required)

UNITS	SYSTEMS	UNIDS
000, 002	090	WBN-2-PNL-090-M030, WBN-0-PNL-090-M12, WBN-2-RE-090-0106, WBN-2-RE-090-0112, WBN-2-RE-090-0130, WBN-2-RE-090-0131

DCN,EDC,N/A	APPLICABLE DESIGN DOCUMENT(S)	CLASSIFICATION
N/A	WB-DC-40-31.2 & CEB-SS-5.10	E

QUALITY RELATED?	SAFETY RELATED? (If yes, QR = yes)	UNVERIFIED ASSUMPTION	SPECIAL REQUIREMENTS AND/OR LIMITING CONDITIONS?	DESIGN OUTPUT ATTACHMENT?	SAR/TS and/or ISFSI SAR/CoC AFFECTED
Yes ☒ No ☐	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒

PREPARER ID	PREPARER PHONE NO	PREPARING ORG (BRANCH)	VERIFICATION METHOD	NEW METHOD OF ANALYSIS
RGBROWN	(423) 365-7769	CEB	DESIGN REVIEW	☐ Yes ☒ No

PREPARER SIGNATURE	DATE	CHECKER SIGNATURE	DATE
Robert G. Brown	1/6/12	Eric Campbell	1/9/12
VERIFIER SIGNATURE	**DATE**	**APPROVAL SIGNATURE**	**DATE**
Eric Campbell	1/9/12	Bill Perkins TKD	1-10-12

STATEMENT OF PROBLEM/ABSTRACT

REVISION 001:

THIS REVISION DEVELOPS ADDITIONAL REQUIRED RESPONSE SPECTRA FOR THE RADIATION MONITORING EQUIPMENT FOR THE PURPOSE OF EVALUATING VENDOR SEISMIC REPORTS.

NOTE: THIS REVISION ALSO CHANGES THE CALCULATION TITLE

LEGIBILITY EVALUATED AND ACCEPTED FOR ISSUE ALL PAGES IN REV. 001

1/6/12

SIGNATURE **DATE**

MICROFICHE/EFICHE Yes ☐ No ☒ FICHE NUMBER(S)

☐ LOAD INTO EDMS AND DESTROY
☒ LOAD INTO EDMS AND RETURN CALCULATION TO CALCULATION LIBRARY. ADDRESS: EQB-1M-WBN
☐ LOAD INTO EDMS AND RETURN CALCULATION TO:

This Sheet Added By Revision 001

NPG CALCULATION COVERSHEET/CCRIS UPDATE

CALC ID	TYPE	ORG	PLANT	BRANCH	NUMBER	REV
	CN	NUC	WBN	CEB	WCGACQ0766	001

ALTERNATE CALCULATION IDENTIFICATION

BLDG	ROOM	ELEV	COORD/AZIM	FIRM	Print Report Yes ☐
03	N/A	N/A	N/A	BECHTEL	

CATEGORIES: A09

KEY NOUNS (A-add, D-delete)

ACTION (A/D)	KEY NOUN	A/D	KEY NOUN
A	SKID		
A	RADIATION MONITORS		

CROSS-REFERENCES (A-add, C-change, D-delete)

ACTION (A/C/D)	XREF CODE	XREF TYPE	XREF PLANT	XREF BRANCH	XREF NUMBER	XREF REV
A	P	CN	WBN	CEB	WCGACQ0112	
A	P	VD	WBN	CEB	04031100	
A	P	VD	WBN	CEB	04031500	
A	P	VD	WBN	CEB	04031300	
A	P	DN	WBN	EEB	EDCR 52341	
A	P	TR	WBN	CEB	04038903-1SP	
A	P	TR	WBN	CEB	04038903-2SP	
A	P	TR	WBN	CEB	04038903-4SP	
A	P	EP	WBN	EEB	WBN-2-PNL-090-M030	
A	P	EP	WBN	EEB	WBN-2-PNL-090-M031	
A	P	EP	WBN	EEB	WBN-0-PNL-090-M12	
A	P	EP	WBN	EEB	WBN-2-RE-090-0106	
A	P	EP	WBN	EEB	WBN-2-RE-090-0112	
A	P	EP	WBN	EEB	WBN-2-RE-090-0130	
A	P	EP	WBN	EEB	WBN-2-RE-090-0131	

CCRIS ONLY UPDATES:
Following are required only when making keyword/cross reference CCRIS updates and page 1 of form NEDP-2-1 is not included:

PREPARER SIGNATURE	DATE	CHECKER SIGNATURE	DATE

PREPARER PHONE NO.	EDMS ACCESSION NO.

This Sheet Added By Revision 001

NPG CALCULATION RECORD OF REVISION

CALCULATION IDENTIFIER: WCGACQ0766

Title

REQUIRED RESPONSE SPECTRA FOR EVALUATION OF RADIATION MONITORING EQUIPMENT

Revision No.	DESCRIPTION OF REVISION
001	THE PURPOSE OF THIS REVISION IS TO DEVELOP THE REQUIRED RESPONSE SPECTRA FOR THE RADIATION MONITORING EQUIPMENT FOR THE PURPOSE OF EVALUATING VENDOR SEISMIC REPORTS. **PAGES ADDED:** SHEETS: 1a, 2a, 3a, A1-A42 (Appendix A, 42 Sheets), Attachment B (8 pages). **PAGES REVISED:** SHEETS: None **PAGES REPLACED:** SHEETS: 4, Attachment Table of Contents **PAGES DELETED:** SHEETS: None **TOTAL NUMBER OF PAGES:** 24+53 = 77 THE WBN SAR, WBN2 FSAR AMENDMENT 107, TECHNICAL SPECIFICATIONS/ BASES AND TECHNICAL REQUIREMENTS MANUAL/ BASES HAVE BEEN REVIEWED BY Robert F Brown RFB 1/6/12 FOR APPLICABILITY TO UNIT 2, DUAL UNIT OPERATION AND THIS REVISION OF THE CALCULATION DOES NOT AFFECT ANY OF THESE DOCUMENTS.

This Sheet Added By Revision 001

NPG CALCULATION COVERSHEET/CCRIS UPDATE

REV 0 EDMS/RIMS NO.	EDMS TYPE:	EDMS ACCESSION NO (N/A for REV. 0)
T93110407002	calculations(nuclear)	N/A

Calc Title:
IN-CABINET REQUIRED RESPONSE SPECTRA FOR RM-1000 RADIATION MONITORS IN MCR PANEL 2-M-30

CALC ID	TYPE	ORG	PLANT	BRANCH	NUMBER	CUR REV	NEW REV	REVISION APPLICABILITY
CURRENT	CN	NUC						Entire calc ☐
NEW	CN	NUC	WBN	CEB	WCGACQ0766	000		Selected pages ☐

ACTION	NEW ☒ REVISION ☐	DELETE ☐ RENAME ☐	SUPERSEDE ☐ DUPLICATE ☐	CCRIS UPDATE ONLY ☐ (Verifier Approval Signatures Not Required)	No CCRIS Changes ☐ (For calc revision, CCRIS been reviewed and no CCRIS changes required)

UNITS	SYSTEMS	UNIDS
002	090	WBN-2-PNL-090-M30, WBN-2-RM-090-0271, WBN-2-RM-090-0271A WBN-2-RM-090-0272, WBN-2-RM-090-0272A, WBN-2-RM-090-0273, WBN-2-RM-090-0273A, WBN-2-RM-090-0274, WBN-2-RM-090-0274A

DCN,EDC,N/A	APPLICABLE DESIGN DOCUMENT(S) :	CLASSIFICATION
N/A	WB-DC-40-31.2 & CEB-SS-5.10	E

QUALITY RELATED?	SAFETY RELATED? (If yes, QR = yes)	UNVERIFIED ASSUMPTION	SPECIAL REQUIREMENTS AND/OR LIMITING CONDITIONS?	DESIGN OUTPUT ATTACHMENT?	SAR/TS and/or ISFSI SAR/CoC AFFECTED
Yes ☒ No ☐	Yes ☒ No ☐	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒	Yes ☐ No ☒

PREPARER ID	PREPARER PHONE NO	PREPARING ORG (BRANCH)	VERIFICATION METHOD	NEW METHOD OF ANALYSIS
EHALI	(423) 365-3028	CEB	DESIGN REVIEW	☐ Yes ☒ No

PREPARER SIGNATURE	DATE	CHECKER SIGNATURE	DATE
EYAD H. ALI [signature]	04/05/11	Robert G Brown [signature]	4/5/11
VERIFIER SIGNATURE	DATE	APPROVAL SIGNATURE	DATE
Robert G Brown [signature]	4/5/11	BILL C. PERKINS [signature] TWD	4-5-11

STATEMENT OF PROBLEM/ABSTRACT

THIS CALCULATION DEVELOPS THE IN-CABINET REQUIRED RESPONSE SPECTRA FOR THE RM-1000 RADIATION MONITORS MOUNTED ON WBNP UNIT 2 MAIN CONTROL ROOM PANEL 2-M-30.

LEGIBILITY EVALUATED AND ACCEPTED FOR ISSUE ALL PAGES IN REV. 0

EYAD H. ALI [signature] 04/05/11
SIGNATURE **DATE**

MICROFICHE/EFICHE Yes ☐ No ☒ FICHE NUMBER(S)

☐ LOAD INTO EDMS AND DESTROY
☒ LOAD INTO EDMS AND RETURN CALCULATION TO CALCULATION LIBRARY. ADDRESS: EQB-1M-WBN
☐ LOAD INTO EDMS AND RETURN CALCULATION TO:

NPG CALCULATION COVERSHEET/CCRIS UPDATE

CALC ID	TYPE	ORG	PLANT	BRANCH	NUMBER	REV
	CN	NUC	WBN	CEB	WCGACQ0766	000

ALTERNATE CALCULATION IDENTIFICATION

BLDG	ROOM	ELEV	COORD/AZIM	FIRM	Print Report Yes ☐
05	CR	755'	N/A	BECHTEL	

CATEGORIES: A09

KEY NOUNS (A-add, D-delete)

ACTION (A/D)	KEY NOUN	A/D	KEY NOUN
A	SEISMIC QUALIF		
A	SEISMIC		
A	RESPONSE SPECTR		
A	PANEL		

CROSS-REFERENCES (A-add, C-change, D-delete)

ACTION (A/C/D)	XREF CODE	XREF TYPE	XREF PLANT	XREF BRANCH	XREF NUMBER	XREF REV
A	P	DN	WBN	EEB	EDCR-2 52338	
A	P	CN	WBN	CEB	WCGACQ0177	
A	P	CN	WBN	CEB	CEBCQS448	
A	P	CN	WBN	CEB	CEBCQS447	
A	P	DB	WBN	CEB	CEB-SS-5.10	
A	P	CE	WBN	CEB	CEB-80-27	
A	P	VD	WBN	EEB	04034100	

CCRIS ONLY UPDATES:
Following are required only when making keyword/cross reference CCRIS updates and page 1 of form NEDP-2-1 is not included:

PREPARER SIGNATURE	DATE	CHECKER SIGNATURE	DATE
PREPARER PHONE NO.	EDMS ACCESSION NO.		

NPG CALCULATION RECORD OF REVISION

CALCULATION IDENTIFIER: **WCGACQ0766**

Title

IN-CABINET REQUIRED RESPONSE SPECTRA FOR RM-1000 RADIATION MONITORS IN MCR PANEL 2-M-30

Revision No.	DESCRIPTION OF REVISION
000	ORIGINAL ISSUE **TOTAL NUMBER OF PAGES:** **24** THE WBN SAR, WBN2 FSAR AMENDMENT 103, TECHNICAL SPECIFICATIONS/ BASES AND TECHNICAL REQUIREMENTS MANUAL/ BASES HAVE BEEN REVIEWED BY EYAD H. ALI FOR APPLICABILITY TO UNIT 2, DUAL UNIT OPERATION AND THIS REVISION OF THE CALCULATION DOES NOT AFFECT ANY OF THESE DOCUMENTS.

NPG CALCULATION TABLE OF CONTENTS

Calculation Identifier: WCGACQ0766	Revision: 001

TABLE OF CONTENTS

This Sheet Replaced By Revision 001

REFERENCES

4.0 PURPOSE

This calculation develops the in-cabinet required response spectra for the RM-1000 Radiation Monitors to be installed in WBNP Unit 2 Main Control Room Panel 2-M-30. These radiation monitors together with I/F Converters are installed in Nuclear Instrumentation Modules (NIM) bins in Panel 2-M-30.

5.0 APPLICABLE DESIGN BASIS

1. WB-DC-40-31.2 Rev. 12, "Seismic/Structural Qualification of Seismic Category I Electrical and Mechanical Equipment"
2. CEB-SS-5.10 Rev. 3, "Seismic Qualification of Electrical, Mechanical, and I&C Devices"

6.0 APPLICABLE REFERENCES

1. EDCR-2 52338 Rev. A
2. WCGACQ0177 Rev. 7, "Seismic Evaluation of Panel 2-M-30 & 2-M-31" (RIMS# T93100515007).
3. CEBCQS448 Rev. 0, "Definition of Required Acceleration Input for Device Seismic Qualification" (RIMS# B41960425002)
4. CEBCQS447 Rev. 2, "Standard Equipment Seismic Qualification Methods for Devices" (RIMS# B41070905001)
5. CEB-80-27 Rev. 5, "Dynamic Earthquake Analysis of the Auxiliary Control Building and Response Spectra for Attached Equipment"
6. General Atomics Dwg No. 04034100 Rev. C
7. DRA No. 52374-13 Rev. 0
8. DRA No. 52338-005 Rev. 0
9. DRA No. 52338-038 Rev. 0

See Attachment A for Copy of Refs. 6.6-6.9

REFERENCES

6.0 APPLICABLE REFERENCES (CONT'D)

10. Roark's Formulas for Stress and Strain 7th Ed.
11. General Electric Dwg No. 0153D2768-1 Rev. 1
12. TVA Dwg No. 47W605-1 Rev. 15

See Attachment A for Copy of Ref. 6.11

7.0 ASSUMPTIONS

None

8.0 SPECIAL REQUIREMENTS AND LIMITING CONDITIONS

None

9.0 METHODOLOGY

The methods from Calc No. CEB-CQS-448 are used to develop the in-cabinet required response spectra at the RM-1000 mounting locations for WBN Unit 2 MCR Panel 2-M-30.

Ref. 6.3

REFERENCES

10.0 JUSTIFICATION/ANALYSIS

From Sheet 34 of Appendix I of Calc No. WCG-ACQ-0177, the first and second mode frequencies of Panel 2-M-30 are 13.35 Hz and 15.33 Hz respectively. Since WCG-ACQ-0177 does not define the direction of these modes, these frequencies are conservatively considered to be in the two horizontal directions and the vertical direction. The methods in sections 4.1.3.2 and 4.1.3.3 of Ref. 6.2 are used to compute the worst case maximum acceleration in each direction at the device locations on the panel. The equations to compute the input accelerations at the device locations are as follows: Ref. 6.2

For the Horizontal direction:

$$Ap_{k.h} := \sqrt{(2.1 \cdot S \cdot Ap_{k.1})^2 + (1.3 \cdot S \cdot Ap_{k.2})^2 + (1.6 \cdot Ap_{k.3})^2 + A_{zpa.k}^{\;2}}$$

For the Vertical direction:

$$Ap_{k.v} := \sqrt{(1.6 \cdot Ap_{k.3})^2 + A_{zpa.k}^{\;2}}$$

where,

$S := \frac{x}{L}$	is the device position ratio. x is the height from the ground to the device and L is the total height of the panel.
$Ap_{k.1}$	is the panel acceleration at the first mode frequency.
$Ap_{k.2}$	Is the panel acceleration at the second mode frequency.
$Ap_{k.3}$	is the acceleration corresponding to the panel local frequency at the device location.
$A_{zpa.k}$	is the panel acceleration at cut-off frequency (33 Hz).

According to Section 4.1.3.3 of Ref. 6.2; since the mass and stiffness distribution is reasonably uniform along the height of the host panel (as shown in Ref. 6.11), a 1st mode participation factor of 1.6 and a 2nd mode participation factor of 1.0 can be used.

10.0 JUSTIFICATION/ANALYSIS (CONT'D)

Determination of Local Frequency:

Weight of Front Plate:

$$W_{plate} := 0.283\frac{lb}{in^3}\cdot[(11.75in\cdot30\cdot in)-(8.7\cdot in\cdot18.25in)]\cdot\frac{1}{4}\cdot in \qquad W_{plate} = 13.706lb$$ Ref. 6.6 & 6.7

Weight of Radiation Monitoring NIM bin:

$W_{RM} := 35\cdot lb$ (each) Ref. 6.6

Consider the Front Plate of the Panel to be simply supported on all four sides and the total weight to be uniformly loaded over entire area:

$$q := \frac{W_{plate}+W_{RM}}{11.75in\cdot30\cdot in} \qquad q = 0.138\frac{lb}{in^2}$$

The maximum local displacement of the Front Plate per Case No. 1 of Table 11.4 on Page 502 of Ref. 6.10 is:

$a := 30\cdot in$ $\quad b := 11.75in$ $\quad \frac{a}{b} = 2.553$ => 3.0 $\quad \alpha := 0.1335$

$t_{plate} := \frac{1}{4}\cdot in$ $\quad E_{steel} := 29000ksi$

$$y_{max} := \frac{\alpha\cdot q\cdot b^4}{E_{steel}\cdot t_{plate}^3} \qquad y_{max} = 7.76\times10^{-4}in$$

$$f_{local} := \frac{1}{2\cdot\pi}\cdot\sqrt{\frac{g}{y_{max}}} \qquad f_{local} = 112.265Hz$$

As shown above, the frequency of the Front Plate where the device is mounted (local frequency of the panel) is rigid (> 33 Hz). Therefore, there will be no contribution to the in-cabinet acceleration at the RM-1000 locations from the local effect of the panel.

10.0 JUSTIFICATION/ANALYSIS (CONT'D)

Therefore, the equations for the input acceleration from Sheet 7 is reduced to:

$$Ap_{k.h} := \sqrt{(1.6 \cdot S \cdot Ap_{k.1})^2 + (1.0 \cdot S \cdot Ap_{k.2})^2 + A_{zpa.k}{}^2} \qquad \text{(Horizontal)}$$

$$Ap_{k.v} := A_{zpa.k} \qquad \text{(Vertical)}$$

Determination of the Device Position Ratio (S):

The device at the higher elevation on the panel is only considered since it has a greater input acceleration. Per Ref. 6.7-6.9, the device position ratio is as follows:

$x := 28.375\,in + 2\cdot(11.75\,in)$ $\qquad x = 51.875\,in$ $\qquad L := 98\cdot in$

$S := \frac{x}{L}$ $\qquad S = 0.529$

The accelerations corresponding to the 1st, 2nd, and cut-off frequencies are as follows:

According to Ref. 6.3; 3% damping ratio for SSE is used since the actual damping ratio is not obtainable.

For N-S (Front-to-Back) Direction SSE:

$Ap_{k.1.NS} := 1.93\cdot g$ $\qquad Ap_{k.2.NS} := 1.24\cdot g$ $\qquad A_{zpa.k.NS} := 0.84\cdot g$

For E-W (Side-to-Side) Direction SSE:

$Ap_{k.1.EW} := 2.34\cdot g$ $\qquad Ap_{k.2.EW} := 1.39\cdot g$ $\qquad A_{zpa.k.EW} := 0.87\cdot g$

For Vertical Direction SSE:

$A_{zpa.k.V} := 0.84\cdot g$

REFERENCES

10.0 JUSTIFICATION/ANALYSIS (CONT'D)

Using the methods provided in Section 4.2 of Ref. 6.3, the Required Response Spectra (RRS) for the RM-1000 Radiation Monitors and I/F Converters in NIM bins installed in Panel 2-M-30 is determined as follows:

N-S (Front-to-Back) Required Response Spectra (SSE 5% Damping):

$$Ap_{k.NS} := \sqrt{(1.6 S \cdot Ap_{k.1.NS})^2 + (1.0 S \cdot Ap_{k.2.NS})^2 + A_{zpa.k.NS}^{\;2}} \qquad Ap_{k.NS} = 1.951g$$

From Page 33 of Ref. 6.3, $m := 2.3314$ $\quad b := 0.45 g$

$f_{NS_1} := 1 \cdot Hz \qquad A_{NS_1} := b \qquad A_{NS_1} = 0.45g$

$A_{NS_2} := 5 \cdot Ap_{k.NS} \qquad A_{NS_2} = 9.757g$

$$f_{NS_2} := \left(\frac{A_{NS_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{NS_2} = 3.742Hz$$

$f_{NS_3} := 16 Hz \qquad A_{NS_3} := A_{NS_2} \qquad A_{NS_3} = 9.757g$

$f_{NS_4} := 33 \cdot Hz \qquad A_{NS_4} := 2 \cdot Ap_{k.NS} \qquad A_{NS_4} = 3.903g$

$f_{NS_5} := 33 \cdot Hz \qquad A_{NS_5} := Ap_{k.NS} \qquad A_{NS_5} = 1.951g$

$f_{NS_6} := 100 Hz \qquad A_{NS_6} := Ap_{k.NS} \qquad A_{NS_6} = 1.951g$

REFERENCES

10.0 JUSTIFICATION/ANALYSIS (CONT'D)

E-W (Side-to-Side) Required Response Spectra (SSE 5% Damping):

$$Ap_{k.EW} := \sqrt{(1.6\cdot S\cdot Ap_{k.1.EW})^2 + (1.0\cdot S\cdot Ap_{k.2.EW})^2 + A_{zpa.k.EW}{}^2} \qquad Ap_{k.EW} = 2.286g$$

From Page 33 of Ref. 6.3, $m := 2.3314$ $\quad b := 0.45\cdot g$

$f_{EW_1} := 1\cdot Hz \qquad A_{EW_1} := b \qquad A_{EW_1} = 0.45g$

$A_{EW_2} := 5\cdot Ap_{k.EW} \qquad A_{EW_2} = 11.43g$

$$f_{EW_2} := \left(\frac{A_{EW_2}}{b}\right)^{\frac{1}{m}}\cdot Hz \qquad f_{EW_2} = 4.005Hz$$

$f_{EW_3} := 16\cdot Hz \qquad A_{EW_3} := A_{EW_2} \qquad A_{EW_3} = 11.43g$

$f_{EW_4} := 33\cdot Hz \qquad A_{EW_4} := 2\cdot Ap_{k.EW} \qquad A_{EW_4} = 4.572g$

$f_{EW_5} := 33\cdot Hz \qquad A_{EW_5} := Ap_{k.EW} \qquad A_{EW_5} = 2.286g$

$f_{EW_6} := 100\cdot Hz \qquad A_{EW_6} := Ap_{k.EW} \qquad A_{EW_6} = 2.286g$

REFERENCES

10.0 JUSTIFICATION/ANALYSIS (CONT'D)

Vertical Required Response Spectra (SSE 5% Damping):

$Ap_{k.v} := A_{zpa.k.V}$ $\quad Ap_{k.v} = 0.84g$

From Page 33 of Ref. 6.3, $m := 2.3314$ $\quad b := 0.45 \cdot g$

$f_{V_1} := 1 \cdot Hz$ $\quad A_{V_1} := b$ $\quad A_{V_1} = 0.45g$

$A_{V_2} := 5 \cdot Ap_{k.v}$ $\quad A_{V_2} = 4.2g$

$$f_{V_2} := \left(\frac{A_{V_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{V_2} = 2.607Hz$$

$f_{V_3} := 16 \cdot Hz$ $\quad A_{V_3} := A_{V_2}$ $\quad A_{V_3} = 4.2g$

$f_{V_4} := 33 \cdot Hz$ $\quad A_{V_4} := 2 \cdot Ap_{k.v}$ $\quad A_{V_4} = 1.68g$

$f_{V_5} := 33 \cdot Hz$ $\quad A_{V_5} := Ap_{k.v}$ $\quad A_{V_5} = 0.84g$

$f_{V_6} := 100 \cdot Hz$ $\quad A_{V_6} := Ap_{k.v}$ $\quad A_{V_6} = 0.84g$

REFERENCES

10.0 JUSTIFICATION/ANALYSIS (CONT'D)

According to Section 4.1.1 of Ref. 6.4, the OBE Required Response Spectra (RRS) will be developed using 70% of SSE levels:

N-S (Front-to-Back) Required Response Spectra (OBE 5% Damping):

$$Ap_{k.NS} := 0.70\sqrt{(1.6 S\cdot Ap_{k.1.NS})^2 + (1.0 S\cdot Ap_{k.2.NS})^2 + A_{zpa.k.NS}{}^2}$$

$$Ap_{k.NS} = 1.366g$$

From Page 33 of Ref. 6.3, $m := 2.3314$ $b := 0.45\cdot g$

$f_{NS_1} := 1\cdot Hz$ $A_{NS_1} := b$ $A_{NS_1} = 0.45g$

$A_{NS_2} := 5\cdot Ap_{k.NS}$ $A_{NS_2} = 6.83g$

$$f_{NS_2} := \left(\frac{A_{NS_2}}{b}\right)^{\frac{1}{m}}\cdot Hz \qquad f_{NS_2} = 3.211Hz$$

