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Single DoF:

$F_n = 100\ Hz$ $M = 10\ lbs$ $K = 10224.92\ lb/in$

$$F_n = \frac{1}{2\pi}\sqrt{\frac{(10224.92\ lb/in)(386.1\ in/sec^2)}{10\ lbs}} = 100\ Hz$$

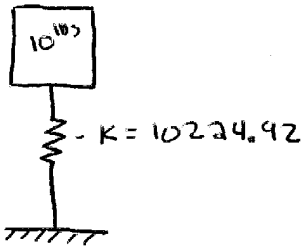
$$RLF_{miles} = 3\sqrt{(\pi/2)(10)(100\ Hz)(0.100\ g^2/Hz)} = 37.599\ g's$$

$\therefore$ Interface force $= 10\ lbs \cdot 37.599\ g's = 375.99\ lbs$

NASTRAN Random Response: Flat Spectrum PSD $= 0.10\ g^2/Hz$ 20-2000Hz
$Q = 10$

$$\text{Spring Force} = \underset{3\,sigma}{3} \cdot (386.1)(\underset{\substack{\text{NASTRAN RMS}\\ \text{spring force}}}{0.32249\ 23}) = 373.541\ lbs$$

$\therefore$ NASTRAN $= 375.54\ lbs$
miles $= 373.54\ lbs$



R. Towner 7/16/97

Calculate frequencies from Formula in Appendix 1.1 of the Shock and Vibration Handbook 3rd Edition, for 2 spring-mass system:

$$\omega_{n_1} = \left(\sqrt{\tfrac{1}{2}\left[A - \sqrt{B}\right]}\right) \text{ rad/sec} \cdot {}^{1\text{ cycle}}/_{2\pi \cdot \text{radians}} = \frac{1}{2\pi}\sqrt{\frac{A-\sqrt{B}}{2}}$$

$$\omega_{n_2} = \frac{1}{2\pi} \cdot \sqrt{\frac{A+\sqrt{B}}{2}}$$

where $A = \frac{K_1}{m_1} + \frac{K_2}{m_2}\left(1 + \frac{m_2}{m_1}\right)$

$$B = \left[\frac{K_1}{m_1} + \frac{K_2}{m_2}\left(1 + \frac{m_2}{m_1}\right)\right]^2 - \frac{4 K_1 \cdot K_2}{m_1 \cdot m_2} = A^2 - \frac{4 \cdot K_1 \cdot K_2}{m_1 \cdot m_2}$$

$K_1 = K_2 = 1.022492 \cdot 10^4$ lb/in

$m_1 = m_2 = 5 \text{ lb} \cdot \left({}^{1}/_{386.1 \frac{\text{in}}{\text{s}^2}}\right) = 0.01295 \ \frac{\text{lb-s}^2}{\text{in}}$

$$\therefore A = \left(\frac{1.022492 \cdot 10^4 \frac{\text{lb}}{\text{in}}}{0.01295 \frac{\text{lb-s}^2}{\text{in}}}\right) + \left(\frac{1.022492 \cdot 10^4 \frac{\text{lb}}{\text{in}}}{0.01295 \frac{\text{lb-s}^2}{\text{in}}}\right)\left(1 + \frac{0.01295 \frac{\text{lb-s}^2}{\text{in}}}{0.01295 \frac{\text{lb-s}^2}{\text{in}}}\right)$$