$f_{NS_3} := 16\cdot Hz$ $A_{NS_3} := A_{NS_2}$ $A_{NS_3} = 6.83g$

$f_{NS_4} := 33\cdot Hz$ $A_{NS_4} := 2\cdot Ap_{k.NS}$ $A_{NS_4} = 2.732g$

$f_{NS_5} := 33\cdot Hz$ $A_{NS_5} := Ap_{k.NS}$ $A_{NS_5} = 1.366g$

$f_{NS_6} := 100\cdot Hz$ $A_{NS_6} := Ap_{k.NS}$ $A_{NS_6} = 1.366g$

REFERENCES

10.0 JUSTIFICATION/ANALYSIS (CONT'D)

E-W (Side-to-Side) Required Response Spectra (OBE 5% Damping):

$$Ap_{k.EW} := 0.70\sqrt{(1.6\cdot S\cdot Ap_{k.1.EW})^2 + (1.0\cdot S\cdot Ap_{k.2.EW})^2 + A_{zpa.k.EW}{}^2}$$

$$Ap_{k.EW} = 1.6g$$

From Page 33 of Ref. 6.3, $m := 2.3314$ $\quad b := 0.45\cdot g$

$f_{EW_1} := 1\cdot Hz$ $\quad A_{EW_1} := b$ $\quad A_{EW_1} = 0.45g$

$A_{EW_2} := 5\cdot Ap_{k.EW}$ $\quad A_{EW_2} = 8.001g$

$$f_{EW_2} := \left(\frac{A_{EW_2}}{b}\right)^{\frac{1}{m}}\cdot Hz \qquad f_{EW_2} = 3.437Hz$$

$f_{EW_3} := 16\cdot Hz$ $\quad A_{EW_3} := A_{EW_2}$ $\quad A_{EW_3} = 8.001g$

$f_{EW_4} := 33\cdot Hz$ $\quad A_{EW_4} := 2\cdot Ap_{k.EW}$ $\quad A_{EW_4} = 3.2g$

$f_{EW_5} := 33\cdot Hz$ $\quad A_{EW_5} := Ap_{k.EW}$ $\quad A_{EW_5} = 1.6g$

$f_{EW_6} := 100\cdot Hz$ $\quad A_{EW_6} := Ap_{k.EW}$ $\quad A_{EW_6} = 1.6g$

REFERENCES

10.0 JUSTIFICATION/ANALYSIS (CONT'D)

Vertical Required Response Spectra (OBE 5% Damping):

$Ap_{k.v} := 0.70 \cdot A_{zpa.k.V}$ $\qquad Ap_{k.v} = 0.588g$

From Page 33 of Ref. 6.3, $\quad m := 2.3314 \qquad b := 0.45 \cdot g$

$f_{V_1} := 1 \cdot Hz \qquad A_{V_1} := b \qquad A_{V_1} = 0.45g$

$A_{V_2} := 5 \cdot Ap_{k.v} \qquad A_{V_2} = 2.94g$

$$f_{V_2} := \left(\frac{A_{V_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{V_2} = 2.237Hz$$

$f_{V_3} := 16 \cdot Hz \qquad A_{V_3} := A_{V_2} \qquad A_{V_3} = 2.94g$

$f_{V_4} := 33 \cdot Hz \qquad A_{V_4} := 2 \cdot Ap_{k.v} \qquad A_{V_4} = 1.176g$

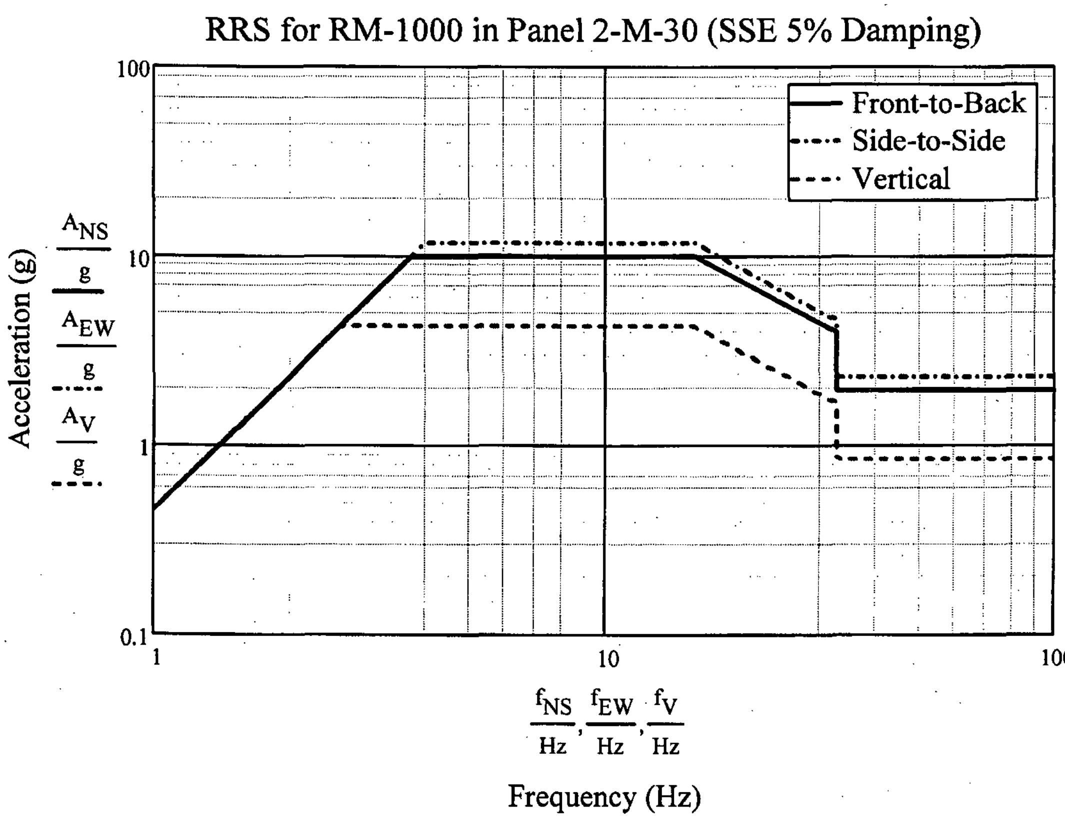
$f_{V_5} := 33 \cdot Hz \qquad A_{V_5} := Ap_{k.v} \qquad A_{V_5} = 0.588g$

$f_{V_6} := 100 \cdot Hz \qquad A_{V_6} := Ap_{k.v} \qquad A_{V_6} = 0.588g$

REFERENCES

10.0 JUSTIFICATION/ANALYSIS (CONT'D)

Required Response Spectra Curves (SSE 5% Damping):



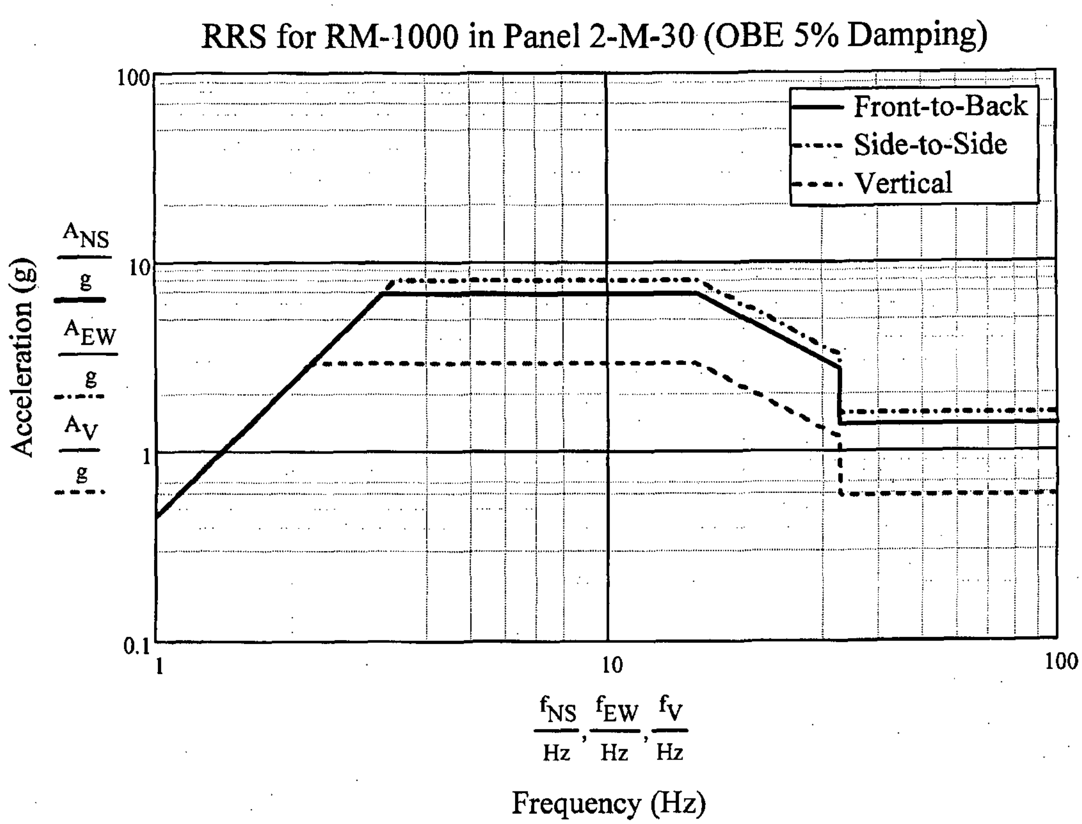
Front-to-Back		Side-to-Side		Vertical	
f (Hz)	a (g)	f (Hz)	a (g)	f (Hz)	a (g)
1.0	0.45	1.0	0.45	1.0	0.45
3.7	9.76	4.0	11.43	2.6	4.20
16.0	9.76	16.0	11.43	16.0	4.20
33.0	3.90	33.0	4.57	33.0	1.68
33.0	1.95	33.0	2.29	33.0	0.84
100.0	1.95	100.0	2.29	100.0	0.84

Calculation Sheet		
Subject: IN-CABINET REQUIRED RESPONSE SPECTRA FOR RM-1000 RADIATION MONITORS IN MCR PANEL 2-M-30	Project	WBN2CCP
Prepared: SEE COVER SHEET Date	Job No.	25402
Checked: SEE COVER SHEET Date	Calc. No.	WCGACQ0766
	Sheet No.	17
	Sheet Rev.	000

REFERENCES

10.0 JUSTIFICATION/ANALYSIS (CONT'D)

Required Response Spectra Curves (OBE 5% Damping):



Front-to-Back		Side-to-Side		Vertical	
f (Hz)	a (g)	f (Hz)	a (g)	f (Hz)	a (g)
1.0	0.45	1.0	0.45	1.0	0.45
3.2	6.83	3.4	8.00	2.2	2.94
16.0	6.83	16.0	8.00	16.0	2.94
33.0	2.73	33.0	3.20	33.0	1.18
33.0	1.37	33.0	1.60	33.0	0.59
100.0	1.37	100.0	1.60	100.0	0.59

REFERENCES

11.0 CONCLUSION

The above curves are the in-cabinet required response spectra for the RM-1000's to be installed on WBN Unit 2 MCR Panel 2-M-30. These RRS curves can be used for comparison to vendor seismic test reports for qualification of the WBN Unit 2 safety related RM-1000 Radiation Monitors in Panel 2-M-30.

11.1 APPENDIX A

to

Calculation

WCG-ACQ-0766

Total pages 42

This Sheet Added By Revision 001

1.0 Purpose:

This calculation develops the required response spectra for the Safety Related Radiation Monitoring Equipment to be installed in WBNP Unit 2 Main Control Room Panels 2-M-30 (previous revision 0) , 0-M-12 and skids WBN-2-RE-090-0106, WBN-2-RE-090-0112, WBN-2-RE-090-0130 and WBN-2-RE-090-0131.

2.0 References:

1. EDCR-2 52338 Rev. A (Information only)
2. WCGACQ0177 Rev. 7, "Seismic Evaluation of Panel 2-M-30 & 2-M-31" (Information only).
3. WCGACQ0112 Rev. 3, "Control Room Design Review (CRDR) Panel 0-M-12 Seismic Qualification" (RIMS# T95100727503)
4. CEBCQS448 Rev. 0, "Definition of Required Acceleration Input for Device Seismic Qualification" (RIMS# B41960425002)
5. CEBCQS447 Rev. 2, "Standard Equipment Seismic Qualification Methods for Devices" (Information only)
6. CEB-80-27 Rev. 5, "Dynamic Earthquake Analysis of the Auxiliary Control Building and Response Spectra for Attached Equipment"
7. General Atomics Dwg No. 04031100 Rev. B
8. General Atomics Dwg No. 04031500 Rev. C
9. General Atomics Dwg No. 04031300 Rev. C
10. DCN 53037 (Information only)
11. 47W605-28 Rev.V (as-constructed drawing panel 0-M-12)
12. not used
13. TVA Dwg No. 47W605-1 Rev. 15
14. EDCR 52341 (Information only)
15. DRA 52341-036
16. DRA 52341-037
17. DRA 52341-080
18. DRA 52341-081
19. DRA 52341-082
20. DRA 52341-084 (Information only)
21. DRA 52341-085 (Information only)
22. DRA 52341-013 (Information only)
23. General Atomics Qualification Basis Report 04038903-1SP for 2-RE-90-130 & -131
24. General Atomics Qualification Basis Report 04038903-2SP for 2-RE-90-106
25. General Atomics Qualification Basis Report 04038903-4SP for 2-RE-90-112
26. Limited Scope Walk Down LSWD-536 panel 0-M-12 (see Attachment B)

3.0 Design Criteria:

1. WB-DC-40-31.2 Rev. 12, "Seismic/Structural Qualification of Seismic Category I Electrical and Mechanical Equipment"

2. CEB-SS-5.10 Rev. 3, "Seismic Qualification of Electrical, Mechanical, and I&C Devices"

4.0 Assumptions:

There are no assumptions that require further verification.

5.0 Special Requirements and Limiting Conditions:

There are no special requirements or limiting conditions.

6.0 Methodology:

The methods in sections 4.1.3.2 and 4.1.3.3 of Calc No. CEB-CQS-448 (Ref. 2.4) are used to develop the acceleration at device locations in the panels and on the skid mounted frames. Using these accelerations the required response spectra (RRS) for the device testing are computed using the methods in section 4.2 of Ref. 2.4.

Per section 4.1.3.2 of Ref. 2.4 the 3% damping SSE floor response spectra are used to determine the acceleration at device locations using the methods in section 4.1.3.2 of Ref. 2.4.

Since the mass and stiffness of the panels and skid frames are reasonably distributed uniformly per section 4.1.3.3 of Ref. 2.4, a 1st mode participation factor of 1.6 and a second mode participation factor of 1.0 can be used.

7.0 Computations And Analysis:

In panel RRS for safety related NIM Bins in panel 0-M-12:

From WCG-ACQ-0112 page 38 (Ref. 2.3) the first and second mode panel frequency in the x direction are 1st mode 18.69 Hz and 2nd mode 21.27 Hz. The front plate local frequency x direction (perpendicular to the panel face plate) is 27.06 Hz. The z direction first mode frequency is 21.0 Hz and no second mode frequency is given. Since the z direction 1st mode frequency is greater than 1/2 of the cut off frequency (33 Hz) the 2nd mode frequency does not need to be considered (Ref. 2.4 section 4.1.3.3 sub item 2). From sheet 13 of Ref. 2.3 the panel x direction is front to back, the panel z direction is side to side and the panel y direction is vertical. From Ref. 2.13 for panel 0-M-12 front to back is north-south and side to side is east-west. The panel is rigid (no modes below 33Hz) in the vertical direction. Page 38 of Ref. 2.3 does not provide local panel frequency in the z and y directions since they are in the plane of the panel face plate and the face plate is rigid in these directions.

For these frequencies the SSE acceleration from the Auxiliary Control Building El 755.5 New Design/Modification ARS (Ref. 2.6) at 3% damping are as follows:

$Ap_{k.1.NS} := 1.05 \cdot g$ $\quad Ap_{k.2.NS} := 1.05 \cdot g$ $\quad Ap_{k.3.NS} := 0.91 \cdot g$ $\quad A_{zpa.k.NS} := 0.84 \cdot g$ (at 33 Hz)

$Ap_{k.1.EW} := 1.01 \cdot g$ $\quad Ap_{k.2.EW} := 0.00 \cdot g$ $\quad A_{zpa.k.EW} := 0.88 \cdot g$ (at 33 Hz)

$A_{zpa.k.V} := 0.84 \cdot g$ (at 33 Hz)

$Ap_{k.1}$ is the panel acceleration at the first mode frequency.

$Ap_{k.2}$ is the panel acceleration at the second mode frequency.

$Ap_{k.3}$ is the acceleration corresponding to the panel local frequency at the device location.

$A_{zpa.k}$ is the panel acceleration at cut-off frequency (33 Hz).

Determination of the Device Position Ratio (S):

For panel 0-M-12 the top of the highest safety related RM23A NIM Bin was determined to be 52" above the bottom of the panel per Limited scope Walkdown Package LSWD-536 (see Attachment B). From Ref. 2.3 sheet 13 the height of panel 0-M-12 is 98.5".

$S := \frac{x}{L}$ is the device position ratio. x is the height from the ground to the device and L is the total height of the panel.

$x := 52 \cdot in$ $\quad L := 98.5 \cdot in$ (Attachment B and Ref. 2.3 sheet 13)

$S := \frac{x}{L}$ $\quad S = 0.528$

The in panel acceleration of the NIM Bin and RRS curves for the SSE are computed as follows:

N-S (Front-to-Back) Required Response Spectra (SSE 5% Damping):

$$Ap_{k.NS} := \sqrt{(1.6 \cdot S \cdot Ap_{k.1.NS})^2 + (1.0 \cdot S \cdot Ap_{k.2.NS})^2 + (1.6 \cdot Ap_{k.3.NS})^2 + A_{zpa.k.NS}{}^2}$$

$Ap_{k.NS} = 1.98 \cdot g$

From Page 33 of Ref. 2.4, $\quad m := 2.3314 \quad b := 0.45 \cdot g$

$f_{NS_1} := 1 \cdot Hz \qquad A_{NS_1} := b \qquad A_{NS_1} = 0.45 \cdot g$

$A_{NS_2} := 5 \cdot Ap_{k.NS} \qquad A_{NS_2} = 9.899 \cdot g$

$$f_{NS_2} := \left(\frac{A_{NS_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{NS_2} = 3.765 \cdot Hz$$

$f_{NS_3} := 16 \cdot Hz \qquad A_{NS_3} := A_{NS_2} \qquad A_{NS_3} = 9.899 \cdot g$

$f_{NS_4} := 33 \cdot Hz \qquad A_{NS_4} := 2 \cdot Ap_{k.NS} \qquad A_{NS_4} = 3.959 \cdot g$

$f_{NS_5} := 33 \cdot Hz \qquad A_{NS_5} := Ap_{k.NS} \qquad A_{NS_5} = 1.98 \cdot g$

$f_{NS_6} := 100 \cdot Hz \qquad A_{NS_6} := Ap_{k.NS} \qquad A_{NS_6} = 1.98 \cdot g$

E-W (Side-to-Side) Required Response Spectra (SSE 5% Damping):

$$Ap_{k.EW} := \sqrt{(1.6 \cdot S \cdot Ap_{k.1.EW})^2 + (1.0 \cdot S \cdot Ap_{k.2.EW})^2 + A_{zpa.k.EW}{}^2}$$

$Ap_{k.EW} = 1.226 \cdot g$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{EW_1} := 1 \cdot Hz$ $A_{EW_1} := b$ $A_{EW_1} = 0.45 \cdot g$

$A_{EW_2} := 5 \cdot Ap_{k.EW}$ $A_{EW_2} = 6.128 \cdot g$

$$f_{EW_2} := \left(\frac{A_{EW_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{EW_2} = 3.065 \cdot Hz$$

$f_{EW_3} := 16 \cdot Hz$ $A_{EW_3} := A_{EW_2}$ $A_{EW_3} = 6.128 \cdot g$

$f_{EW_4} := 33 \cdot Hz$ $A_{EW_4} := 2 \cdot Ap_{k.EW}$ $A_{EW_4} = 2.451 \cdot g$

$f_{EW_5} := 33 \cdot Hz$ $A_{EW_5} := Ap_{k.EW}$ $A_{EW_5} = 1.226 \cdot g$

$f_{EW_6} := 100 \cdot Hz$ $A_{EW_6} := Ap_{k.EW}$ $A_{EW_6} = 1.226 \cdot g$

Vertical Required Response Spectra (SSE 5% Damping):

$Ap_{k.v} := A_{zpa.k.V}$ $Ap_{k.v} = 0.84 \cdot g$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{V_1} := 1 \cdot Hz$ $A_{V_1} := b$ $A_{V_1} = 0.45 \cdot g$

$A_{V_2} := 5 \cdot Ap_{k.v}$ $A_{V_2} = 4.2 \cdot g$

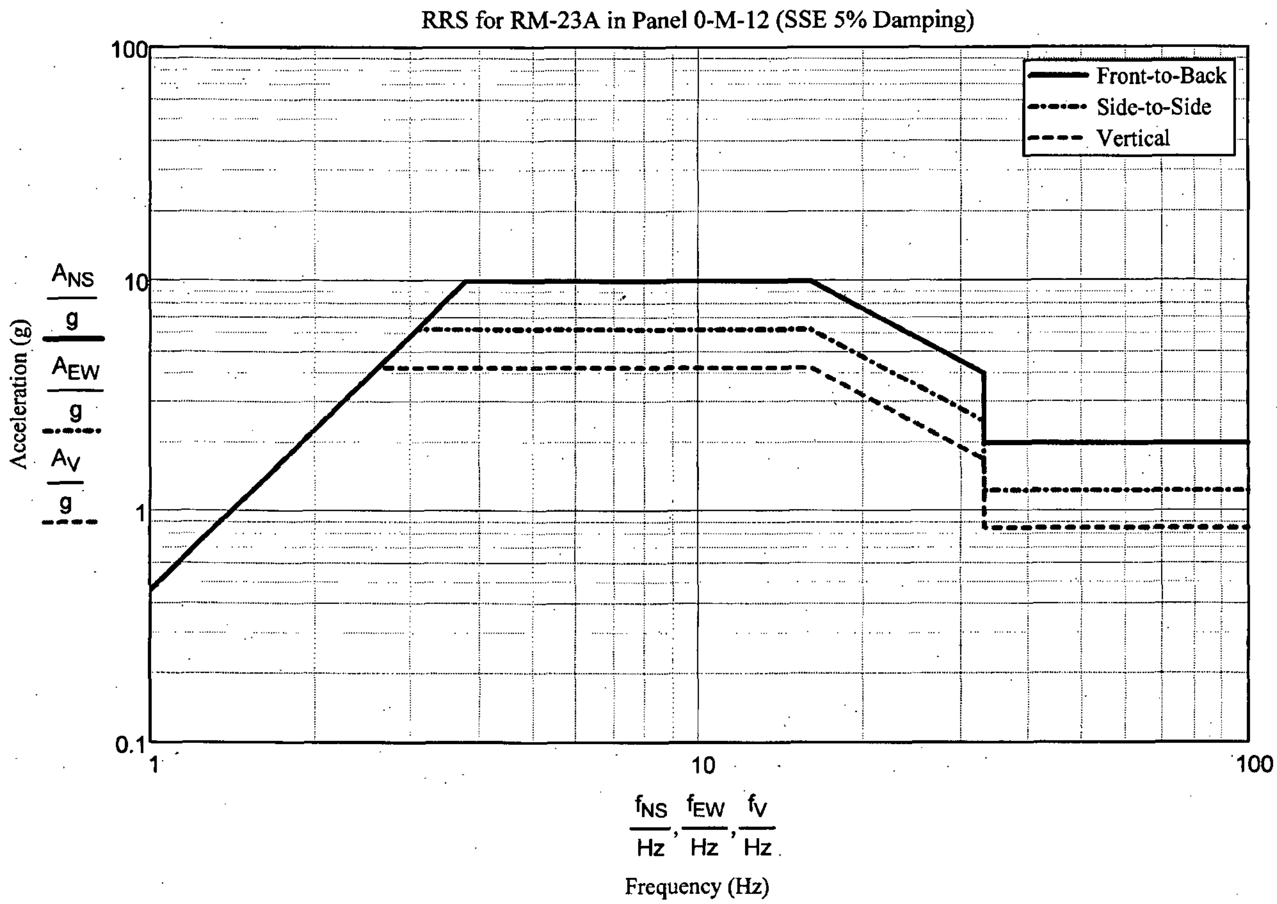
$$f_{V_2} := \left(\frac{A_{V_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{V_2} = 2.607 \cdot Hz$$

$$f_{V_3} := 16 \cdot Hz \qquad A_{V_3} := A_{V_2} \qquad A_{V_3} = 4.2 \cdot g$$

$$f_{V_4} := 33 \cdot Hz \qquad A_{V_4} := 2 \cdot Ap_{k.v} \qquad A_{V_4} = 1.68 \cdot g$$

$$f_{V_5} := 33 \cdot Hz \qquad A_{V_5} := Ap_{k.v} \qquad A_{V_5} = 0.84 \cdot g$$

$$f_{V_6} := 100 \cdot Hz \qquad A_{V_6} := Ap_{k.v} \qquad A_{V_6} = 0.84 \cdot g$$