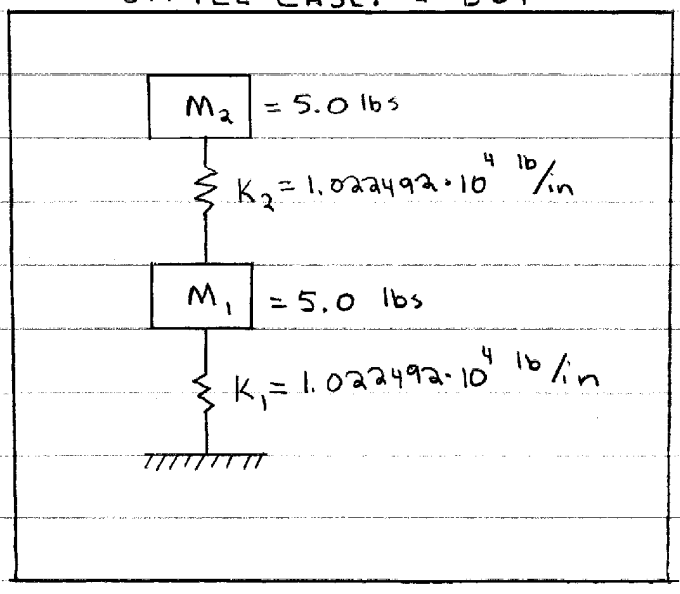
$$A = 2.3687073 \cdot 10^6 \frac{1}{\text{s}^2}$$

$$\therefore B = \left(2.3687073 \cdot 10^6 \frac{1}{\text{s}^2}\right)^2 - \frac{4 \cdot \left(1.022492 \cdot 10^4 \frac{\text{lb}}{\text{in}}\right)^2}{\left(0.01295 \frac{\text{lb-s}^2}{\text{in}}\right)^2} = 3.1170969 \cdot 10^{12}$$

$\omega_{n_1} = 87.40325$ Hz

$\omega_{n_2} = 228.8247$ Hz

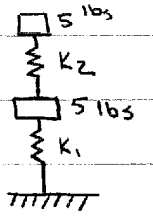
SAMPLE CASE: 2-DOF



For 2-mass/spring system, calculate the modal effective mass contribution and compare with the NASTRAN results:

- From A. Chopra/E. Cruz "Evaluation of Building Code Formulas for Earthquake Forces" from the Journal of Structural Engineering, Vol. 112, No. 8, August 1986

$$W_{eff} = \frac{\left([M][\phi]\right)^2}{[M][\phi^2]}$$



$$[M] = \begin{bmatrix} 5.0 & 0.0 \\ 0.0 & 5.0 \end{bmatrix}$$

$$[\phi] = \begin{bmatrix} \phi_1 & \phi_2 \\ 4.61986 & -7.47509 \\ 7.47509 & 4.61986 \end{bmatrix}$$

$$\text{Eff } Wt_1 = \frac{\left[(5.0^{\#})(4.61986) + (5^{\#})(7.47509)\right]^2}{(4.61986)^2(5) + (7.47509)^2(5)} = 9.4721 \text{ lbs}$$

$$\text{Eff } Wt_2 = \frac{\left[(5.0^{\#})(-7.47509) + (5^{\#})(4.61986)\right]^2}{(5^{\#})(-7.47509)^2 + (5^{\#})(4.61986)^2} = 0.5279 \text{ lbs}$$

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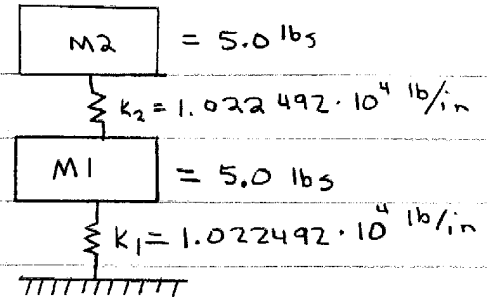

MSC NASTRAN V69 – effmassa.V69 results

F_{n_1} = 87.40324 Hz – (9.472136 lbs-X, 0.0 lbs-Y, 0.0 lbs-Z)

F_{n_2} = 228.8247 Hz – (0.527864 lbs-X, 0.0 lbs-Y, 0.0 lbs-Z)

MSC NASTRAN V69 – Checka.V69 results

F_{n_1} = 87.40324 Hz – (9.4721 lbs-X, 0.0 lb-Y, 0.0 lbs-Z)

F_{n_2} = 228.8247 Hz – (-0.52786 lbs-X, 0.0 lb-Y, 0.0 lbs-Z)