Front-to-Back		Side-to-Side		Vertical	
f (Hz)	a (g)	f (Hz)	a (g)	f (Hz)	a (g)
1.0	0.45	1.0	0.45	1.0	0.45
3.8	9.90	3.1	6.13	2.6	4.20
16.0	9.90	16.0	6.13	16.0	4.20
33.0	3.96	33.0	2.45	33.0	1.68
33.0	1.98	33.0	1.23	33.0	0.84
100.0	1.98	100.0	1.23	100.0	0.84

According to Section 4.3.1 of Ref. 2.5, the OBE Required Response Spectra (RRS) will be developed using 70% of SSE levels:

N-S (Front-to-Back) Required Response Spectra (OBE 5% Damping):

$$Ap_{k.NS} := 0.70\sqrt{\left(1.6 \cdot S \cdot Ap_{k.1.NS}\right)^2 + \left(1.0 \cdot S \cdot Ap_{k.2.NS}\right)^2 + \left(1.6 \cdot Ap_{k.3.NS}\right)^2 + A_{zpa.k.NS}{}^2}$$

$$Ap_{k.NS} = 1.386 \cdot g$$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{NS_1} := 1 \cdot Hz$ $A_{NS_1} := b$ $A_{NS_1} = 0.45 \cdot g$

$A_{NS_2} := 5 \cdot Ap_{k.NS}$ $A_{NS_2} = 6.929 \cdot g$

$$f_{NS_2} := \left(\frac{A_{NS_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{NS_2} = 3.231 \cdot Hz$$

$f_{NS_3} := 16 \cdot Hz$ $A_{NS_3} := A_{NS_2}$ $A_{NS_3} = 6.929 \cdot g$

$f_{NS_4} := 33 \cdot Hz$ $A_{NS_4} := 2 \cdot Ap_{k.NS}$ $A_{NS_4} = 2.772 \cdot g$

$f_{NS_5} := 33 \cdot Hz$ $A_{NS_5} := Ap_{k.NS}$ $A_{NS_5} = 1.386 \cdot g$

$f_{NS_6} := 100 \cdot Hz$ $A_{NS_6} := Ap_{k.NS}$ $A_{NS_6} = 1.386 \cdot g$

E-W (Side-to-Side) Required Response Spectra (OBE 5% Damping):

$$Ap_{k.EW} := 0.70 \cdot \sqrt{\left(1.6 \cdot S \cdot Ap_{k.1.EW}\right)^2 + \left(1.0 \cdot S \cdot Ap_{k.2.EW}\right)^2 + A_{zpa.k.EW}{}^2}$$

$$Ap_{k.EW} = 0.858 \cdot g$$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{EW_1} := 1 \cdot Hz$ $A_{EW_1} := b$ $A_{EW_1} = 0.45 \cdot g$

$A_{EW_2} := 5 \cdot Ap_{k.EW}$ $\qquad A_{EW_2} = 4.29 \cdot g$

$f_{EW_2} := \left(\frac{A_{EW_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{EW_2} = 2.63 \cdot Hz$

$f_{EW_3} := 16 \cdot Hz \qquad A_{EW_3} := A_{EW_2} \qquad A_{EW_3} = 4.29 \cdot g$

$f_{EW_4} := 33 \cdot Hz \qquad A_{EW_4} := 2 \cdot Ap_{k.EW} \qquad A_{EW_4} = 1.716 \cdot g$

$f_{EW_5} := 33 \cdot Hz \qquad A_{EW_5} := Ap_{k.EW} \qquad A_{EW_5} = 0.858 \cdot g$

$f_{EW_6} := 100 \cdot Hz \qquad A_{EW_6} := Ap_{k.EW} \qquad A_{EW_6} = 0.858 \cdot g$

Vertical Required Response Spectra (OBE 5% Damping):

$Ap_{k.v} := 0.70 \cdot A_{zpa.k.V} \qquad Ap_{k.v} = 0.588 \cdot g$

From Page 33 of Ref. 2.4, $\quad m := 2.3314 \qquad b := 0.45 \cdot g$

$f_{V_1} := 1 \cdot Hz \qquad A_{V_1} := b \qquad A_{V_1} = 0.45 \cdot g$

$A_{V_2} := 5 \cdot Ap_{k.v} \qquad A_{V_2} = 2.94 \cdot g$

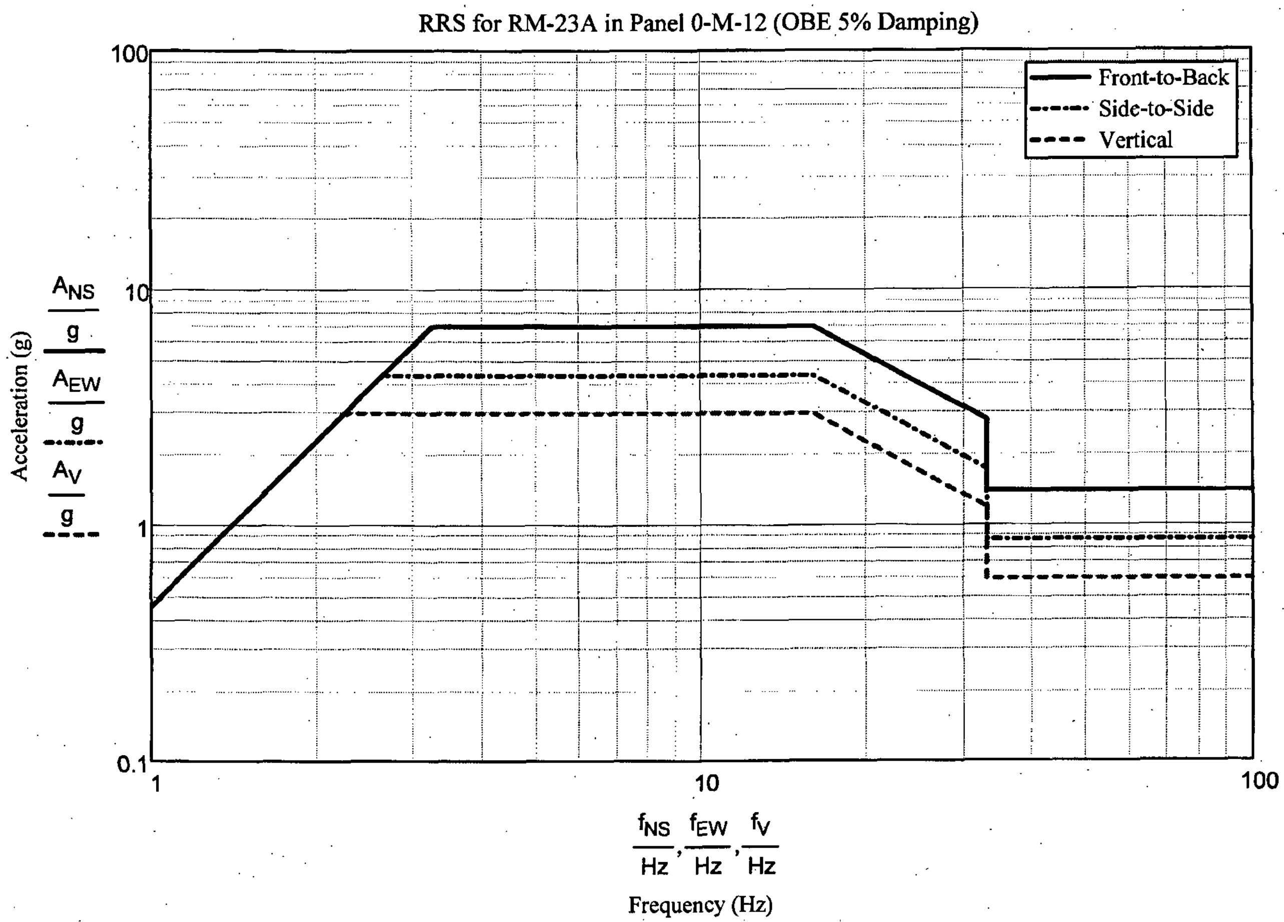
$f_{V_2} := \left(\frac{A_{V_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{V_2} = 2.237 \cdot Hz$

$f_{V_3} := 16 \cdot Hz \qquad A_{V_3} := A_{V_2} \qquad A_{V_3} = 2.94 \cdot g$

$f_{V_4} := 33 \cdot Hz \qquad A_{V_4} := 2 \cdot Ap_{k.v} \qquad A_{V_4} = 1.176 \cdot g$

$f_{V_5} := 33 \cdot Hz \qquad A_{V_5} := Ap_{k.v} \qquad A_{V_5} = 0.588 \cdot g$

$f_{V_6} := 100 \cdot Hz \qquad A_{V_6} := Ap_{k.v} \qquad A_{V_6} = 0.588 \cdot g$



Front-to-Back		Side-to-Side		Vertical	
f (Hz)	a (g)	f (Hz)	a (g)	f (Hz)	a (g)
1.0	0.45	1.0	0.45	1.0	0.45
3.2	6.93	2.6	4.29	2.2	2.94
16.0	6.93	16.0	4.29	16.0	2.94
33.0	2.77	33.0	1.72	33.0	1.18
33.0	1.39	33.0	0.86	33.0	0.59
100.0	1.39	100.0	0.86	100.0	0.59

Safety related system 090 skids:

The skids for 2-RE-090-0106 (Ref. 2.9 & 2.15), -0112 (Ref. 2.8 & 2.15), -0130 (Ref. 2.7 & 2.16) and -0131 (Ref. 2.7 & 2.16) consist of a rigid skid base fabricated from structural steel which is bolted to the building floor slabs. A welded steel frame is attached to each skid base to support various system 090 components for each skid. The heavier components (detectors, pumps and blowers) are attached directly to the rigid skid base and can be seismically qualified using the building ARS since the skid base is rigidly attached to the floor slabs. Based on this General Atomics (GA) was provided the building floor ARS curves for the seismic qualification of the skid mounted equipment.

The final GA qualification reports 04038903-1SP, 04038903-2SP and 04038903-4SP have shown that the welded frames attached to the skids have first and second mode fundamental frequencies less than 33 Hz. Therefore the frame frequencies determined by the GA reports are used to determine the RRS required for evaluation of the seismic qualification of components mounted to the skid frames.

For skids 2-RE-090-0106 and -0112, the in panel RRS will be computed at 34" above the base of the skid and at the top of the frame (59" above the base of the skid) since components are installed at or below these levels of the frames (Ref. 2.8 and 2.9).

For skids 2-RE-090-0130 and -131, the in panel RRS will only be computed at the top of the frame (68" above the base of the skid) since components are installed at or below this level of the frames (Ref. 2.7).

In panel RRS for safety related skid 106 and 112 (@ 34"):

From GA Report 04038903-2SP and -4SP section 3.3.1 a resonance search of the tested skid frame between 1 and 33 HZ found the 1st mode panel frequency in the front to back direction (east west for WBN2) to be 21 Hz and in the side to side direction (north south for WBN2) to be 18 Hz. From Ref. 2.18 for skid 106 and 112 front to back is east-west and side to side is north-south and the skids are attached to floor El. 737. There are no 2nd mode frequencies between 1 and 33 Hz and since the 1st mode frequencies are greater than 1/2 of the cut off frequency 2nd mode frequency need be considered (Ref. 2.4 section 4.1.3.3). The frame is rigid in the vertical direction. The frame is a tube steel structure and local panel frequency need not be considered since the seismic testing of components provided by GA 04038903-2SP and -4SP has accounted for the local effects (i.e. boxes housing the components).

For these frequencies the SSE acceleration from the Auxiliary Control Building El 736.5 New Design/Modification ARS (Ref. 2.6) at 3% damping are as follows:

$Ap_{k.1.NS} := 0.85 \cdot g$ $\quad Ap_{k.2.NS} := 0.00 \cdot g$ $\quad A_{zpa.k.NS} := 0.71 \cdot g$ (at 33 Hz)

$Ap_{k.1.EW} := 0.84 \cdot g$ $\quad Ap_{k.2.EW} := 0.00 \cdot g$ $\quad A_{zpa.k.EW} := 0.77 \cdot g$ (at 33 Hz)

$A_{zpa.k.V} := 0.59 \cdot g$ (at 33 Hz)

$Ap_{k.1}$ is the panel acceleration at the first mode frequency.

$Ap_{k.2}$ is the panel acceleration at the second mode frequency.

$Ap_{k.3}$ is the acceleration corresponding to the panel local frequency at the device location.

$A_{zpa.k}$ is the panel acceleration at cut-off frequency (33 Hz).

Determination of the Device Position Ratio (S) @ 34":

$S := \frac{x}{L}$ is the device position ratio. x is the height from the ground to the device and L is the total height of the panel.

$x := 34 \cdot in$ $L := 59 \cdot in$ (Ref. 2.8 & 2.9)

$S := \frac{x}{L}$ $S = 0.576$

The RRS curves for the SSE are computed as follows:

N-S (Side-to-Side) Required Response Spectra (SSE 5% Damping):

$$Ap_{k.NS} := \sqrt{(1.6 \cdot S \cdot Ap_{k.1.NS})^2 + (1.0 \cdot S \cdot Ap_{k.2.NS})^2 + A_{zpa.k.NS}{}^2}$$

$Ap_{k.NS} = 1.058 \cdot g$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{NS_1} := 1 \cdot Hz$ $A_{NS_1} := b$ $A_{NS_1} = 0.45 \cdot g$

$A_{NS_2} := 5 \cdot Ap_{k.NS}$ $A_{NS_2} = 5.288 \cdot g$

$f_{NS_2} := \left(\frac{A_{NS_2}}{b}\right)^{\frac{1}{m}} \cdot Hz$ $f_{NS_2} = 2.877 \cdot Hz$

$f_{NS_3} := 16 \cdot Hz$ $A_{NS_3} := A_{NS_2}$ $A_{NS_3} = 5.288 \cdot g$

$f_{NS_4} := 33 \cdot Hz$ $A_{NS_4} := 2 \cdot Ap_{k.NS}$ $A_{NS_4} = 2.115 \cdot g$

$f_{NS_5} := 33 \cdot Hz$ $A_{NS_5} := Ap_{k.NS}$ $A_{NS_5} = 1.058 \cdot g$

$f_{NS_6} := 100 \cdot Hz$ $A_{NS_6} := Ap_{k.NS}$ $A_{NS_6} = 1.058 \cdot g$

Truncated N-S (Side-to-Side) Required Response Spectra (SSE 5% Damping) Ref. 2.4 section 4.2.2:

$f_{TNS_1} := 1Hz$ $\quad A_{TNS_1} := b$ $\quad A_{TNS_1} := 0.45 \cdot g$

Between 1 Hz and 90% of the first natural frequency of the skid frame the truncated RRS must not intersect the 5% building ARS. To prevent this, Ref. 2.4 section 4.2.2.2.d requires the truncated RRS to be adjusted to clear the first peak of the broadened floor spectra at 90% of the lower boundary of the broadened plateau of the first peak. Using digitized north-south SSE from the Auxiliary Control Building El 736.5 New Design/Modification ARS (Ref. 2.6) at 3% damping the first peak occurs at 5.13 Hz with an acceleration of 3.078 G. Adjusting the truncated RRS to clear the 5% ARS plateau at 90% of 5 HZ the second point of the truncated RRS is computed as follows:

$f_{TNS_2} := .9 \cdot 5Hz$ $\quad f_{TNS_2} = 4.5 \cdot Hz$ $\quad A_{TNS_2} := \sqrt{\frac{3}{5}} \cdot 3.078 \cdot g$ $\quad A_{TNS_2} = 2.384 \cdot g$

NOTE: Square root of 3/5 is used to convert digitized 3% damping ARS to 5% damping ARS. Refer to Ref.2.4 section 4.1.3.4 second paragraph which shows this method of converting a peak 5% damped floor spectra to a peak 3% damped floor spectra. In this case we are converting a 3% damped peak to a 5% damped peak.

The acceleration value for 90% of the first natural frequency of the skid frame is computed as follows:

$f_{TNS_3} := .9 \cdot 18Hz$ $\quad f_{TNS_3} = 16.2 \cdot Hz$ $\quad A_{TNS_3} := 5.29 \cdot g$ (conservatively using RRS value for 16 Hz computed above)

The truncated RRS between 90% of the first natural frequency of the skid frame and the ZPA is the same as the non-truncated RRS as follows:

$f_{TNS_4} := 33 \cdot Hz$ $\quad A_{TNS_4} := 2 \cdot Ap_{k.NS}$ $\quad A_{TNS_4} = 2.115 \cdot g$

$f_{TNS_5} := 33 \cdot Hz$ $\quad A_{TNS_5} := Ap_{k.NS}$ $\quad A_{TNS_5} = 1.058 \cdot g$

$f_{TNS_6} := 100 \cdot Hz$ $\quad A_{TNS_6} := Ap_{k.NS}$ $\quad A_{TNS_6} = 1.058 \cdot g$

E-W (Front-to-Back) Required Response Spectra (SSE 5% Damping):

$$Ap_{k.EW} := \sqrt{(1.6 \cdot S \cdot Ap_{k.1.EW})^2 + (1.0 \cdot S \cdot Ap_{k.2.EW})^2 + A_{zpa.k.EW}^2}$$

$Ap_{k.EW} = 1.092 \cdot g$

From Page 33 of Ref. 2.4, $\quad m := 2.3314$ $\quad b := 0.45 \cdot g$

$f_{EW_1} := 1 \cdot Hz$ $\quad A_{EW_1} := b$ $\quad A_{EW_1} = 0.45 \cdot g$

$A_{EW_2} := 5 \cdot Ap_{k.EW}$ $\quad A_{EW_2} = 5.461 \cdot g$

$f_{EW_2} := \left(\dfrac{A_{EW_2}}{b}\right)^{\frac{1}{m}} \cdot Hz$ $\qquad f_{EW_2} = 2.917 \cdot Hz$

$f_{EW_3} := 16 \cdot Hz$ $\qquad A_{EW_3} := A_{EW_2}$ $\qquad A_{EW_3} = 5.461 \cdot g$

$f_{EW_4} := 33 \cdot Hz$ $\qquad A_{EW_4} := 2 \cdot Ap_{k.EW}$ $\qquad A_{EW_4} = 2.184 \cdot g$

$f_{EW_5} := 33 \cdot Hz$ $\qquad A_{EW_5} := Ap_{k.EW}$ $\qquad A_{EW_5} = 1.092 \cdot g$

$f_{EW_6} := 100 \cdot Hz$ $\qquad A_{EW_6} := Ap_{k.EW}$ $\qquad A_{EW_6} = 1.092 \cdot g$

Truncated E-W (Front-to-Back) Required Response Spectra (SSE 5% Damping):

$f_{TEW_1} := 1Hz$ $\qquad A_{TEW_1} := b$ $\qquad A_{TEW_1} := 0.45 \cdot g$

Between 1 Hz and 90% of the first natural frequency of the skid frame the truncated RRS must not intersect the 5% building ARS. To prevent this, Ref. 2.4 section 4.2.2.2.d requires the truncated RRS to be adjusted to clear the first peak of the broadened floor spectra at 90% of the lower boundary of the broadened plateau of the first peak. Using digitized east-west SSE from the Auxiliary Control Building El 736.5 New Design/Modification ARS (Ref. 2.6) at 3% damping the first peak occurs at 5.13 Hz with an acceleration of 5.2 G. Adjusting the truncated RRS to clear the 5% ARS plateau at 90% of 5 HZ the second point of the truncated RRS is computed as follows:

$f_{TEW_2} := .9 \cdot 5Hz$ $\qquad f_{TEW_2} = 4.5 \cdot Hz$ $\qquad A_{TEW_2} := \sqrt{\dfrac{3}{5}} \cdot 5.2 \cdot g$ $\qquad A_{TEW_2} = 4.028 \cdot g$

NOTE: Square root of 3/5 is used to convert digitized 3% damping ARS to 5% damping ARS. Refer to Ref.2.4 section 4.1.3.4 second paragraph which shows this method of converting a peak 5% damped floor spectra to a peak 3% damped floor spectra. In this case we are converting a 3% damped peak to a 5% damped peak.

The acceleration value for 90% of the first natural frequency of the skid frame is computed as follows:

$f_{TEW_3} := .9 \cdot 21Hz$ $\qquad f_{TEW_3} = 18.9 \cdot Hz$

Conservatively using linear Interpolation between the 16 Hz and 33 Hz values of the non-truncated RRS for 18.9 Hz (comparing slope of line on sheet A17 with that on sheet A18 shows this to be conservative):

$$A_{TEW_3} := A_{EW_4} + \frac{f_{EW_4} - f_{TEW_3}}{f_{EW_4} - f_{EW_3}} \cdot \left(A_{EW_3} - A_{EW_4}\right)$$

$A_{TEW_3} = 4.902 \cdot g$

The truncated RRS between 90% of the first natural frequency of the skid frame and the ZPA is the same as the non-truncated RRS as follows:

$f_{TEW_4} := 33 \cdot Hz$ $\quad A_{TEW_4} := 2 \cdot Ap_{k.EW}$ $\quad A_{TEW_4} = 2.184 \cdot g$

$f_{TEW_5} := 33 \cdot Hz$ $\quad A_{TEW_5} := Ap_{k.EW}$ $\quad A_{TEW_5} = 1.092 \cdot g$

$f_{TEW_6} := 100 \cdot Hz$ $\quad A_{TEW_6} := Ap_{k.EW}$ $\quad A_{TEW_6} = 1.092 \cdot g$

Vertical Required Response Spectra (SSE 5% Damping):

$Ap_{k.v} := A_{zpa.k.V}$ $\quad Ap_{k.v} = 0.59 \cdot g$

From Page 33 of Ref. 2.4, $m := 2.3314$ $\quad b := 0.45 \cdot g$

$f_{V_1} := 1 \cdot Hz$ $\quad A_{V_1} := b$ $\quad A_{V_1} = 0.45 \cdot g$

$A_{V_2} := 5 \cdot Ap_{k.v}$ $\quad A_{V_2} = 2.95 \cdot g$

$$f_{V_2} := \left(\frac{A_{V_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{V_2} = 2.24 \cdot Hz$$

$f_{V_3} := 16 \cdot Hz$ $\quad A_{V_3} := A_{V_2}$ $\quad A_{V_3} = 2.95 \cdot g$

$f_{V_4} := 33 \cdot Hz$ $\quad A_{V_4} := 2 \cdot Ap_{k.v}$ $\quad A_{V_4} = 1.18 \cdot g$

$f_{V_5} := 33 \cdot Hz$ $\quad A_{V_5} := Ap_{k.v}$ $\quad A_{V_5} = 0.59 \cdot g$

$f_{V_6} := 100 \cdot Hz$ $\quad A_{V_6} := Ap_{k.v}$ $\quad A_{V_6} = 0.59 \cdot g$

Truncated Vertical Required Response Spectra (SSE 5% Damping):

$f_{TV_1} := 1Hz$ $\quad A_{TV_1} := b$ $\quad A_{TV_1} := 0.45 \cdot g$

Since the skid frame is rigid in the vertical direction the first natural frequency is conservatively taken as 33 Hz. The acceleration value for 90% of the first natural frequency of the skid frame is computed as follows:

$f_{TV_2} := .9 \cdot 33Hz \qquad f_{TV_2} = 29.7 \cdot Hz$

Conservatively using linear Interpolation between the 16 Hz and 33 Hz values of the non-truncated RRS for 18.9 Hz (comparing slope of line on sheet A17 with that on sheet A18shows this to be conservative):

$$A_{TV_2} := A_{V_4} + \frac{f_{V_4} - f_{TV_2}}{f_{V_4} - f_{V_3}} \cdot \left(A_{V_3} - A_{V_4}\right)$$

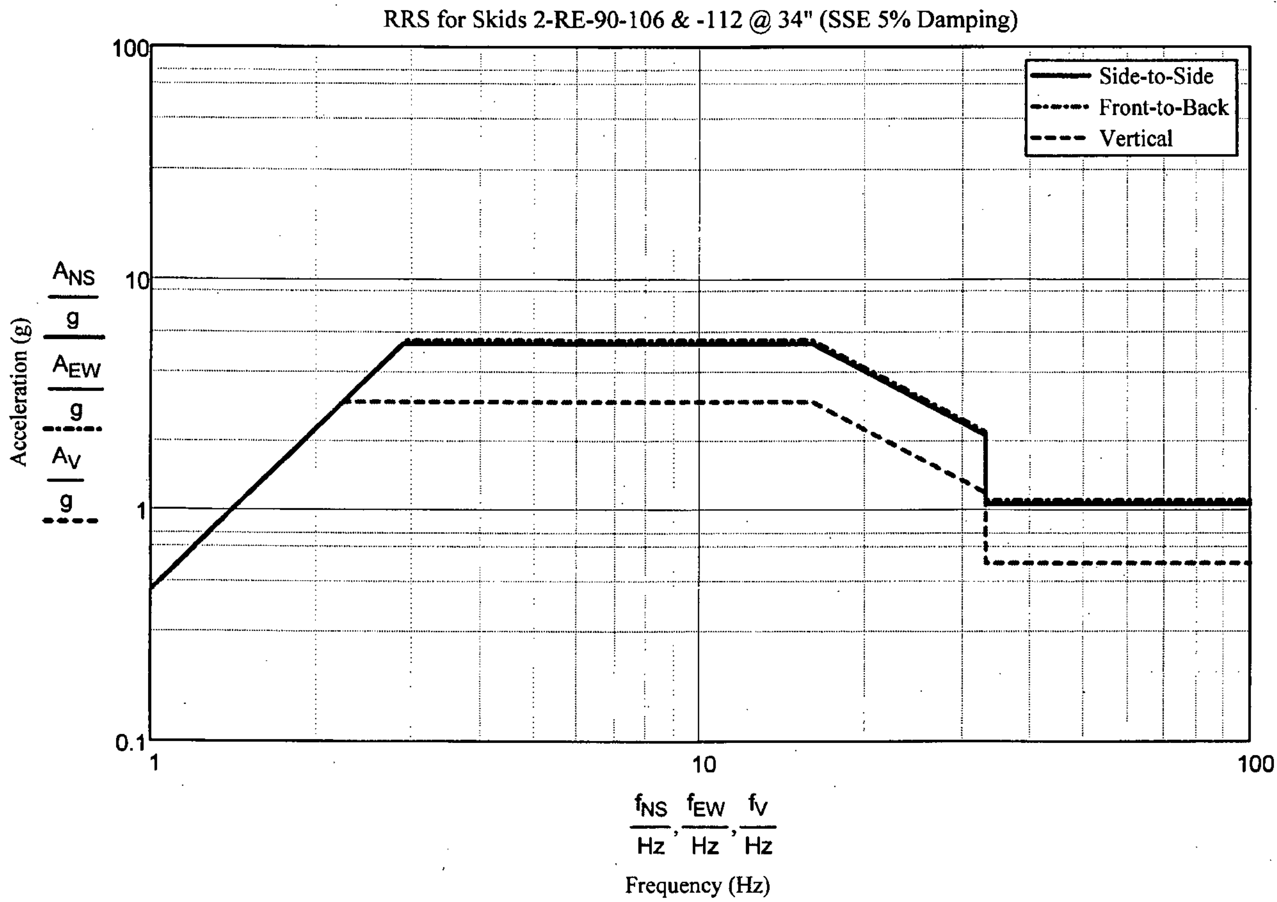
$A_{TV_2} = 1.524 \cdot g$

The truncated RRS between 90% of the first natural frequency of the skid frame and the ZPA is the same as the non-truncated RRS as follows:

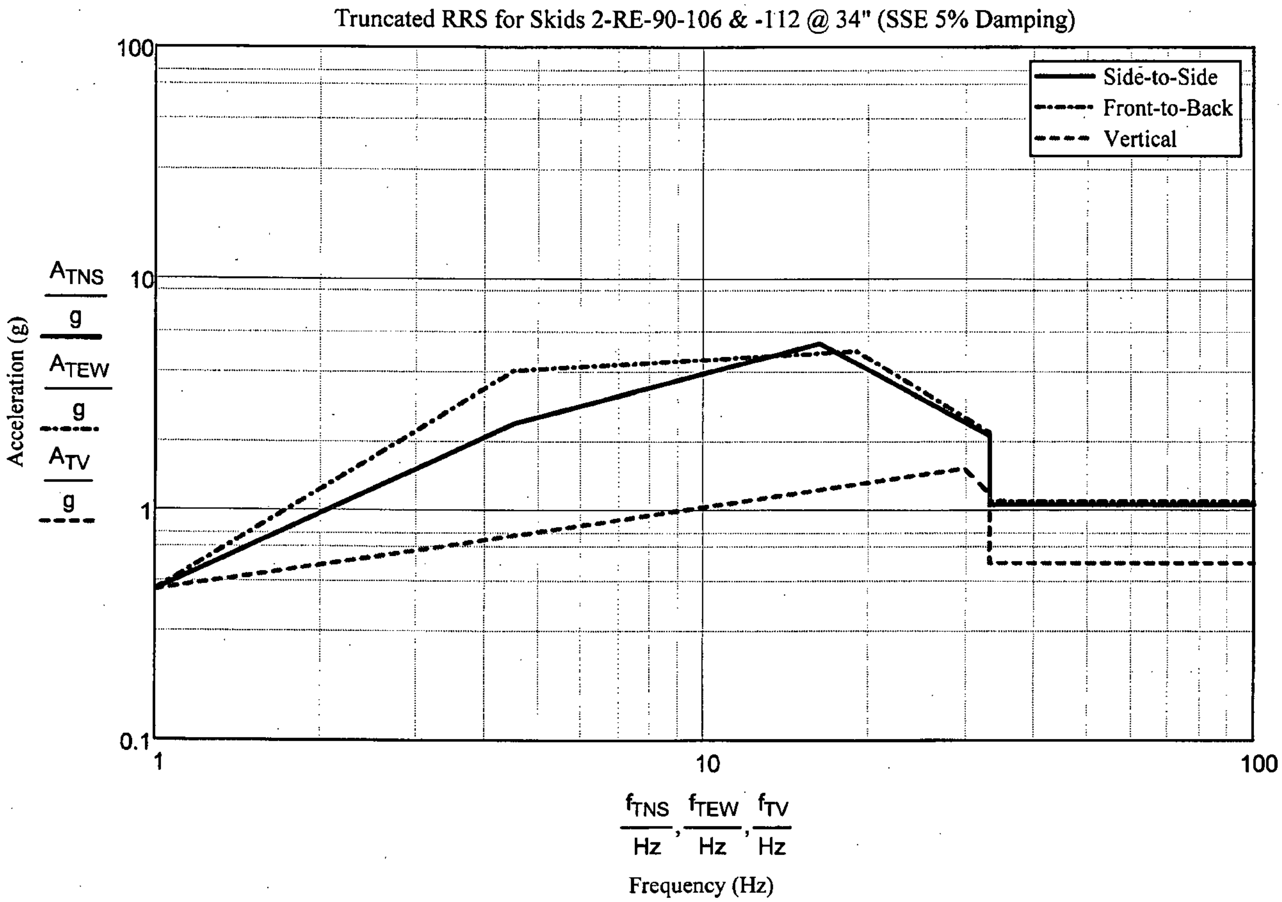
$f_{TV_3} := 33 \cdot Hz \qquad A_{TV_3} := 2 \cdot Ap_{k.v} \qquad A_{TV_3} = 1.18 \cdot g$

$f_{TV_4} := 33 \cdot Hz \qquad A_{TV_4} := Ap_{k.v} \qquad A_{TV_4} = 0.59 \cdot g$

$f_{TV_5} := 100 \cdot Hz \qquad A_{TV_5} := Ap_{k.v} \qquad A_{TV_5} = 0.59 \cdot g$



Side-to-Side		Front-to-Back		Vertical	
f (Hz)	a (g)	f (Hz)	a (g)	f (Hz)	a (g)
1.0	0.45	1.0	0.45	1.0	0.45
2.9	5.29	2.9	5.46	2.2	2.95
16.0	5.29	16.0	5.46	16.0	2.95
33.0	2.12	33.0	2.18	33.0	1.18
33.0	1.06	33.0	1.09	33.0	0.59
100.0	1.06	100.0	1.09	100.0	0.59



Side-to-Side		Front-to-Back		Vertical	
f (Hz)	a (g)	f (Hz)	a (g)	f (Hz)	a (g)
1.0	0.45	1.0	0.45	1.0	0.45
4.5	2.38	4.5	4.03	29.7	1.52
16.2	5.29	18.9	4.9	33.0	1.18
33.0	2.12	33.0	2.18	33.0	0.59
33.0	1.06	33.0	1.09	100.0	0.59
100.0	1.06	100.0	1.09		

According to Section 4.3.1 of Ref. 2.5, the OBE Required Response Spectra (RRS) will be developed using 70% of SSE levels:

N-S (Side-to-Side) Required Response Spectra (OBE 5% Damping):

$$Ap_{k.NS} := 0.70\sqrt{\left(1.6 \cdot S \cdot Ap_{k.1.NS}\right)^2 + \left(1.0 \cdot S \cdot Ap_{k.2.NS}\right)^2 + A_{zpa.k.NS}{}^2}$$

$$Ap_{k.NS} = 0.74 \cdot g$$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{NS_1} := 1 \cdot Hz$ $A_{NS_1} := b$ $A_{NS_1} = 0.45 \cdot g$

$A_{NS_2} := 5 \cdot Ap_{k.NS}$ $A_{NS_2} = 3.701 \cdot g$

$$f_{NS_2} := \left(\frac{A_{NS_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{NS_2} = 2.469 \cdot Hz$$

$f_{NS_3} := 16 \cdot Hz$ $A_{NS_3} := A_{NS_2}$ $A_{NS_3} = 3.701 \cdot g$

$f_{NS_4} := 33 \cdot Hz$ $A_{NS_4} := 2 \cdot Ap_{k.NS}$ $A_{NS_4} = 1.481 \cdot g$

$f_{NS_5} := 33 \cdot Hz$ $A_{NS_5} := Ap_{k.NS}$ $A_{NS_5} = 0.74 \cdot g$

$f_{NS_6} := 100 \cdot Hz$ $A_{NS_6} := Ap_{k.NS}$ $A_{NS_6} = 0.74 \cdot g$

E-W (Front-to-Back) Required Response Spectra (OBE 5% Damping):

$$Ap_{k.EW} := 0.70 \cdot \sqrt{\left(1.6 \cdot S \cdot Ap_{k.1.EW}\right)^2 + \left(1.0 \cdot S \cdot Ap_{k.2.EW}\right)^2 + A_{zpa.k.EW}{}^2}$$

$$Ap_{k.EW} = 0.764 \cdot g$$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{EW_1} := 1 \cdot Hz$ $A_{EW_1} := b$ $A_{EW_1} = 0.45 \cdot g$

$A_{EW_2} := 5 \cdot Ap_{k.EW}$ $A_{EW_2} = 3.822 \cdot g$

$$f_{EW_2} := \left(\frac{A_{EW_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{EW_2} = 2.503 \cdot Hz$$

$f_{EW_3} := 16 \cdot Hz$ $A_{EW_3} := A_{EW_2}$ $A_{EW_3} = 3.822 \cdot g$

$f_{EW_4} := 33 \cdot Hz$ $A_{EW_4} := 2 \cdot Ap_{k.EW}$ $A_{EW_4} = 1.529 \cdot g$

$f_{EW_5} := 33 \cdot Hz$ $A_{EW_5} := Ap_{k.EW}$ $A_{EW_5} = 0.764 \cdot g$

$f_{EW_6} := 100 \cdot Hz$ $A_{EW_6} := Ap_{k.EW}$ $A_{EW_6} = 0.764 \cdot g$

Vertical Required Response Spectra (OBE 5% Damping):

$Ap_{k.v} := 0.70 \cdot A_{zpa.k.V}$ $Ap_{k.v} = 0.413 \cdot g$

From Page 33 of Ref. 6.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{V_1} := 1 \cdot Hz$ $A_{V_1} := b$ $A_{V_1} = 0.45 \cdot g$

$A_{V_2} := 5 \cdot Ap_{k.v}$ $A_{V_2} = 2.065 \cdot g$

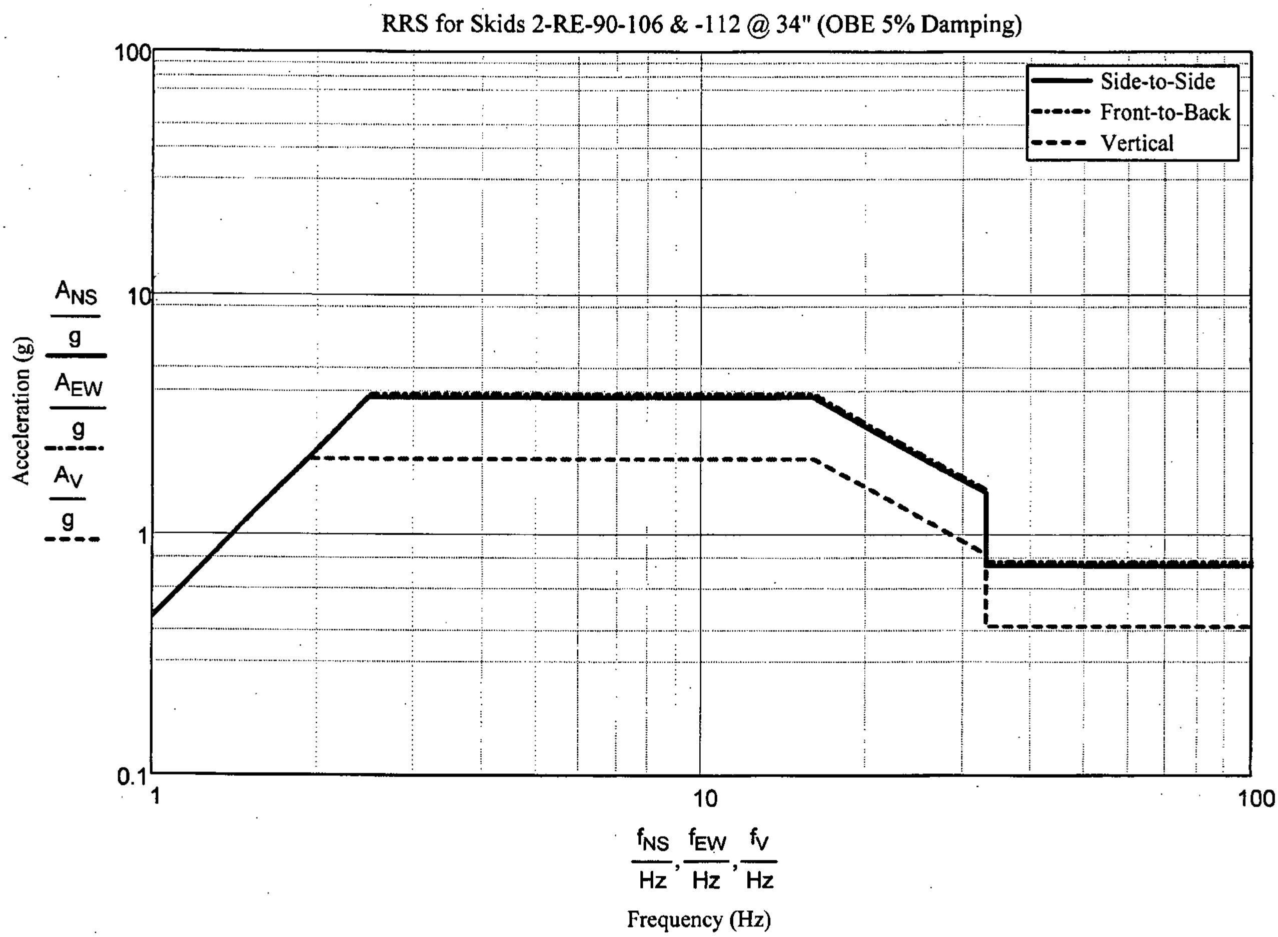
$$f_{V_2} := \left(\frac{A_{V_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{V_2} = 1.922 \cdot Hz$$

$f_{V_3} := 16 \cdot Hz$ $A_{V_3} := A_{V_2}$ $A_{V_3} = 2.065 \cdot g$

$f_{V_4} := 33 \cdot Hz$ $A_{V_4} := 2 \cdot Ap_{k.v}$ $A_{V_4} = 0.826 \cdot g$

$f_{V_5} := 33 \cdot Hz$ $A_{V_5} := Ap_{k.v}$ $A_{V_5} = 0.413 \cdot g$

$f_{V_6} := 100 \cdot Hz$ $A_{V_6} := Ap_{k.v}$ $A_{V_6} = 0.413 \cdot g$



Side-to-Side		Front-to-Back		Vertical	
f (Hz)	a (g)	f (Hz)	a (g)	f (Hz)	a (g)
1.0	0.45	1.0	0.45	1.0	0.45
2.5	3.70	2.5	3.82	1.9	2.07
16.0	3.70	16.0	3.82	16.0	2.07
33.0	1.48	33.0	1.53	33.0	0.83
33.0	0.74	33.0	0.76	33.0	0.41
100.0	0.74	100.0	0.76	100.0	0.41

In panel RRS for safety related skid 106 and 112 (@ 59"):

$x := 59 \cdot in$ $L := 59 \cdot in$ (Ref. 2.8 & 2.9)

$S := \frac{x}{L}$ $S = 1$

The RRS curves for the SSE are computed as follows:

N-S (Side-to-Side) Required Response Spectra (SSE 5% Damping):

$$Ap_{k.NS} := \sqrt{\left(1.6 \cdot S \cdot Ap_{k.1.NS}\right)^2 + \left(1.0 \cdot S \cdot Ap_{k.2.NS}\right)^2 + A_{zpa.k.NS}{}^2}$$

$Ap_{k.NS} = 1.534 \cdot g$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{NS_1} := 1 \cdot Hz$ $A_{NS_1} := b$ $A_{NS_1} = 0.45 \cdot g$

$A_{NS_2} := 5 \cdot Ap_{k.NS}$ $A_{NS_2} = 7.671 \cdot g$

$$f_{NS_2} := \left(\frac{A_{NS_2}}{b}\right)^{\frac{1}{m}} \cdot Hz$$ $f_{NS_2} = 3.375 \cdot Hz$

$f_{NS_3} := 16 \cdot Hz$ $A_{NS_3} := A_{NS_2}$ $A_{NS_3} = 7.671 \cdot g$

$f_{NS_4} := 33 \cdot Hz$ $A_{NS_4} := 2 \cdot Ap_{k.NS}$ $A_{NS_4} = 3.068 \cdot g$

$f_{NS_5} := 33 \cdot Hz$ $A_{NS_5} := Ap_{k.NS}$ $A_{NS_5} = 1.534 \cdot g$

$f_{NS_6} := 100 \cdot Hz$ $A_{NS_6} := Ap_{k.NS}$ $A_{NS_6} = 1.534 \cdot g$

Truncated N-S (Side-to-Side) Required Response Spectra (SSE 5% Damping) Ref. 2.4 section 4.2.2:

$f_{TNS_1} := 1Hz$ $\quad A_{TNS_1} := b$ $\quad A_{TNS_1} := 0.45 \cdot g$

Between 1 Hz and 90% of the first natural frequency of the skid frame the truncated RRS must not intersect the 5% building ARS. To prevent this, Ref. 2.4 section 4.2.2.2.d requires the truncated RRS to be adjusted to clear the first peak of the broadened floor spectra at 90% of the lower boundary of the broadened plateau of the first peak. Using digitized north-south SSE from the Auxiliary Control Building El 736.5 New Design/Modification ARS (Ref. 2.6) at 3% damping the first peak occurs at 5.13 Hz with an acceleration of 3.078 G. Adjusting the truncated RRS to clear the 5% ARS plateau at 90% of 5 HZ the second point of the truncated RRS is computed as follows:

$f_{TNS_2} := .9 \cdot 5Hz$ $\quad f_{TNS_2} = 4.5 \cdot Hz$ $\quad A_{TNS_2} := \sqrt{\frac{3}{5}} \cdot 3.078 \cdot g$ $\quad A_{TNS_2} = 2.384 \cdot g$

NOTE: Square root of 3/5 is used to convert digitized 3% damping ARS to 5% damping ARS. Refer to Ref.2.4 section 4.1.3.4 second paragraph which shows this method of converting a peak 5% damped floor spectra to a peak 3% damped floor spectra. In this case we are converting a 3% damped peak to a 5% damped peak.

The acceleration value for 90% of the first natural frequency of the skid frame is computed as follows:

$f_{TNS_3} := .9 \cdot 18Hz$ $\quad f_{TNS_3} = 16.2 \cdot Hz$ $\quad A_{TNS_3} := 7.67 \cdot g$ (conservatively using RRS value for 16 Hz computed above)

The truncated RRS between 90% of the first natural frequency of the skid frame and the ZPA is the same as the non-truncated RRS as follows:

$f_{TNS_4} := 33 \cdot Hz$ $\quad A_{TNS_4} := 2 \cdot Ap_{k.NS}$ $\quad A_{TNS_4} = 3.068 \cdot g$

$f_{TNS_5} := 33 \cdot Hz$ $\quad A_{TNS_5} := Ap_{k.NS}$ $\quad A_{TNS_5} = 1.534 \cdot g$

$f_{TNS_6} := 100 \cdot Hz$ $\quad A_{TNS_6} := Ap_{k.NS}$ $\quad A_{TNS_6} = 1.534 \cdot g$

E-W (Front-to-Back) Required Response Spectra (SSE 5% Damping):

$$Ap_{k.EW} := \sqrt{(1.6 \cdot S \cdot Ap_{k.1.EW})^2 + (1.0 \cdot S \cdot Ap_{k.2.EW})^2 + A_{zpa.k.EW}{}^2}$$

$Ap_{k.EW} = 1.549 \cdot g$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{EW_1} := 1 \cdot Hz$ $A_{EW_1} := b$ $A_{EW_1} = 0.45 \cdot g$

$A_{EW_2} := 5 \cdot Ap_{k.EW}$ $A_{EW_2} = 7.745 \cdot g$

$$f_{EW_2} := \left(\frac{A_{EW_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{EW_2} = 3.389 \cdot Hz$$

$f_{EW_3} := 16 \cdot Hz$ $A_{EW_3} := A_{EW_2}$ $A_{EW_3} = 7.745 \cdot g$

$f_{EW_4} := 33 \cdot Hz$ $A_{EW_4} := 2 \cdot Ap_{k.EW}$ $A_{EW_4} = 3.098 \cdot g$

$f_{EW_5} := 33 \cdot Hz$ $A_{EW_5} := Ap_{k.EW}$ $A_{EW_5} = 1.549 \cdot g$

$f_{EW_6} := 100 \cdot Hz$ $A_{EW_6} := Ap_{k.EW}$ $A_{EW_6} = 1.549 \cdot g$

Truncated E-W (Front-to-Back) Required Response Spectra (SSE 5% Damping):

$f_{TEW_1} := 1Hz$ $A_{TEW_1} := b$ $A_{TEW_1} := 0.45 \cdot g$

Between 1 Hz and 90% of the first natural frequency of the skid frame the truncated RRS must not intersect the 5% building ARS. To prevent this, Ref. 2.4 section 4.2.2.2.d requires the truncated RRS to be adjusted to clear the first peak of the broadened floor spectra at 90% of the lower boundary of the broadened plateau of the first peak. Using digitized north-south SSE from the Auxiliary Control Building El 736.5 New Design/Modification ARS (Ref. 2.6) at 3% damping the first peak occurs at 5.13 Hz with an acceleration of 5.2 G. Adjusting the truncated RRS to clear the 5% ARS plateau at 90% of 5 HZ the second point of the truncated RRS is computed as follows:

$f_{TEW_2} := .9 \cdot 5Hz$ $f_{TEW_2} = 4.5 \cdot Hz$ $A_{TEW_2} := \sqrt{\frac{3}{5}} \cdot 5.2 \cdot g$ $A_{TEW_2} = 4.028 \cdot g$

NOTE: Square root of 3/5 is used to convert digitized 3% damping ARS to 5% damping ARS. Refer to Ref.2.4 section 4.1.3.4 second paragraph which shows this method of converting a peak 5% damped floor spectra to a peak 3% damped floor spectra. In this case we are converting a 3% damped peak to a 5% damped peak.