} EFFWUF

CSA NASTRAN Results

F_{n_1} = 87.403 Hz – (9.4795 lbs-X, 0.0 lb-Y, 0.0 lbs-Z)

F_{n_2} = 228,825 Hz – (0.5293 lbs-X, 0.0 lb-Y, 0.0 lbs-Z)

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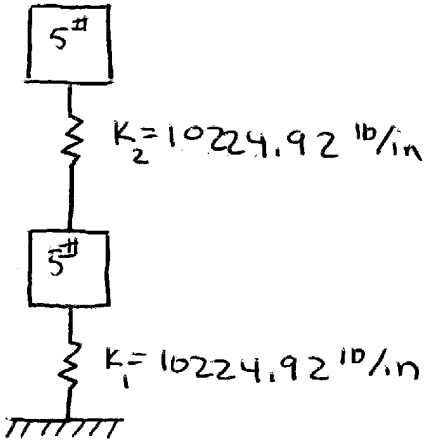
CSA NASTRAN Random Example

2-DOF:



$F_{n_1} = 87.403$ Hz - Eff wt = 9.4795 lbs

$F_{n_2} = 228.825$ Hz - Eff wt = 0.5283 lbs

$$RLF_1 = 3\sqrt{(\pi/2)(10)(87.403\,Hz)(0.100\,g^2/Hz)} = 35.1515\ g's$$

$$RLF_2 = 3\sqrt{(\pi/2)(10)(228.825\,Hz)(0.100\,g^2/Hz)} = 56.8765\ g's$$

use Eff wt / Rss to get interface force

$$F_{rss} = \sqrt{((35.1515\,g's)(9.4795\,lbs))^2 + ((56.8765\,g's)(0.5283\,lbs))^2} = 334.57\ lbs$$

From NASTRAN random response:

$$\text{Spring Force} = \underset{3\ sigma}{3} \cdot (386.1)(\underset{\substack{\text{NASTRAN RMS}\\ \text{Spring Force}}}{0.2864468}) = 331.79$$

∴ NASTRAN = 331.79 lbs
Miles = (10 lbs)(35.1515 g's) = 351.515 lbs
Eff wt = 334.57 lbs

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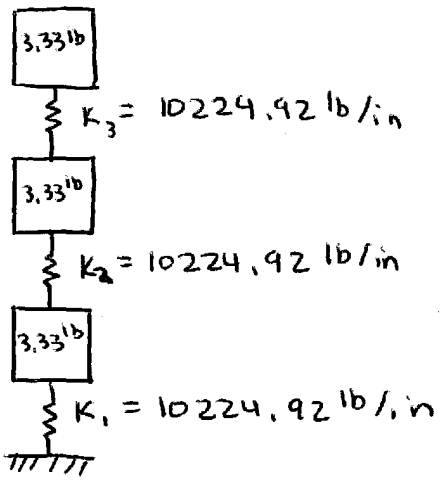
3-DOF:



F_{n_1} = 77.0828 Hz Eff wt = 9.1481 lb

F_{n_2} = 215.9811 Hz Eff wt = 0.7494 lb

F_{n_3} = 312.1018 Hz Eff wt = 0.1105 lb

$RLF_1 = 3\sqrt{(\pi/2)(10)(77.0828\ Hz)(0.100\ g^2/Hz)} = 33.011$ g's

$RLF_2 = 3\sqrt{(\pi/2)(10)(215.9811\ Hz)(0.100\ g^2/Hz)} = 55.257$ g's

$RLF_3 = 3\sqrt{(\pi/2)(10)(312.1018\ Hz)(0.100\ g^2/Hz)} = 66.425$ g's

Use Eff wt / RSS to get interface force:

$$F_{rss} = \sqrt{((9.1481\ lbs)(33.011\ g's))^2 + ((0.7494\ lb)(55.257\ g's))^2 + ((0.1105\ lb)(66.425\ g's))^2}$$