The acceleration value for 90% of the first natural frequency of the skid frame is computed as follows:

$f_{TEW_3} := .9 \cdot 21Hz$ $\quad f_{TEW_3} = 18.9 \cdot Hz$

Conservatively using linear Interpolation between the 16 Hz and 33 Hz values of the non-truncated RRS for 18.9 Hz (comparing slope of line on sheet A27 with that on sheet A28shows this to be conservative):

$$A_{TEW_3} := A_{EW_4} + \frac{f_{EW_4} - f_{TEW_3}}{f_{EW_4} - f_{EW_3}} \cdot \left(A_{EW_3} - A_{EW_4}\right)$$

$A_{TEW_3} = 6.952 \cdot g$

The truncated RRS between 90% of the first natural frequency of the skid frame and the ZPA is the same as the non-truncated RRS as follows:

$f_{TEW_4} := 33 \cdot Hz$ $\quad A_{TEW_4} := 2 \cdot Ap_{k.EW}$ $\quad A_{TEW_4} = 3.098 \cdot g$

$f_{TEW_5} := 33 \cdot Hz$ $\quad A_{TEW_5} := Ap_{k.EW}$ $\quad A_{TEW_5} = 1.549 \cdot g$

$f_{TEW_6} := 100 \cdot Hz$ $\quad A_{TEW_6} := Ap_{k.EW}$ $\quad A_{TEW_6} = 1.549 \cdot g$

Vertical Required Response Spectra (SSE 5% Damping):

$Ap_{k.v} := A_{zpa.k.V}$ $\quad Ap_{k.v} = 0.59 \cdot g$

From Page 33 of Ref. 2.4, $m := 2.3314$ $\quad b := 0.45 \cdot g$

$f_{V_1} := 1 \cdot Hz$ $\quad A_{V_1} := b$ $\quad A_{V_1} = 0.45 \cdot g$

$A_{V_2} := 5 \cdot Ap_{k.v}$ $\quad A_{V_2} = 2.95 \cdot g$

$$f_{V_2} := \left(\frac{A_{V_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{V_2} = 2.24 \cdot Hz$$

$f_{V_3} := 16 \cdot Hz$ $\quad A_{V_3} := A_{V_2}$ $\quad A_{V_3} = 2.95 \cdot g$

$f_{V_4} := 33 \cdot Hz$ $\quad A_{V_4} := 2 \cdot Ap_{k.v}$ $\quad A_{V_4} = 1.18 \cdot g$

$f_{V_5} := 33 \cdot Hz$ $\quad A_{V_5} := Ap_{k.v}$ $\quad A_{V_5} = 0.59 \cdot g$

$f_{V_6} := 100 \cdot Hz$ $\quad A_{V_6} := Ap_{k.v}$ $\quad A_{V_6} = 0.59 \cdot g$

Truncated Vertical Required Response Spectra (SSE 5% Damping):

$f_{TV_1} := 1Hz$ $\quad$ $A_{TV_1} := b$ $\quad$ $A_{TV_1} := 0.45 \cdot g$

Since the skid frame is rigid in the vertical direction the first natural frequency is conservatively taken as 33 Hz. The acceleration value for 90% of the first natural frequency of the skid frame is computed as follows:

$f_{TV_2} := .9 \cdot 33Hz$ $\quad$ $f_{TV_2} = 29.7 \cdot Hz$

Conservatively using linear Interpolation between the 16 Hz and 33 Hz values of the non-truncated RRS for 18.9 Hz (comparing slope of line on sheet A27 with that on sheet A28shows this to be conservative):

$$A_{TV_2} := A_{V_4} + \frac{f_{V_4} - f_{TV_2}}{f_{V_4} - f_{V_3}} \cdot \left(A_{V_3} - A_{V_4}\right)$$

$$A_{TV_2} = 1.524 \cdot g$$

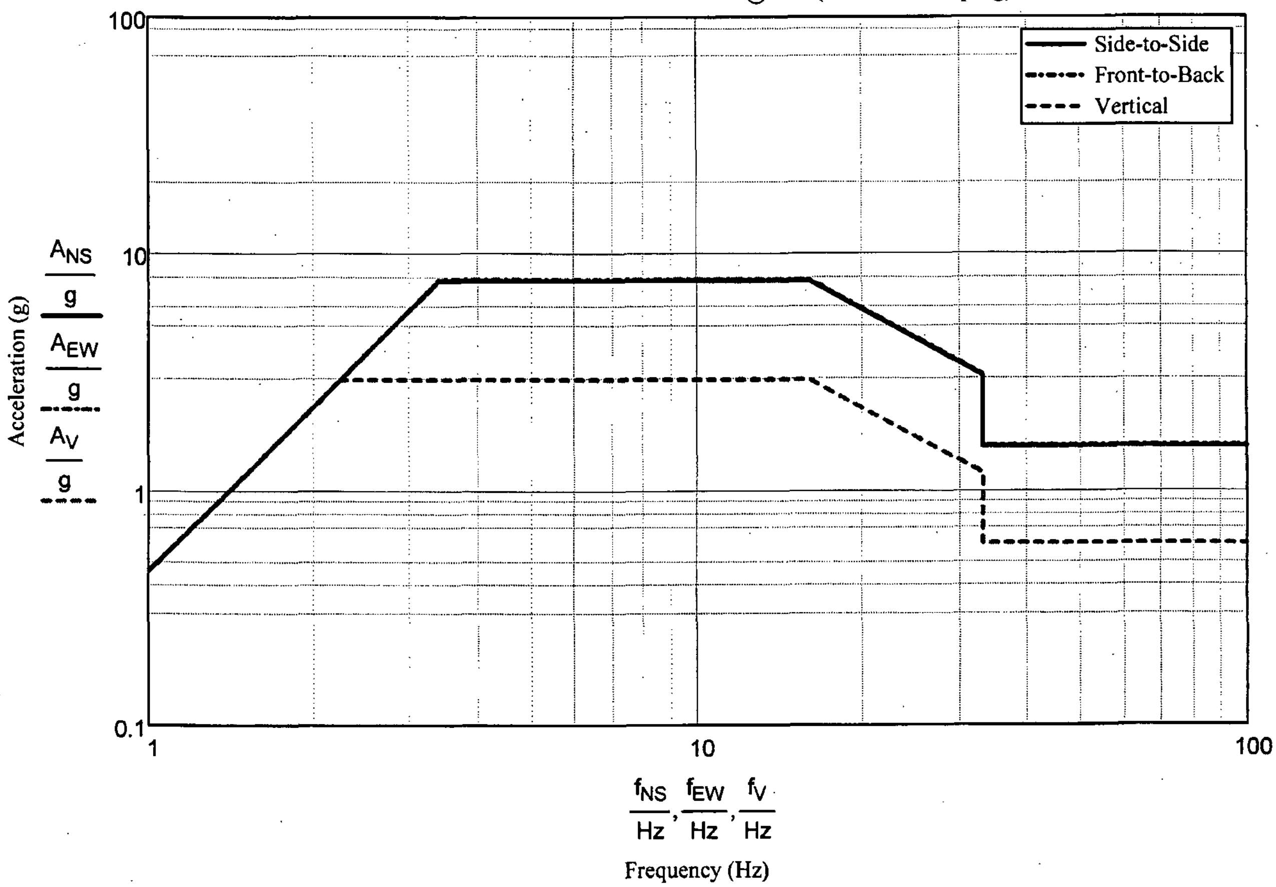
The truncated RRS between 90% of the first natural frequency of the skid frame and the ZPA is the same as the non-truncated RRS as follows:

$f_{TV_3} := 33 \cdot Hz$ $\quad$ $A_{TV_3} := 2 \cdot Ap_{k.v}$ $\quad$ $A_{TV_3} = 1.18 \cdot g$

$f_{TV_4} := 33 \cdot Hz$ $\quad$ $A_{TV_4} := Ap_{k.v}$ $\quad$ $A_{TV_4} = 0.59 \cdot g$

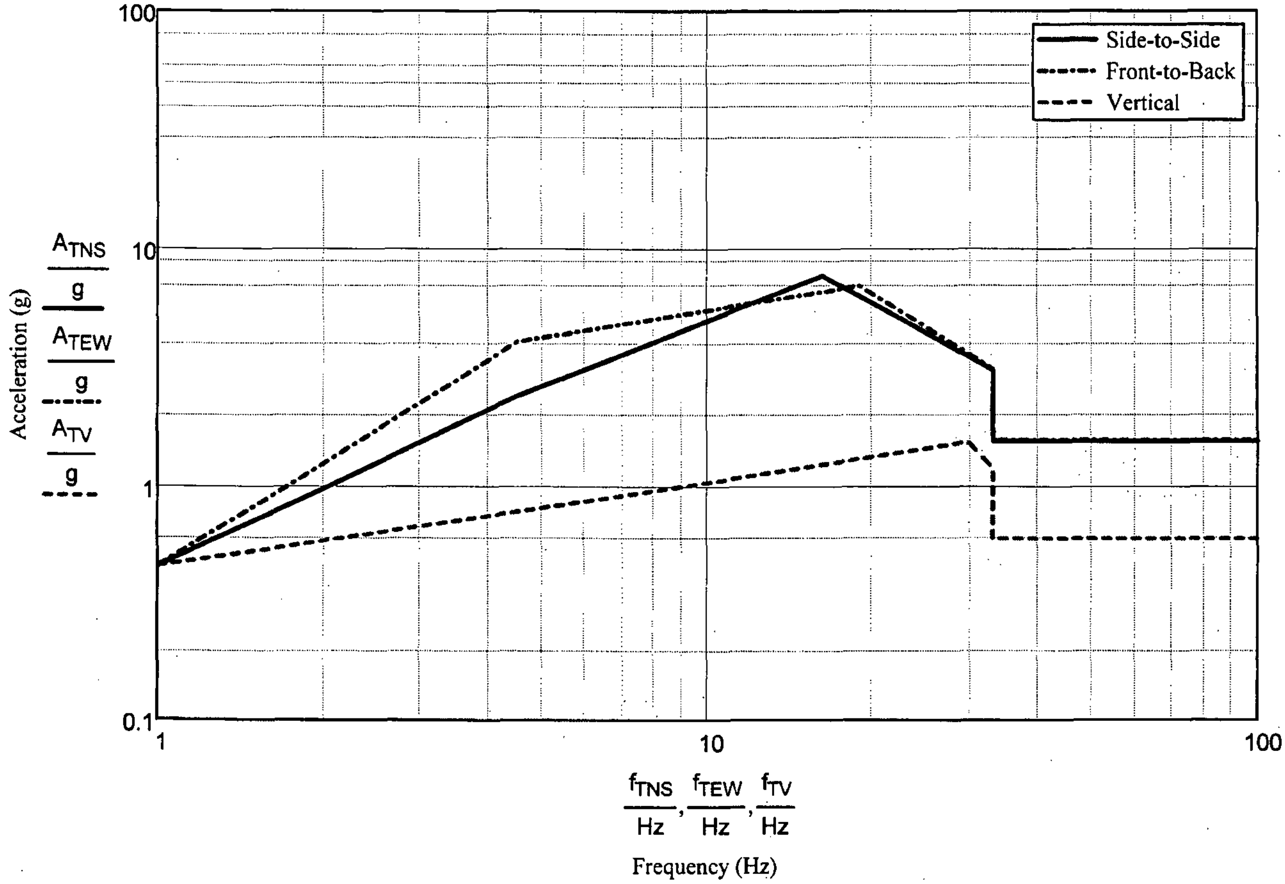
$f_{TV_5} := 100 \cdot Hz$ $\quad$ $A_{TV_5} := Ap_{k.v}$ $\quad$ $A_{TV_5} = 0.59 \cdot g$

RRS for Skids 2-RE-90-106 & -112 @ 59" (SSE 5% Damping)



Side-to-Side		Front-to-Back		Vertical	
f (Hz)	a (g)	f (Hz)	a (g)	f (Hz)	a (g)
1.0	0.45	1.0	0.45	1.0	0.45
3.4	7.67	3.4	7.75	2.2	2.95
16.0	7.67	16.0	7.75	16.0	2.95
33.0	3.07	33.0	3.10	33.0	1.18
33.0	1.53	33.0	1.55	33.0	0.59
100.0	1.53	100.0	1.55	100.0	0.59

Truncated RRS for Skids 2-RE-90-106 & -112 @ 59" (SSE 5% Damping)



Side-to-Side		Front-to-Back		Vertical	
f (Hz)	a (g)	f (Hz)	a (g)	f (Hz)	a (g)
1.0	0.45	1.0	0.45	1.0	0.45
4.5	2.38	4.5	4.03	29.7	1.52
16.2	7.67	18.9	6.95	33.0	1.18
33.0	3.07	33.0	3.10	33.0	0.59
33.0	1.53	33.0	1.55	100.0	0.59
100.0	1.53	100.0	1.55		

According to Section 4.3.1 of Ref. 2.5, the OBE Required Response Spectra (RRS) will be developed using 70% of SSE levels:

N-S (Side-to-Side) Required Response Spectra (OBE 5% Damping):

$$Ap_{k.NS} := 0.70\sqrt{\left(1.6 \cdot S \cdot Ap_{k.1.NS}\right)^2 + \left(1.0 \cdot S \cdot Ap_{k.2.NS}\right)^2 + A_{zpa.k.NS}{}^2}$$

$$Ap_{k.NS} = 1.074 \cdot g$$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{NS_1} := 1 \cdot Hz$ $A_{NS_1} := b$ $A_{NS_1} = 0.45 \cdot g$

$A_{NS_2} := 5 \cdot Ap_{k.NS}$ $A_{NS_2} = 5.37 \cdot g$

$$f_{NS_2} := \left(\frac{A_{NS_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{NS_2} = 2.896 \cdot Hz$$

$f_{NS_3} := 16 \cdot Hz$ $A_{NS_3} := A_{NS_2}$ $A_{NS_3} = 5.37 \cdot g$

$f_{NS_4} := 33 \cdot Hz$ $A_{NS_4} := 2 \cdot Ap_{k.NS}$ $A_{NS_4} = 2.148 \cdot g$

$f_{NS_5} := 33 \cdot Hz$ $A_{NS_5} := Ap_{k.NS}$ $A_{NS_5} = 1.074 \cdot g$

$f_{NS_6} := 100 \cdot Hz$ $A_{NS_6} := Ap_{k.NS}$ $A_{NS_6} = 1.074 \cdot g$

E-W (Front-to-Back) Required Response Spectra (OBE 5% Damping):

$$Ap_{k.EW} := 0.70 \cdot \sqrt{\left(1.6 \cdot S \cdot Ap_{k.1.EW}\right)^2 + \left(1.0 \cdot S \cdot Ap_{k.2.EW}\right)^2 + A_{zpa.k.EW}{}^2}$$

$$Ap_{k.EW} = 1.084 \cdot g$$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{EW_1} := 1 \cdot Hz$ $A_{EW_1} := b$ $A_{EW_1} = 0.45 \cdot g$

$A_{EW_2} := 5 \cdot Ap_{k.EW}$ $A_{EW_2} = 5.421 \cdot g$

$$f_{EW_2} := \left(\frac{A_{EW_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{EW_2} = 2.908 \cdot Hz$$

$f_{EW_3} := 16 \cdot Hz$ $A_{EW_3} := A_{EW_2}$ $A_{EW_3} = 5.421 \cdot g$

$f_{EW_4} := 33 \cdot Hz$ $A_{EW_4} := 2 \cdot Ap_{k.EW}$ $A_{EW_4} = 2.169 \cdot g$

$f_{EW_5} := 33 \cdot Hz$ $A_{EW_5} := Ap_{k.EW}$ $A_{EW_5} = 1.084 \cdot g$

$f_{EW_6} := 100 \cdot Hz$ $A_{EW_6} := Ap_{k.EW}$ $A_{EW_6} = 1.084 \cdot g$

Vertical Required Response Spectra (OBE 5% Damping):

$Ap_{k.v} := 0.70 \cdot A_{zpa.k.V}$ $Ap_{k.v} = 0.413 \cdot g$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{V_1} := 1 \cdot Hz$ $A_{V_1} := b$ $A_{V_1} = 0.45 \cdot g$

$A_{V_2} := 5 \cdot Ap_{k.v}$ $A_{V_2} = 2.065 \cdot g$

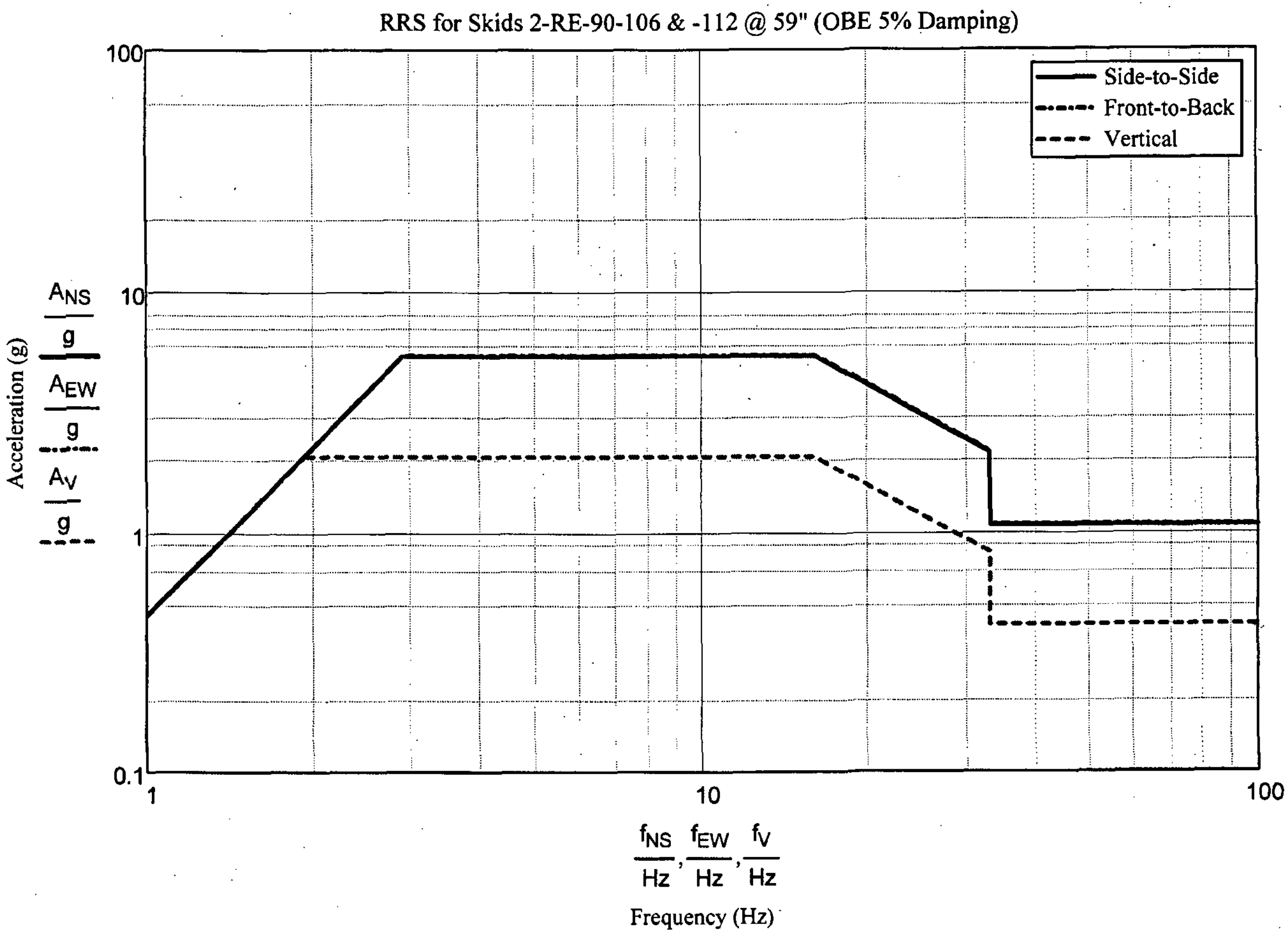
$$f_{V_2} := \left(\frac{A_{V_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{V_2} = 1.922 \cdot Hz$$

$f_{V_3} := 16 \cdot Hz$ $A_{V_3} := A_{V_2}$ $A_{V_3} = 2.065 \cdot g$

$f_{V_4} := 33 \cdot Hz$ $A_{V_4} := 2 \cdot Ap_{k.v}$ $A_{V_4} = 0.826 \cdot g$

$f_{V_5} := 33 \cdot Hz$ $A_{V_5} := Ap_{k.v}$ $A_{V_5} = 0.413 \cdot g$

$f_{V_6} := 100 \cdot Hz$ $A_{V_6} := Ap_{k.v}$ $A_{V_6} = 0.413 \cdot g$



Side-to-Side		Front-to-Back		Vertical	
f (Hz)	a (g)	f (Hz)	a (g)	f (Hz)	a (g)
1.0	0.45	1.0	0.45	1.0	0.45
2.9	5.37	2.9	5.42	1.9	2.07
16.0	5.37	16.0	5.42	16.0	2.07
33.0	2.15	33.0	2.17	33.0	0.83
33.0	1.07	33.0	1.08	33.0	0.41
100.0	1.07	100.0	1.08	100.0	0.41

In panel RRS for safety related skid 130 and 131:

From GA Report 04038903-1SP section 3.3.1 Table 3-6 the 1st mode frame frequency is 27.9 Hz in the side to side direction (north south skid 130 and east west skid 131). The 2nd mode frame frequency is 35.4 Hz. in the front to back direction (north south skid 131 and east west skid 130). See Ref. 2.17 and 2.19 for skid orientation and elvation. Since the 1st mode frequencies are greater than 1/2 of the cut off frequency no 2nd mode frequency need be considered. The frame was rigid in the vertical direction. The frame is a tube steel structure and local panel frequency need not be considered since the seismic testing of components provided by GA 04038903-1SP has accounted for the local effects (i.e. boxes housing the components).

For these frequencies the SSE acceleration from the Auxiliary Control Building El 711.5 New Design/Modification ARS (Ref. 2.6) at 3% damping are as follows:

$Ap_{k.1.NS} := 0.44 \cdot g$ $\quad Ap_{k.2.NS} := 0.00 \cdot g$ $\quad A_{zpa.k.NS} := 0.43 \cdot g$

$Ap_{k.1.EW} := 0.49 \cdot g$ $\quad Ap_{k.2.EW} := 0.00 \cdot g$ $\quad A_{zpa.k.EW} := 0.49 \cdot g$

$A_{zpa.k.V} := 0.25 \cdot g$

$Ap_{k.1}$ is the panel acceleration at the first mode frequency.

$Ap_{k.2}$ is the panel acceleration at the second mode frequency.

$Ap_{k.3}$ is the acceleration corresponding to the panel local frequency at the device location.

$A_{zpa.k}$ is the panel acceleration at cut-off frequency (33 Hz).

Determination of the Device Position Ratio (S):

The device location at the top of the panel is only considered since it has a greater input acceleration.

$S := \frac{x}{L}$ is the device position ratio. x is the height from the ground to the device and L is the total height of the panel.

$x := 68 \cdot in$ $\quad L := 68 \cdot in$ (Ref. 2.7)

$S := \frac{x}{L}$ $\quad S = 1$

The RRS curves for the SSE are computed as follows:

N-S Required Response Spectra (SSE 5% Damping):

$$Ap_{k.NS} := \sqrt{\left(1.6 \cdot S \cdot Ap_{k.1.NS}\right)^2 + \left(1.0 \cdot S \cdot Ap_{k.2.NS}\right)^2 + A_{zpa.k.NS}{}^2}$$

$Ap_{k.NS} = 0.825 \cdot g$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{NS_1} := 1 \cdot Hz$ $A_{NS_1} := b$ $A_{NS_1} = 0.45 \cdot g$

$A_{NS_2} := 5 \cdot Ap_{k.NS}$ $A_{NS_2} = 4.125 \cdot g$

$$f_{NS_2} := \left(\frac{A_{NS_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{NS_2} = 2.586 \cdot Hz$$

$f_{NS_3} := 16 \cdot Hz$ $A_{NS_3} := A_{NS_2}$ $A_{NS_3} = 4.125 \cdot g$

$f_{NS_4} := 33 \cdot Hz$ $A_{NS_4} := 2 \cdot Ap_{k.NS}$ $A_{NS_4} = 1.65 \cdot g$

$f_{NS_5} := 33 \cdot Hz$ $A_{NS_5} := Ap_{k.NS}$ $A_{NS_5} = 0.825 \cdot g$

$f_{NS_6} := 100 \cdot Hz$ $A_{NS_6} := Ap_{k.NS}$ $A_{NS_6} = 0.825 \cdot g$

Truncated N-S Required Response Spectra (SSE 5% Damping):

$f_{TNS_1} := 1Hz$ $A_{TNS_1} := b$ $A_{TNS_1} := 0.45 \cdot g$

Between 1 Hz and 90% of the first natural frequency of the skid frame the truncated RRS must not intersect the 5% building ARS. To prevent this, Ref. 2.4 section 4.2.2.2.d requires the truncated RRS to be adjusted to clear the first peak of the broadened floor spectra at 90% of the lower boundary of the broadened plateau of the first peak. Using digitized north-south SSE from the Auxiliary Control Building El 711.5 New Design/Modification ARS (Ref. 2.6) at 3% damping the first peak occurs above 4.5 Hz with an acceleration of 1.663 G. Adjusting the truncated RRS to clear the 5% ARS plateau at 90% of 4.5 HZ the second point of the truncated RRS is computed as follows:

$f_{TNS_2} := .9 \cdot 4.5Hz$ $f_{TNS_2} = 4.05 \cdot Hz$ $A_{TNS_2} := \sqrt{\frac{3}{5}} \cdot 1.633 \cdot g$ $A_{TNS_2} = 1.265 \cdot g$

NOTE: Square root of 3/5 is used to convert digitized 3% damping ARS to 5% damping ARS. Refer to Ref.2.4 section 4.1.3.4 second paragraph which shows this method of converting a peak 5% damped floor spectra to a peak 3% damped floor spectra. In this case we are converting a 3% damped peak to a 5% damped peak.

The acceleration value for 90% of the first natural frequency of the skid frame is computed as follows:

$f_{TNS_3} := .9 \cdot 27.9Hz$ $f_{TNS_3} = 25.11 \cdot Hz$

Conservatively using linear Interpolation between the 16 Hz and 33 Hz values of the non-truncated RRS for 18.9 Hz (comparing slope of line on sheet A38 with that on sheet A39shows this to be conservative):

$$A_{TNS_3} := A_{NS_4} + \frac{f_{NS_4} - f_{TNS_3}}{f_{NS_4} - f_{NS_3}} \cdot \left(A_{NS_3} - A_{NS_4}\right)$$

$$A_{TNS_3} = 2.798 \cdot g$$

The truncated RRS between 90% of the first natural frequency of the skid frame and the ZPA is the same as the non-truncated RRS as follows:

$f_{TNS_4} := 33 \cdot Hz$ $\quad A_{TNS_4} := 2 \cdot Ap_{k.NS}$ $\quad A_{TNS_4} = 1.65 \cdot g$

$f_{TNS_5} := 33 \cdot Hz$ $\quad A_{TNS_5} := Ap_{k.NS}$ $\quad A_{TNS_5} = 0.825 \cdot g$

$f_{TNS_6} := 100 \cdot Hz$ $\quad A_{TNS_6} := Ap_{k.NS}$ $\quad A_{TNS_6} = 0.825 \cdot g$

E-W Required Response Spectra (SSE 5% Damping):

$$Ap_{k.EW} := \sqrt{\left(1.6 \cdot S \cdot Ap_{k.1.EW}\right)^2 + \left(1.0 \cdot S \cdot Ap_{k.2.EW}\right)^2 + A_{zpa.k.EW}{}^2}$$

$$Ap_{k.EW} = 0.925 \cdot g$$

From Page 33 of Ref. 2.4, $\quad m := 2.3314 \quad b := 0.45 \cdot g$

$f_{EW_1} := 1 \cdot Hz$ $\quad A_{EW_1} := b$ $\quad A_{EW_1} = 0.45 \cdot g$

$A_{EW_2} := 5 \cdot Ap_{k.EW}$ $\quad A_{EW_2} = 4.623 \cdot g$

$$f_{EW_2} := \left(\frac{A_{EW_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{EW_2} = 2.716 \cdot Hz$$

$f_{EW_3} := 16 \cdot Hz$ $\quad A_{EW_3} := A_{EW_2}$ $\quad A_{EW_3} = 4.623 \cdot g$

$f_{EW_4} := 33 \cdot Hz$ $\quad A_{EW_4} := 2 \cdot Ap_{k.EW}$ $\quad A_{EW_4} = 1.849 \cdot g$

$f_{EW_5} := 33 \cdot Hz$ $\quad A_{EW_5} := Ap_{k.EW}$ $\quad A_{EW_5} = 0.925 \cdot g$

$f_{EW_6} := 100 \cdot Hz$ $\quad A_{EW_6} := Ap_{k.EW}$ $\quad A_{EW_6} = 0.925 \cdot g$

Truncated E-W Required Response Spectra (SSE 5% Damping):

$f_{TEW_1} := 1Hz$ $\qquad A_{TEW_1} := b$ $\qquad A_{TEW_1} := 0.45 \cdot g$

Between 1 Hz and 90% of the first natural frequency of the skid frame the truncated RRS must not intersect the 5% building ARS. To prevent this, Ref. 2.4 section 4.2.2.2.d requires the truncated RRS to be adjusted to clear the first peak of the broadened floor spectra at 90% of the lower boundary of the broadened plateau of the first peak. Using digitized east-west SSE from the Auxiliary Control Building El 711.5 New Design/Modification ARS (Ref. 2.6) at 3% damping the first peak occurs at 5.0 Hz with an acceleration of 2.56 G. Adjusting the truncated RRS to clear the 5% ARS plateau at 90% of 5 HZ the second point of the truncated RRS is computed as follows:

$f_{TEW_2} := .9 \cdot 5Hz$ $\qquad f_{TEW_2} = 4.5 \cdot Hz$ $\qquad A_{TEW_2} := \sqrt{\frac{3}{5}} \cdot 2.56 \cdot g$ $\qquad A_{TEW_2} = 1.983 \cdot g$

NOTE: Square root of 3/5 is used to convert digitized 3% damping ARS to 5% damping ARS. Refer to Ref.2.4 section 4.1.3.4 second paragraph which shows this method of converting a peak 5% damped floor spectra to a peak 3% damped floor spectra. In this case we are converting a 3% damped peak to a 5% damped peak.

The acceleration value for 90% of the first natural frequency of the skid frame is computed as follows:

$f_{TEW_3} := .9 \cdot 27.9Hz$ $\qquad f_{TEW_3} = 25.11 \cdot Hz$

Conservatively using linear Interpolation between the 16 Hz and 33 Hz values of the non-truncated RRS for 18.9 Hz (comparing slope of line on sheet A38 with that on sheet A39shows this to be conservative):

$$A_{TEW_3} := A_{EW_4} + \frac{f_{EW_4} - f_{TEW_3}}{f_{EW_4} - f_{EW_3}} \cdot \left(A_{EW_3} - A_{EW_4}\right)$$

$A_{TEW_3} = 3.136 \cdot g$

The truncated RRS between 90% of the first natural frequency of the skid frame and the ZPA is the same as the non-truncated RRS as follows:

$f_{TEW_4} := 33 \cdot Hz$ $\qquad A_{TEW_4} := 2 \cdot Ap_{k.EW}$ $\qquad A_{TEW_4} = 1.849 \cdot g$

$f_{TEW_5} := 33 \cdot Hz$ $\qquad A_{TEW_5} := Ap_{k.EW}$ $\qquad A_{TEW_5} = 0.925 \cdot g$

$f_{TEW_6} := 100 \cdot Hz$ $\qquad A_{TEW_6} := Ap_{k.EW}$ $\qquad A_{TEW_6} = 0.925 \cdot g$

Vertical Required Response Spectra (SSE 5% Damping):

$Ap_{k.v} := A_{zpa.k.V}$ $\qquad Ap_{k.v} = 0.25 \cdot g$

From Page 33 of Ref. 2.4, $\quad m := 2.3314 \qquad b := 0.45 \cdot g$

$f_{V_1} := 1 \cdot Hz \qquad A_{V_1} := b \qquad A_{V_1} = 0.45 \cdot g$

$A_{V_2} := 5 \cdot Ap_{k.v} \qquad A_{V_2} = 1.25 \cdot g$

$$f_{V_2} := \left(\frac{A_{V_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{V_2} = 1.55 \cdot Hz$$

$f_{V_3} := 16 \cdot Hz \qquad A_{V_3} := A_{V_2} \qquad A_{V_3} = 1.25 \cdot g$

$f_{V_4} := 33 \cdot Hz \qquad A_{V_4} := 2 \cdot Ap_{k.v} \qquad A_{V_4} = 0.5 \cdot g$

$f_{V_5} := 33 \cdot Hz \qquad A_{V_5} := Ap_{k.v} \qquad A_{V_5} = 0.25 \cdot g$

$f_{V_6} := 100 \cdot Hz \qquad A_{V_6} := Ap_{k.v} \qquad A_{V_6} = 0.25 \cdot g$

Truncated Vertical Required Response Spectra (SSE 5% Damping):

$f_{TV_1} := 1Hz \qquad A_{TV_1} := b \qquad A_{TV_1} := 0.45 \cdot g$

Since the skid frame is rigid in the vertical direction the first natural frequency is conservatively taken as 33 Hz. The acceleration value for 90% of the first natural frequency of the skid frame is computed as follows:

$f_{TV_2} := .9 \cdot 33Hz \qquad f_{TV_2} = 29.7 \cdot Hz$

Conservatively using linear Interpolation between the 16 Hz and 33 Hz values of the non-truncated RRS for 18.9 Hz (comparing slope of line on sheet A38 with that on sheet A39shows this to be conservative):

$$A_{TV_2} := A_{V_4} + \frac{f_{V_4} - f_{TV_2}}{f_{V_4} - f_{V_3}} \cdot \left(A_{V_3} - A_{V_4}\right)$$

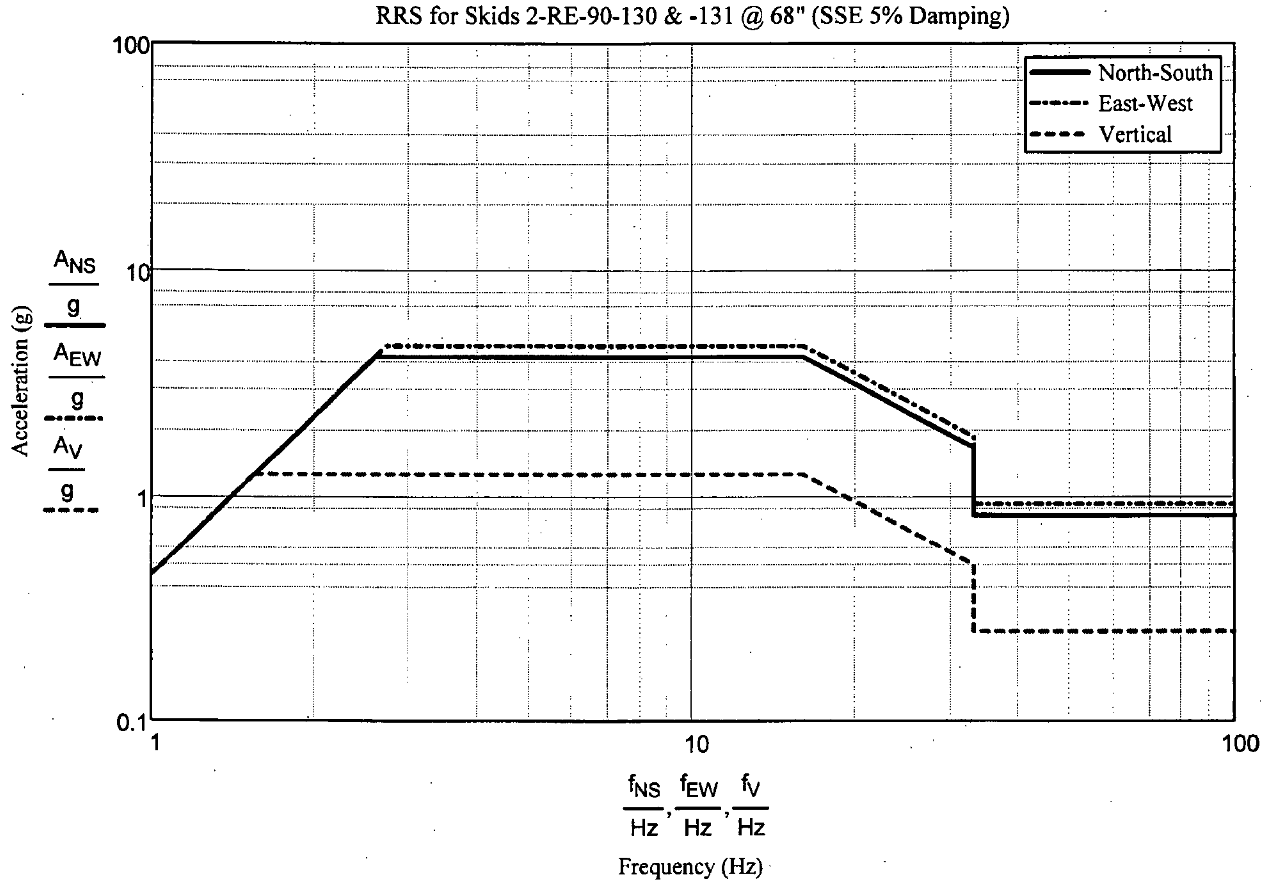
$A_{TV_2} = 0.646 \cdot g$

The truncated RRS between 90% of the first natural frequency of the skid frame and the ZPA is the same as the non-truncated RRS as follows:

$f_{TV_3} := 33 \cdot Hz$ $\quad A_{TV_3} := 2 \cdot Ap_{k.v}$ $\quad A_{TV_3} = 0.5 \cdot g$

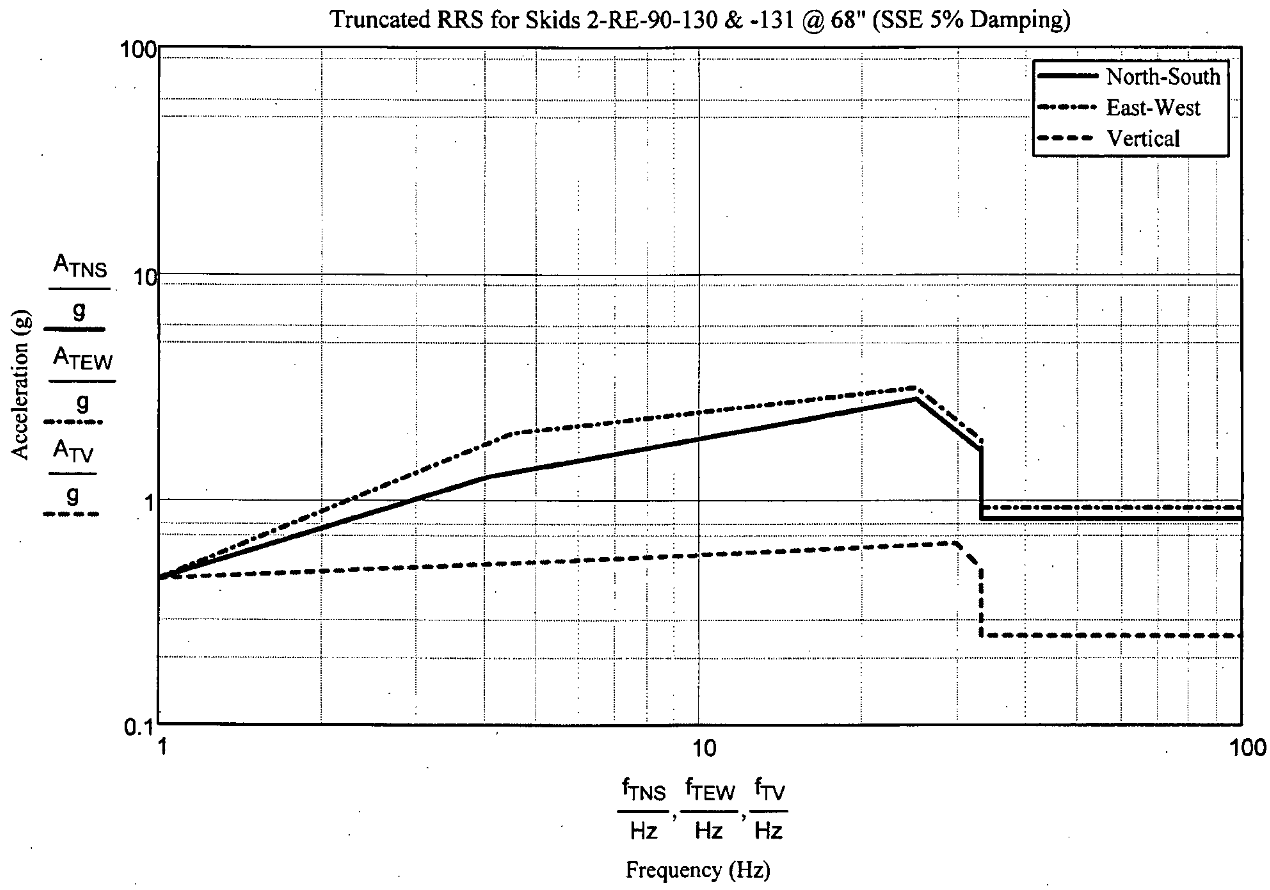
$f_{TV_4} := 33 \cdot Hz$ $\quad A_{TV_4} := Ap_{k.v}$ $\quad A_{TV_4} = 0.25 \cdot g$

$f_{TV_5} := 100 \cdot Hz$ $\quad A_{TV_5} := Ap_{k.v}$ $\quad A_{TV_5} = 0.25 \cdot g$



North-South		East-West		Vertical	
f (Hz)	a (g)	f (Hz)	a (g)	f (Hz)	a (g)
1.0	0.45	1.0	0.45	1.0	0.45
2.6	4.13	2.7	4.62	1.6	1.25
16.0	4.13	16.0	4.62	16.0	1.25
33.0	1.65	33.0	1.85	33.0	0.50
33.0	0.83	33.0	0.93	33.0	0.25
100.0	0.83	100.0	0.93	100.0	0.25

For Skid 2-RE-90-130, North-South is side to side and East-West is front to back.
For Skid 2-RE-90-131, North-South is front to back and East-west is side to side.



North-South		East-West		Vertical	
f (Hz)	a (g)	f (Hz)	a (g)	f (Hz)	a (g)
1.0	0.45	1.0	0.45	1.0	0.45
4.1	1.27	4.5	1.98	29.7	0.65
25.1	2.80	25.1	3.14	33.0	0.50
33.0	1.65	33.0	1.85	33.0	0.25
33.0	0.83	33.0	0.93	100.0	0.25
100.0	0.83	100.0	0.93		

For Skid 2-RE-90-130, North-South is side to side and East-West is front to back.
For Skid 2-RE-90-131, North-South is front to back and East-west is side to side.

According to Section 4.3.1 of Ref. 2.5, the OBE Required Response Spectra (RRS) will be developed using 70% of SSE levels:

N-S Required Response Spectra (OBE 5% Damping):

$$Ap_{k.NS} := 0.70\sqrt{(1.6 \cdot S \cdot Ap_{k.1.NS})^2 + (1.0 \cdot S \cdot Ap_{k.2.NS})^2 + A_{zpa.k.NS}{}^2}$$

$$Ap_{k.NS} = 0.577 \cdot g$$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{NS_1} := 1 \cdot Hz$ $A_{NS_1} := b$ $A_{NS_1} = 0.45 \cdot g$

$A_{NS_2} := 5 \cdot Ap_{k.NS}$ $A_{NS_2} = 2.887 \cdot g$

$$f_{NS_2} := \left(\frac{A_{NS_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{NS_2} = 2.22 \cdot Hz$$

$f_{NS_3} := 16 \cdot Hz$ $A_{NS_3} := A_{NS_2}$ $A_{NS_3} = 2.887 \cdot g$

$f_{NS_4} := 33 \cdot Hz$ $A_{NS_4} := 2 \cdot Ap_{k.NS}$ $A_{NS_4} = 1.155 \cdot g$

$f_{NS_5} := 33 \cdot Hz$ $A_{NS_5} := Ap_{k.NS}$ $A_{NS_5} = 0.577 \cdot g$

$f_{NS_6} := 100 \cdot Hz$ $A_{NS_6} := Ap_{k.NS}$ $A_{NS_6} = 0.577 \cdot g$

E-W Required Response Spectra (OBE 5% Damping):

$$Ap_{k.EW} := 0.70 \cdot \sqrt{(1.6 \cdot S \cdot Ap_{k.1.EW})^2 + (1.0 \cdot S \cdot Ap_{k.2.EW})^2 + A_{zpa.k.EW}{}^2}$$

$$Ap_{k.EW} = 0.647 \cdot g$$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{EW_1} := 1 \cdot Hz$ $A_{EW_1} := b$ $A_{EW_1} = 0.45 \cdot g$

$A_{EW_2} := 5 \cdot Ap_{k.EW}$ $A_{EW_2} = 3.236 \cdot g$

$$f_{EW_2} := \left(\frac{A_{EW_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{EW_2} = 2.331 \cdot Hz$$

$f_{EW_3} := 16 \cdot Hz$ $A_{EW_3} := A_{EW_2}$ $A_{EW_3} = 3.236 \cdot g$

$f_{EW_4} := 33 \cdot Hz$ $A_{EW_4} := 2 \cdot Ap_{k.EW}$ $A_{EW_4} = 1.294 \cdot g$

$f_{EW_5} := 33 \cdot Hz$ $A_{EW_5} := Ap_{k.EW}$ $A_{EW_5} = 0.647 \cdot g$

$f_{EW_6} := 100 \cdot Hz$ $A_{EW_6} := Ap_{k.EW}$ $A_{EW_6} = 0.647 \cdot g$

Vertical Required Response Spectra (OBE 5% Damping):

$Ap_{k.v} := 0.70 \cdot A_{zpa.k.V}$ $Ap_{k.v} = 0.175 \cdot g$

From Page 33 of Ref. 2.4, $m := 2.3314$ $b := 0.45 \cdot g$

$f_{V_1} := 1 \cdot Hz$ $A_{V_1} := b$ $A_{V_1} = 0.45 \cdot g$

$A_{V_2} := 5 \cdot Ap_{k.v}$ $A_{V_2} = 0.875 \cdot g$

$$f_{V_2} := \left(\frac{A_{V_2}}{b}\right)^{\frac{1}{m}} \cdot Hz \qquad f_{V_2} = 1.33 \cdot Hz$$

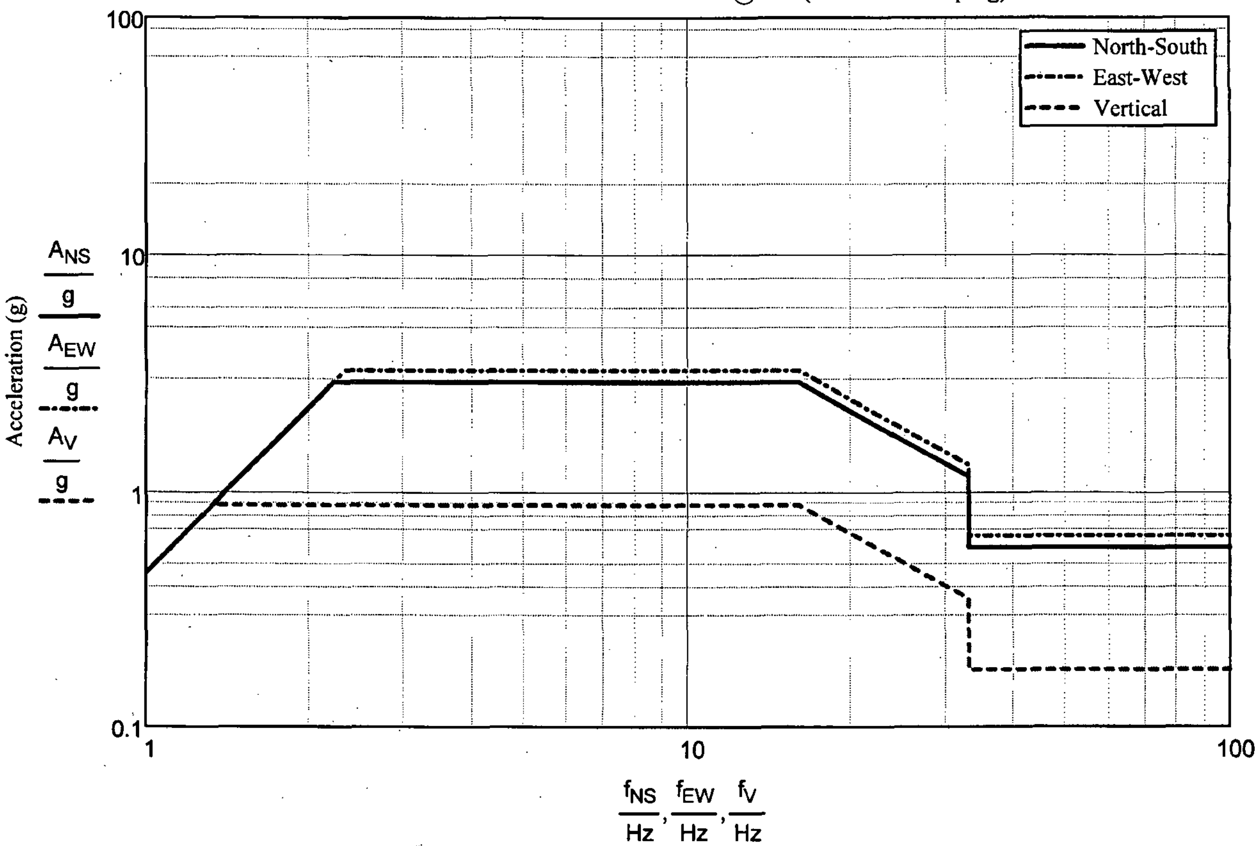
$f_{V_3} := 16 \cdot Hz$ $A_{V_3} := A_{V_2}$ $A_{V_3} = 0.875 \cdot g$

$f_{V_4} := 33 \cdot Hz$ $A_{V_4} := 2 \cdot Ap_{k.v}$ $A_{V_4} = 0.35 \cdot g$

$f_{V_5} := 33 \cdot Hz$ $A_{V_5} := Ap_{k.v}$ $A_{V_5} = 0.175 \cdot g$

$f_{V_6} := 100 \cdot Hz$ $A_{V_6} := Ap_{k.v}$ $A_{V_6} = 0.175 \cdot g$

RRS for Skids 2-RE-90-130 & -131 @ 68" (OBE 5% Damping)



North-South		East-West		Vertical	
f (Hz)	a (g)	f (Hz)	a (g)	f (Hz)	a (g)
1.0	0.45	1.0	0.45	1.0	0.45
2.2	2.89	2.3	3.24	1.3	0.88
16.0	2.89	16.0	3.24	16.0	0.88
33.0	1.16	33.0	1.29	33.0	0.35
33.0	0.58	33.0	0.65	33.0	0.18
100.0	0.58	100.0	0.65	100.0	0.18

8.0 Conclusion:

The above curves are the required response spectra for the safety related radiation monitoring equipment to be installed on WBN Unit 2 MCR Panels 2-M-30 (provided with Rev. 0 of this calc.), 0-M-12 and skids for WBN-2-RE-090-0106, WBN-2-RE-090-0112, WBN-2-RE-090-0130 and WBN-2-RE-090-0131. These RRS curves can be used for comparison to vendor seismic test reports for qualification of the WBN Unit 2 safety related Radiation Monitoring equipment.

Calculation Sheet		Project	WBN2CCP
Subject: REQUIRED RESPONSE SPECTRA FOR EVALUATION OF RADIATION MONITORING EQUIPMENT		Job No.	25402
		Calc. No.	WCGACQ0766
		Sheet No.	1 of 1
Prepared: SEE COVER SHEET	Date	Sheet Rev.	This Sheet Replaced By 001
Checked: SEE COVER SHEET	Date		

REFERENCES

12.0 ATTACHMENTS

ATTACHMENT TABLE OF CONTENTS

TOTAL No. OF ATTACHMENT PAGES 14

BECHTEL

DRAWING REVISION AUTHORIZATION (DRA)

EDCR NUMBER 52338-A

PAGE 140

DRA NUMBER 52338-005

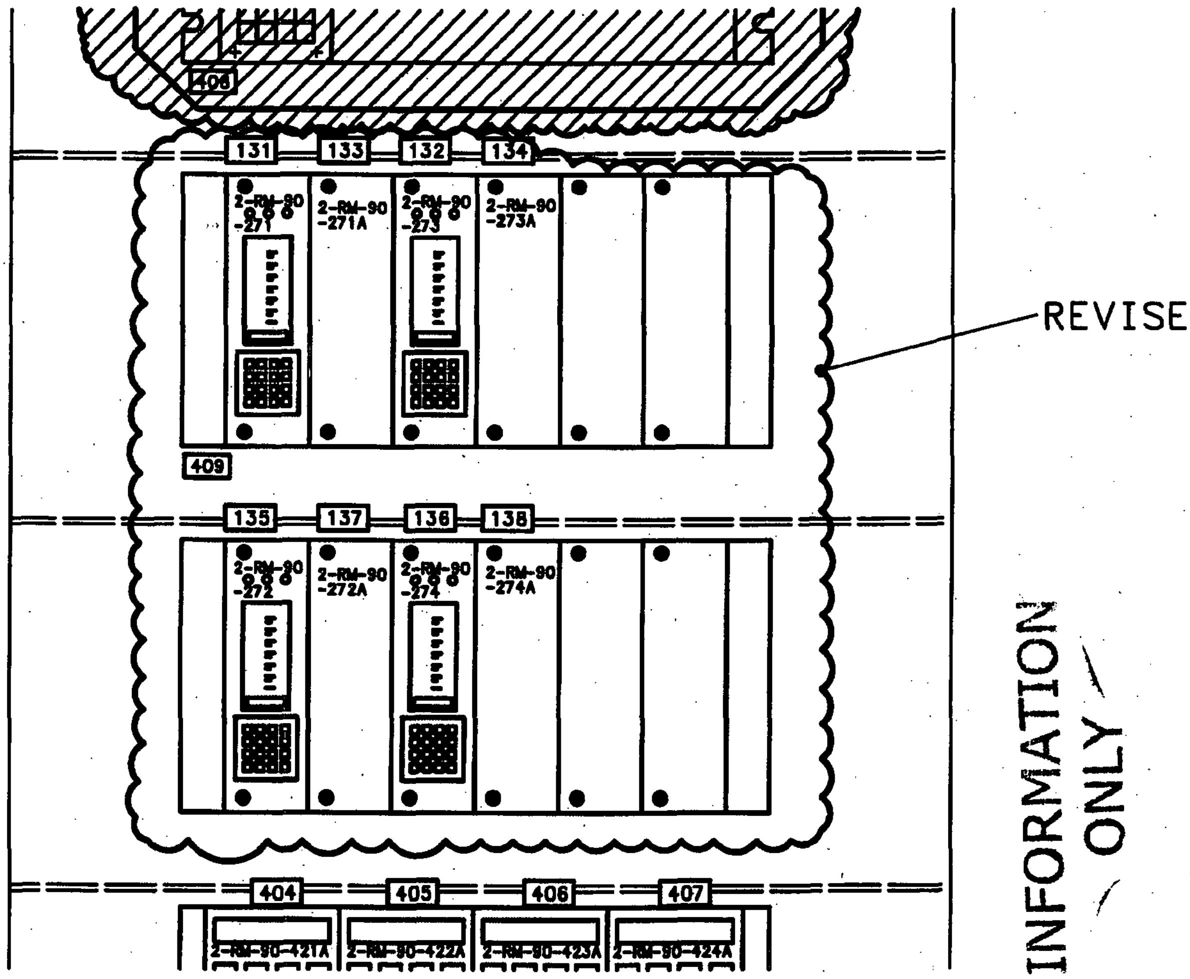
PAGE 1 OF 1

JOB NO.	DWG TYPE	DRAWING NUMBER	REV. NO.	DWG TITLE & CATEGORY (NEW DWGS ONLY)
25402	CC	2-47W605-156	0	Attachment No. A Sheet 1 ~~Of~~ EHA 4/5/11 Calculation No. WCG-ACQ-0766 Rev.000

OTHER DOCUMENTS AFFECTED BY THIS CHANGE

SEE EDCR INDEX

DESCRIPTION OF CHANGE



INFORMATION ONLY

NOTE TO DRAFTER: (DO NOT INCORPORATE)
DRA 52374-12 IS A PREDECESSOR DRA.

REV	PREPARED BY / DATE	CHECKED BY / DATE	CHANGE REFERENCE
0	David V. Shf DAVID W. SEIFER 4-14-10	Joe Temples JoeT. Temples 4/14/10	EDCR 52338-A

25402-3DP-G04G-00046-006

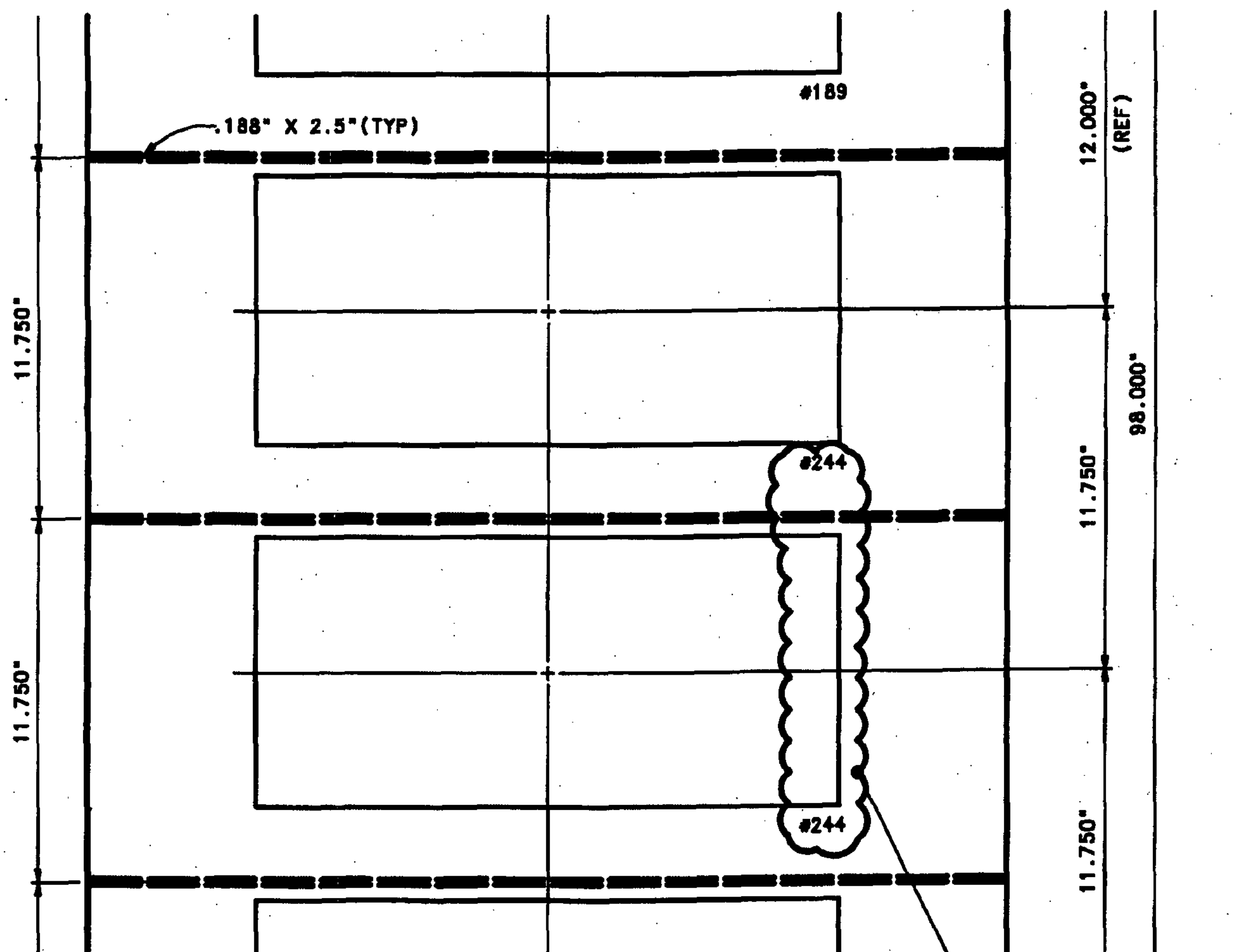
BECHTEL	# DRAWING REVISION AUTHORIZATION (DRA)	EDCR NUMBER 52338-A PAGE 172 DRA NUMBER 52338-038 PAGE 1 OF 1

JOB NO.	DWG TYPE	DRAWING NUMBER	REV. NO.	DWG TITLE & CATEGORY (NEW DWGS ONLY)
25402	CC	2-47W605-157	0	Attachment No. A Sheet 2 ~~Of~~ EHM 4/15/10 Calculation No. WCG-ACQ-0766 Rev.000

OTHER DOCUMENTS AFFECTED BY THIS CHANGE

SEE EDCR INDEX

DESCRIPTION OF CHANGE



CONSTRUCTION NOTE: (DO NOT INCORPORATE)
-DRA 52374-13 IS A PREDECESSOR DRA.
-INSTALL GENERAL ATOMIC NIM BIN FROM CONTRACT 77448 INTO 2-M-30 USING TYPICAL CUTOUT 2-47A605-244.

INFORMATION ONLY

REV	PREPARED BY / DATE	CHECKED BY / DATE	CHANGE REFERENCE
0	David W. Slifer 4-14-10 DAVID W. SLIFER	Joe Temples 4/14/10 Joe T. Templin	EDCR 52338-A

25402-3DP-G04G-00048-008

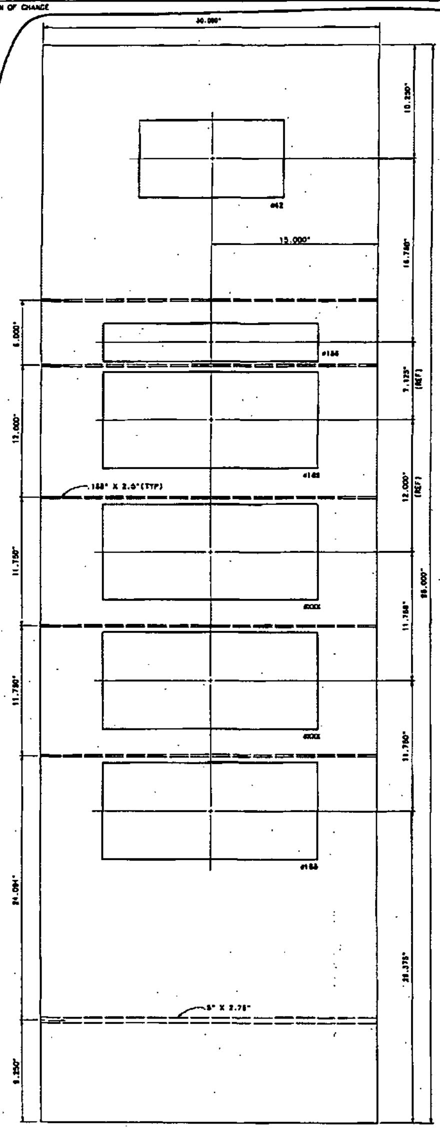
General Atomics Electronic Systems Drawing

04034100, Revision C, Outline High Range Area Monitor System

EDCR No. [illegible]
Page 26

		JOB NUMBER	
BECHTEL	DRAWING REVISION AUTHORIZATION (DRA)	25402	PAGE 1 OF 1 DRA [illegible]52374-13 REV. 0

DESCRIPTION OF CHANGE



PANEL 2-M-30

NOTES:
1. ALL DIMENSIONS ARE ± 1/16" (.063).
2. FOR COMPONENT DETAIL AND CUTOUT SIZE SEE 47A605-DWG AS NOTED.

COMPONENT	NUMBER
42	47A605-42
70	47A605-XXX
166	47A605-166
186	47A605-186
189	47A605-188

3. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.
4. DRAWING IS TO 1/4"=1" SCALE.

Attachment No. A
Sheet 4 ~~of~~ EHM 4/5/11
Calculation No. WCG-ACQ-0766
Rev ~~0~~ 0

EDCR 52374

INFORMATION ONLY

COMPANION DWGS:
0-47W605-1 ------- GENERAL NOTES AND REFERENCES
2-47W605-136------ ELECTRICAL LAYOUT OF CONTROL BOARD 2-M-30
47A605-SERIES --- INSTRUMENT DETAIL AND PANEL CUTOUT
2-47W605-183 ---- NAMEPLATE TABULATION DRAWING

REV	PREPARED BY / DATE	CHECKED BY / DATE	CHANGE REFERENCE
0	[signature] 5-24-?	[signature] 5/24/??	EDCR #52374

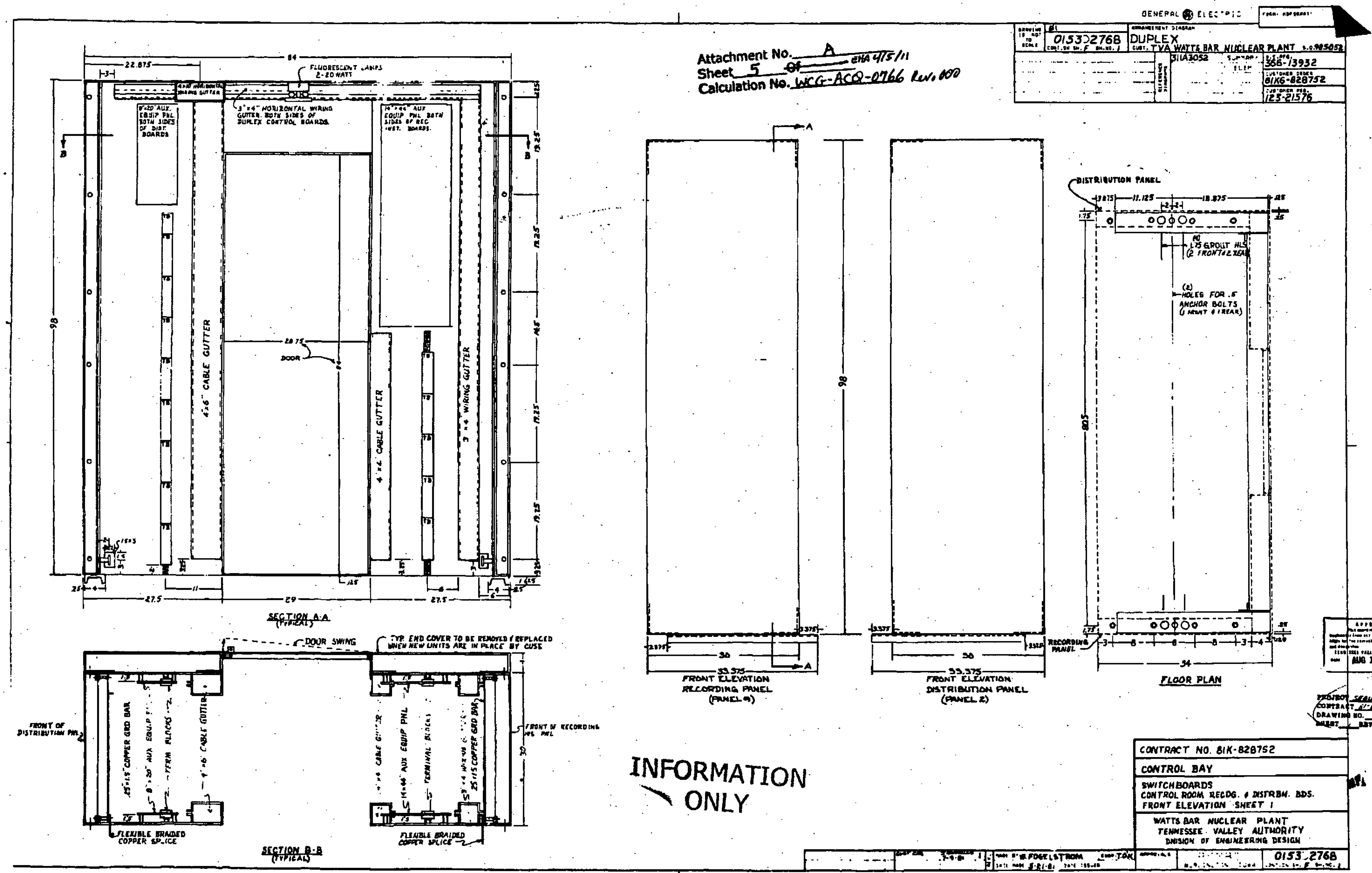
DRAWING TITLE & CATEGORY (NEW DWGS ONLY)
ELECTRIC PANEL CUTOUT ORIENTATION
PANEL 2-M-30

DWG TYPE	DRAWING NUMBER	REV NO.	CAT NO.
CC	2-47W605-157 (CI)	0	4-2

OTHER DOCUMENTS AFFECTED BY THIS CHANGE
SEE EDCR #52374 INDEX SHEET

CAD MAINTAINED DRAWING

Attachment No. A EHA 4/5/11
Sheet 5 Of
Calculation No. WCG-ACQ-0766 Rev. 000



INFORMATION ONLY

LSWD-536

LIMITED SCOPE WALKDOWN PACKAGE COVER SHEET
Attachment E2 Page 1 of 1

PACKAGE NUMBER **LSWD - 536**

This Sheet Added By Rev. 001

REVISION 0

TITLE Verify dimensions of Panel 0-M-12 for CALC WCGACQ-0766.

SCOPING DOCUMENT (IF APPLICABLE) N/A

Attachment No. B
Sheet 1 ~~Of~~ RFB 1/6/12
Calculation No. WCGACQ 0766

PREPARED BY 12/22/2011
Timothy R Belk

APPROVALS/ REVIEW 12/22/11
Robert G Brown

RESPONSIBLE ORGANIZATION SUPERVISOR
Bill C Perkins

LEGIBILITY EVALUATED AND ALL PAGES ACCEPTED FOR ISSUE REV. 0
Initials: TRB Date: 12/22/11

Timothy R Belk 12/22/2011
WALKDOWN TEAM LEADER
(Verifier)

LIMITED SCOPE WALKDOWN REQUEST AND DATA COLLECTING FORM
Attachment E1 PAGE 1 OF 2

INITIATING DOCUMENT WCGACQ-0766

LOCATION (Unit, Building, Elevation, Room, Column Lines)
UNIT 0, CONTROL BLDG, EL.-755',
CONTROL ROOM, 6'Nof P & 12' W of C6.

This Sheet Added By
Rev. 001

SCOPE Engineering Walkdown for actual dimension to top of 2-RM-90-106 -NIM BIN on Front Face of Panel 0-M-12 in Main Control Room for CIVIL Calculation WCGACQ-0766

Attachment No. B
Sheet 2 ~~of~~ RGB 1/6/12
Calculation No. WCGACQ 0766

DATA TOLERANCE REQUIREMENTS Current Design Criteria

Robert G Brown

NAME / SIGNATURE

BECHTEL CIVIL ESQ

REQUESTING ORGANIZATION

12/22/11

DATE

LSWD-536

LIMITED SCOPE WALKDOWN REQUEST AND DATA COLLECTING FORM
Attachment E1 PAGE 2 OF 2

PERFORMING ORGANIZATION BECHTEL CIVIL DESIGN

RESULTS See attached DATA Sheets

This Sheet Added By
Rev. 001

Attachment No. B
Sheet 3 ~~Of~~ 12GB 1/6/12
Calculation No. WCGACQ 0766

Timothy R. Beck
WALKDOWN TEAM MEMBER SIGNATURE 12/22/2011 DATE

Javier Burgoa
WALKDOWN TEAM LEADER (Verifier) SIGNATURE 12/22/11 DATE

Attachment C7

WP No. LSWD- 536 Rev. 0 Page 4 of 8

Unit 1/Unit 0 Operations Review

Circle item number(s) below that apply and obtain appropriate signatures.

This Sheet Added By
Rev. 001

Attachment No. B
Sheet 4 ~~Of~~ RGB 1/6/12
Calculation No. WCGACQ0766

A. Walkdown Package requires Critical Evolutions review.

1. Unit 1/Unit 0 component with risk of Unit 1 reactor/turbine trip/ OR ESF ACTUATION.
2. Unit 1/Unit 0 component with risk of Unit 1 runback.
3. Other ____

B. Walkdown requires coordination with Unit 1and 2 Operations Department.

1. U2 equipment energized for U1 operation.
2. Personnel required in Unit 1/Unit 0 area other than normal egress.
3. Close proximity to electrical boards, panels, or components that could cause a Unit 1 Alarm condition or perturbation.
4. Unit 1/Unit 0 component in train/channel room outside normal work week.
5. Other U2 Aux support

C. Walk down requires Unit 2 Operations Department review only ____

1. Unit 2 de-energized mechanical equipment in Unit 2 space
2. Unit 2 de-energized electrical equipment in Unit 2 space with no nearby Unit 1/Unit 0 electrical equipment.
3. Other ____

Unit 2 Operations Review N/A WCS 12-22-11 Date ____

Unit 1 Operations Coordination [signature] Date 12/22/11

Critical Evolutions Review N/A WCS 12-22-11 Date ____

WDP-GEN-1
Appendix C
Attachment C2
Walkdown Package Record of Revision

WP NO. LSWD 536 Rev _ Page 5 of 8

SCOPE OR TITLE OF WALKDOWN PACKAGE

DESCRIPTION: VERIFY DIMENSIONS ON PANEL 0-M-12

Revision No.	Date	Description of Revision
0	12/22/11	INITIAL ISSUE

This Sheet Added By
Rev. 001

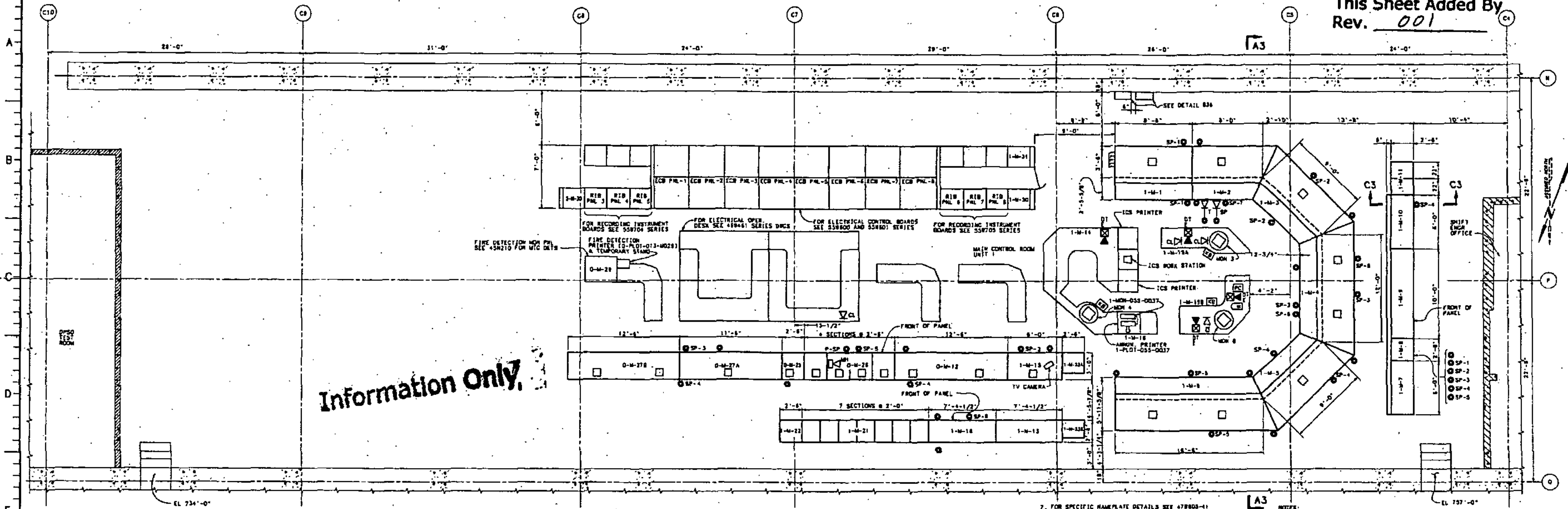
Attachment No. B
Sheet 5 ~~Of~~ RGB 1/16/12
Calculation No. WCGACQ0766

ZSWD-536

PAGE 6 OF 8

This Sheet Added By Rev. 001

Information Only



PLAN EL 755'-0"

NTS

DRAWING REFERENCE CHART

47W605 DRAWING SHEET NO.	TYPE OF DRAWING	47W605 DRAWING SHEET NO.	TYPE OF DRAWING	47W605 DRAWING SHEET NO.	TYPE OF DRAWING	47W605 DRAWING SHEET NO.	TYPE OF DRAWING	47W605 DRAWING SHEET NO.	TYPE OF DRAWING
01	GENERAL LAYOUTS & NOTES	41	NAMEPLATE DETAILS	81	CIVIL PNL 1-M-9, 0-M-27A&B	121	NAMEPLATE PNL 1-M-4	161	CUTOUT PNL 1-M-31
02	AUX INST RM LAYOUT	42	NAMEPLATE DETAILS	82	CIVIL PNL 1-M-3 & 4	122	NAMEPLATE PNL 1-M-4	162	FRONTVIEW PNL 0-M-25
03	TYPICAL MOUNTING	43	NAMEPLATE DETAILS	83	CIVIL PNL 1-M-3 & 4	123	VOID	163	CUTOUT PNL 0-M-25
04	VOID	44	NAMEPLATE DETAILS	84	NAMEPLATE PNL 0-L-4	124	NAMEPLATE PNL 1-M-3	164	NAMEPLATE PNL 0-M-25
05	VOID	45	NAMEPLATE DETAILS	85	NAMEPLATE PNL 0-L-4	125	NAMEPLATE PNL 1-M-3	165	NAMEPLATE PNL 1-M-1
06	VOID	46	NAMEPLATE DETAILS	86	NAMEPLATE PNL 0-L-4	126	NAMEPLATE PNL 1-M-3	166	NAMEPLATE PNL 0-M-12
07	VOID	47	NAMEPLATE DETAILS	87	NAMEPLATE PNL 0-L-4	127	VOID	167	ANN HORN & CHIME DETAILS
08	VOID	48	NAMEPLATE DETAILS	88	NAMEPLATE PNL 0-L-4	128	NAMEPLATE PNL 1-L-10	168	NAMEPLATE PNL 1-M-3
09	VOID	49	NAMEPLATE DETAILS	89	NAMEPLATE PNL 1-M-11	129	NAMEPLATE PNL 1-L-10	169	NAMEPLATE ANNUNCIATORS
10	VOID	50	FRONTVIEW PNL 1-M-1	90	NAMEPLATE PNL 1-M-11	130	NAMEPLATE PNL 1-L-10	170	NAMEPLATE PNL 0-M-26
11	VOID	51	FRONTVIEW PNL 1-M-2	91	NAMEPLATE PNL 0-M-26	131	NAMEPLATE PNL 1-L-10	171	TB LOCATION PANEL 1-M-11
12	VOID	52	FRONTVIEW PNL 1-M-3	92	NAMEPLATE PNL 0-M-26	132	NAMEPLATE PNL 1-M-6	172	FRONTVIEW PNL 1-M-23A
13	VOID	53	FRONTVIEW PNL 1-M-4	93	NAMEPLATE PNL 0-M-26	133	NAMEPLATE PNL 1-M-6	173	CUTOUT PNL 1-M-23A
14	VOID	54	FRONTVIEW PNL 1-M-6	94	NAMEPLATE PNL 0-M-26	134	NAMEPLATE PNL 1-M-6	174	INTERNALS PNL 1-M-23A
15	VOID	55	FRONTVIEW PNL 1-M-6	95	NAMEPLATE PNL 0-M-26	135	VOID	175	ANN DEMARCATION
16	VOID	56	FRONTVIEW PNL 1-M-18	96	NAMEPLATE PNL 0-M-27B	136	NAMEPLATE PNL 1-M-6	176	NAMEPLATE ANN. DEMAR.
17	VOID	57	FRONTVIEW PNL 1-M-11	97	NAMEPLATE PNL 0-M-27B	137	NAMEPLATE PNL 1-M-6	177	ANN STATUS LIGHT BOXES
18	FRONTVIEW PNLS 1-M-7 & 8	58	FRONTVIEW PNL 1-M-10	98	NAMEPLATE PNL 0-M-27B	138	NAMEPLATE PNL 1-M-8	178	HANDSWITCH DETAILS
19	FRONTVIEW PNL 0-M-26	59	FRONTVIEW PNL 1-M-5	99	NAMEPLATE PNL 0-M-27B	139	NAMEPLATE PNL 1-M-15	179	ANN GRID SYSTEM
20	NAMEPLATE PNL 1-M-8	60	CUTOUT PNL 1-M-9	100	NAMEPLATE PNL 0-M-27B	140	NAMEPLATE PNL 1-M-15	180	PNL 1-M-15 BUZZER
21	VOID	61	CUTOUT PNL 0-M-27A	101	NAMEPLATE PNL 0-M-27B	141	NAMEPLATE PNL 1-M-2		
22	VOID	62	CUTOUT PNL 0-M-27B	102	NAMEPLATE PNL 0-M-27A	142	NAMEPLATE PNL 1-M-2		
23	FRONTVIEW PNL 0-M-27A	63	CUTOUT PNL 1-M-11	103	NAMEPLATE PNL 0-M-27A	143	NAMEPLATE PNL 1-M-2	229	NAMEPLATE PANEL 1-M-7
24	VOID	64	CUTOUT PNL 1-M-15	104	NAMEPLATE PNL 0-M-27A	144	NAMEPLATE PNL 1-M-1		
25	FRONTVIEW PNL 0-M-27B	65	CUTOUT PNL 1-L-10	105	NAMEPLATE PNL 0-M-27A	145	NAMEPLATE PNL 1-M-1		
26	VOID	66	CUTOUT PNL 1-M-10	106	NAMEPLATE PNL 0-M-27A	146	NAMEPLATE PNL 1-M-1	236	FRONTVIEW PNL 1-M-18
27	VOID	67	CUTOUT PNL 0-L-4	107	NAMEPLATE PNL 0-M-12	147	NAMEPLATE PNL 1-M-1	237	NAMEPLATE PNL 1-M-18
28	FRONTVIEW PNL 0-M-12	68	CUTOUT PNL 0-M-26	108	NAMEPLATE PNL 0-M-12	148	NAMEPLATE PNL 1-M-5	238	FRONTVIEW PNL 1-M-14, 19A, 19B & 0-M-29
29	VOID	69	CUTOUT PNL 1-M-1	109	NAMEPLATE PNL 0-M-12	149	NAMEPLATE PNL 1-M-5	239	NAMEPLATE PNL 1-M-14, 19A, 19B & 0-M-29
30	FRONTVIEW PNL 2-M-15	70	CUTOUT PNL 1-M-2	110	NAMEPLATE PNL 1-M-9	150	CUTOUT DETAILS PNL 1-M-3A&B	240	FRONTVIEW PNL 1-M-13
31	NAMEPLATE PNL 2-M-15	71	CUTOUT PNL 1-M-3	111	NAMEPLATE PNL 1-M-9	151	NAMEPLATE PNL 1-M-5	241	NAMEPLATE PANEL 1-M-13
32	FRONTVIEW PNL 1-M-3	72	CUTOUT PNL 1-M-4	112	NAMEPLATE PNL 1-M-9	152	NAMEPLATE PNL 1-M-5	242	ELEC TECH SPEC COMPLIANCE TABLES
33	VOID	73	CUTOUT PNL 1-M-5	113	NAMEPLATE PNL 1-M-9	153	NAMEPLATE PNL 1-M-30	243	ELEC TECH SPEC COMPLIANCE TABLES
34	VOID	74	CUTOUT PNL 1-M-6	114	NAMEPLATE PNL 1-M-9	154	NAMEPLATE PNL 1-M-31		
35	FRONTVIEW PNL 2-M-9	75	CUTOUT PNL 1-M-8	115	NAMEPLATE PNL 1-M-9	155	NAMEPLATE PNL 2-M-31		
36	TYPICAL MOUNTING	76	CUTOUT PNL 1-M-12	116	NAMEPLATE PNL 1-M-10	156	FRONTVIEW PNL 1-M-30		
37	VOID	77	CUTOUT PNL 1-M-30	117	NAMEPLATE PNL 1-M-4	157	CUTOUT PNL 1-M-30		
38	VOID	78	CUTOUT PNL 1-M-9	118	NAMEPLATE PNL 1-M-4	158	FRONTVIEW PNL 2-M-31		
39	CONTROLLER DETAILS	79	CUTOUT PNL 0-M-27A	119	NAMEPLATE PNL 1-M-4	159	CUTOUT PNL 2-M-31		
40	VOID	80	CUTOUT PNL 0-M-27B	120	NAMEPLATE PNL 1-M-4	160	FRONTVIEW PNL 1-M-31		

DRAWING SYMBOLS:

- Y-SP ---- SOUND POWERED TEL JACK FOR DIESEL GEN BLDG C
- -------- PAX TELEPHONE JACK
- SP-1 ---- SOUND POWERED TEL JACK FOR TURB CONTROL, GEN & AUX POWER SYSTEM
- SP-2 ---- SOUND POWERED TEL JACK FOR FEEDWATER, STEAM, & CONDENSATE SYSTEM
- SP-3 ---- SOUND POWERED TEL JACK FOR REACTOR CONTROL SYSTEM
- SP-4 ---- SOUND POWERED TEL JACK FOR REACTOR COOLANT SYS & AUX STEAM
- SP-5 ---- SOUND POWERED TEL JACK FOR ENGINEERED SAFEGUARDS & AUX SYSTEM
- SP-6 ---- SOUND POWERED TEL JACK FOR REFUELING
- SP-7 ---- SOUND POWERED TEL JACK FOR EHC MONITORING
- T --- TELEPHONE, TEST
- SP --- TELEPHONE SOUND POWER
- D.T / E ----- TELEPHONE, DESK, TOUCH TONE, ELECTRONIC SET
- CL ----- TELEPHONE, DESK, TOUCH TONE, CORDLESS
- TTY ----- TELETYPE JACK
- R ------ RADIO REMOTE CONTROL DESK SET
- -------- SMOKE DETECTOR MOUNTED BELOW PANEL EXHAUST FANS
- KB ------ KEYBOARD
- PC ------ PAGING CONTROL HANDSET
- MH ------ MAGNETO HOWLER
- O ------- PYR-A-LARM REMOTE ALARM LAMP PYROTRONICS

NOTES:

1. DESCRIPTION IS INCLUDED FOR GENERAL INFORMATION ONLY. ACTUAL NOMENCLATURE AND ENGRAVING SHALL BE PER RESPECTIVE 47W605 SERIES DRAWINGS.
2. FOR ANNUNCIATOR WINDOW DESIGNATIONS AND LEGENDS SEE TVA DRAWING 47W601-55-SERIES.
3. FOR SMOKE DETECTOR LOCATION SEE 47W816-2.
4. FOR THE STRL DETAILS OF M-19A & B SEE YORK ELECTRO - PANEL CONTROL CO. INC. DRAWING E-7080, SHEETS 1, 2 AND 3 ON TVA CONTRACT 85PJ2-838372.
5. DRAWING SYMBOLS ARE SPECIFIC TO THIS DRAWING ONLY.
6. FOR SPECIFIC COMPONENT CUTOUT DETAILS SEE 47A605 SERIES DRAWINGS.
7. FOR SPECIFIC NAMEPLATE DETAILS SEE 47W605-41 THRU 47W605-49 DRAWINGS.
8. FOR SPECIFIC CONTROLLER LABELING DETAILS SEE 47W605-39.
9. COMMUNICATIONS JACKS WILL BE INSTALLED BY TVA FIELD.
10. FOR CUTOUT DETAILS FOR PANELS M-7 & M-8 REFER TO WESTINGHOUSE COMPANY TRANSMITTED BINDERS ISSUED WITH PANEL DRAWINGS.
11. SEE DRAWING REFERENCE CHART FOR SPECIFIC DRAWINGS -VS- PANEL INFORMATION.
12. FOR MAIN CONTROL ROOM RED CARPET AREAS SEE DRAWING 46W402-2.
13. FOR WORK STATION DIMENSIONS, SEE DRAWING 46W481-8 THRU -16.
14. THE FOLLOWING ITEMS MOUNTED OR LOCATED IN THE MAIN CONTROL ROOM HAVE STYLE 45B NAMEPLATES (REFERENCE DRAWING 47W605-43) WITH ONLY THE UNID FROM MEL ENGRAVED:
    1-RCPT-261-0001, 1-RCPT-261-0114, 1-RCPT-261-0115,
    1-RCPT-261-0117, 1-CONS-264-0002, 1-CONS-261-0005,
    1-HORN-261-0001, 1-PLOT-261-0014, 1-PLOT-261-0016,
    1-MON-261-0003, 1-CPU-264-0003, 1-MON-264-0004,
    1-CPU-264-0004, 1-MON-264-0005, 1-CPU-264-0005,
    1-MON-264-0003, 1-CPU-264-0006, 1-MON-261-0013,
    1-CPU-261-0015, 1-RCPT-261-0200, 1-MON-055-0037,
    1-CPU-055-0037, 1-FCP-261-0021 & 1-HM-261-0031.
15. THE FOLLOWING ITEMS MOUNTED OR LOCATED IN THE MAIN CONTROL ROOM HAVE STYLE 23C NAMEPLATES (REFERENCE DRAWING 47W605-42):
    1-XI-261-0002
    1-XI-261-0004
    1-XI-261-0006
    LINE 1 WILL INCLUDE THE UNID.
    LINE 2 WILL INCLUDE "ICS DIGITAL DISPLAY"
16. FOR ADDITIONAL INFORMATION ON 1-M-19A, -19B & 1-M-14, SEE DWG SERIES 46W481-8 THRU -16 AND CONTR. NO. 92NNA-75979A.

CONTROL PANEL NOMENCLATURE:

UNIT 1 PANEL NO.

- 1-M-1 --------- GENERATOR AND AUXILIARY POWER
- 1-M-2 --------- TURBINE CONTROL
- 1-M-3 --------- FEEDWATER STEAM, AND CONDENSATE
- 1-M-4 --------- REACTOR CONTROL
- 1-M-5 --------- REACTOR COOLANT SYSTEM AND AUXILIARY STEAM
- 1-M-6 --------- ENGINEERED SAFEGUARDS SYSTEMS & AUX SYSTEMS
- 1-M-7 --------- CIRCUIT BREAKERS
- 1-M-8 --------- TURBINE SUPERVISORY CONTROL
- 1-M-9 --------- VENTILATION, ICE CONTAINMENT, & REACTOR BLDG
- 1-M-10 -------- TEMPERATURE MONITORING
- 1-M-11 -------- GROSS FUEL FAILURE DETECTOR
- 1-M-13 -------- NEUTRON MONITORING
- 1-M-14 -------- ASOS WORK AREA
- 1-M-15 -------- UNIT WATER SERVICES
- 1-M-16 -------- ASOS WORK AREA/ICS CONSOLE (SPDS)
- 1-M-17 -------- FUTURE
- 1-M-18 -------- TRAVELING INCORE SYSTEM
- 1-M-19A ------- BOP WORK AREA/ICS CONSOLE (SPDS)
- 1-M-19B ------- LEAD OP. WORK AREA/ICS CONSOLE (SPDS)
- 1-M-21 -------- ANNUNCIATOR CABINET
- 1-M-22 -------- ANNUNCIATOR DEMULTIPLEXER
- 1-M-23A ------- UPPER HEAD INJECTION
- 1-M-23B ------- UPPER HEAD INJECTION
- 1-M-24 -------- LINE PRINTER
- 1-M-30 -------- POST ACCIDENT RADIATION MONITORING
- 1-M-31 -------- POST ACCIDENT RADIATION MONITORING
- 0-M-25 -------- ACOUSTIC MONITORING
- 0-M-26 -------- DIESEL GENERATOR CONTROL
- 0-M-27A ------- ESSENTIAL RAW COOLING WATER
- 0-M-27B ------- COMPONENT COOLING WATER
- 0-M-12 -------- RADIATION MONITORING AND RECORDING
- 0-M-29 -------- FIRE DETECTION MONITOR PANEL

* FOR ORIGINAL SIGNATURES, SEE RO MICROFILM COPY

COMPANION DRAWINGS: 47W605-2 THRU 47W605-41

ISSUED BY:

PRINTS REQ & #

Attachment No. B
Sheet 6 ~~Of~~ RGB116112
Calculation No. WCGACQ0766

REV	CHANGE REF	PREPARER	CHECKER	APPROVED	DATE
P	53410 ADMIN	RWE	GJB	JKa	DTS

REVISED PER DCA 53410-03-0 AND REVISED SCALE PER ADMIN.

SCALE: NTS EXCEPT AS NOTED

PROJECT FACILITY: CONTROL BUILDING UNITS 1 ~~& 2~~

UNIT 1 ONLY

TITLE

ELECTRICAL LAYOUT OF CONTROL BOARDS

WATTS BAR NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY

DESIGN: DRAFTER * CHECKER * DESIGNER * REVIEWER *
DISCIPLINE INTERFACE: C E M N
ENGINEERING APPROVAL: 1 * 2 * 3 *

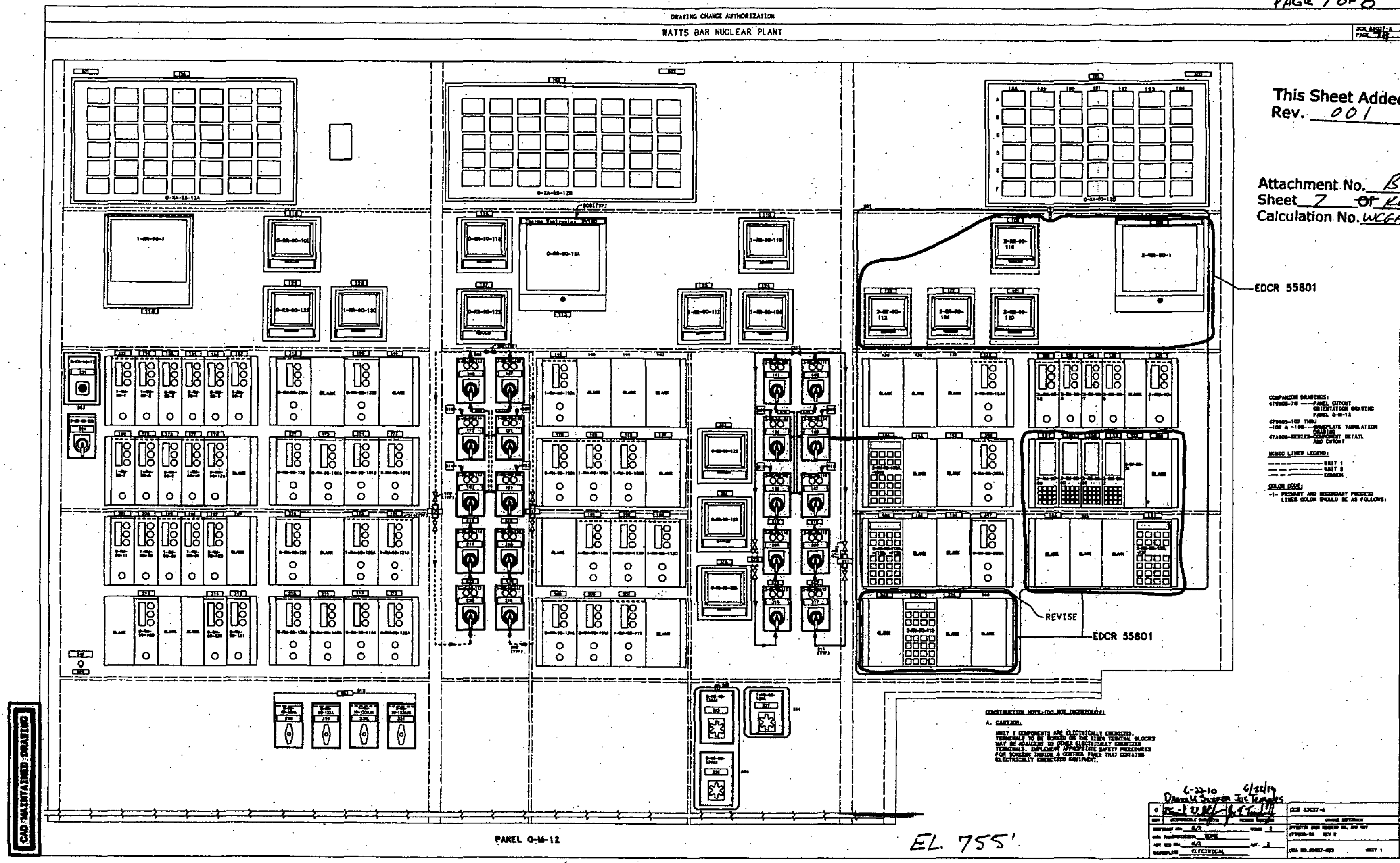
DATE 6-26-74 | 85 | E | 47W605-1 | R14 | P

CAD MAINTAINED DRAWING

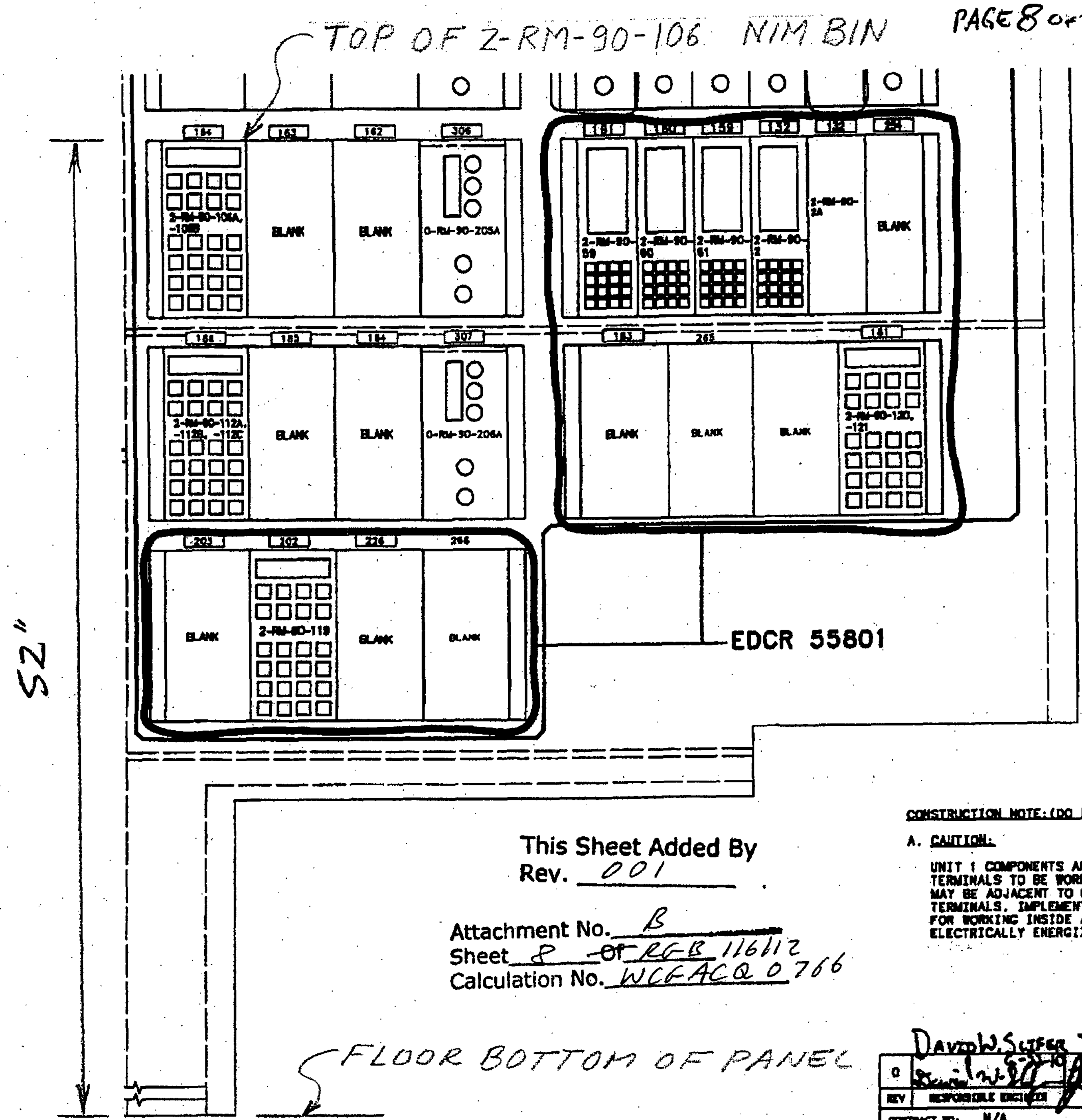
AS CONSTRUCTED

This Sheet Added By
Rev. 001

Attachment No. B
Sheet 7 of 8 ~~KGE 11/6/02~~
Calculation No. WCGACQ0766



Information Only



This Sheet Added By
Rev. 001

Attachment No. B
Sheet 8 ~~Of~~ RGB 1/6/12
Calculation No. WCFACQ 0766

CONSTRUCTION NOTE: (DO N

A. CAUTION:

UNIT 1 COMPONENTS AR
TERMINALS TO BE WORK
MAY BE ADJACENT TO O
TERMINALS. IMPLEMENT
FOR WORKING INSIDE A
ELECTRICALLY ENERGIZ

0	David W. Seifer
REV	RESPONSIBLE ENGINEER

CONTRACT NO.: N/A
DCA PREREQUISITES: NONE
ART CCD NO.: N/A
ELECTRICAL

FRONT FACE OF PANEL 0-M-12

WDTM [signature] 12/22/11
Javier Burgoa

WDTL [signature] 12/22/2011
Timothy R Bell