F_{rss} = 304.902 lbs

From NASTRAN Random Response Analysis RLF

Spring Force = 3 (3 sigma) · (386.1) · (0.2607073 NASTRAN RMS spring Force) = 301.977 lbs

∴ NASTRAN = 301.977 lbs
Miles Eqn = (10 lbs)(33.011) = 330.11 lbs
Eff wt = 304.902 lbs

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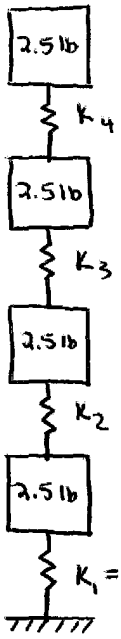
4-DOF:



$F_{n_1} = 69.459$ Hz Eff wt = 8.9412 lbs

$F_{n_2} = 200.000$ Hz Eff wt = 0.83398 lbs

$F_{n_3} = 306.418$ Hz Eff wt = 0.1957 lbs

$F_{n_4} = 375.877$ Hz Eff wt = 0.0368 lbs

$RLF_1 = 3\sqrt{(\pi/2)(10)(69.459\,Hz)(0.100\,g^2/Hz)} = 31.336$ g's

$RLF_2 = 3\sqrt{(\pi/2)(10)(200.0\,Hz)(0.100\,g^2/Hz)} = 53.174$ g's

$RLF_3 = 3\sqrt{(\pi/2)(10)(306.418\,Hz)(0.100\,g^2/Hz)} = 65.817$ g's

$RLF_4 = 3\sqrt{(\pi/2)(10)(375.877\,Hz)(0.100\,g^2/Hz)} = 72.896$ g's

use Eff. wt / RSS to calculate interface force:

$$F_{rss} = \sqrt{((8.9412\,lbs)(31.336\,g's))^2 + ((0.8341\,lbs)(53.174\,g's))^2 + ((0.1957\,lbs)(65.817\,g's))^2 + ((0.0368\,lbs)(72.896\,g's))^2} = 283.97\,lbs$$

From NASTRAN random response:

$$\text{Spring Force} = \underbrace{3}_{3\ sigma} \cdot (386.1) \cdot \underbrace{(0.24251)}_{\substack{NASTRAN\ RMS \\ spring\ Force}} = 280.899\ lbs$$

∴ NASTRAN - 280.899 lbs
Miles Eqn = (10 lb)(31.336 g's) = 313.36 lbs
Eff wt = 283.97 lbs

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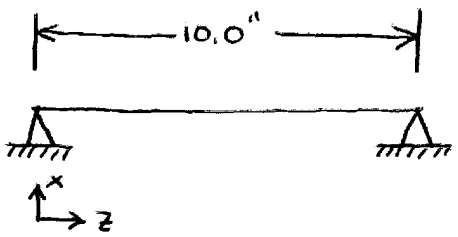
Simple Supported Beam Example



$A = 1.0\ in^2$
$I_x = 10\ in^4$
$I_y = 1.050 \cdot 10^{-3}\ in^4$
$J = 10$
$Wt = 1.0\ lb$

$E = 10 \cdot 10^6\ psi$
$\rho = 0.10\ lb/in^3$

$F_{n_1} = 100.009\ Hz$ Eff $wt = 0.80791\ lb$

$F_{n_2} = 399.698\ Hz$ Eff $wt = 0.000\ lb$

$F_{n_3} = 899.616\ Hz$ Eff $wt = 0.0870\ lbs$

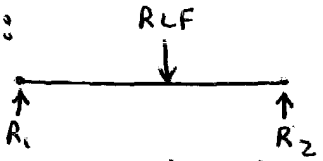
$F_{n_4} = 1594.558\ Hz$ Eff $wt = 0.000\ lbs$

$$RLF_1 = 3\sqrt{(\pi/2)(10)(0.10\ g^2/Hz)(100.009\ Hz)} = 37.601\ g's$$

$$RLF_3 = 3\sqrt{(\pi/2)(10)(0.10\ g^2/Hz)(899.616\ Hz)} = 112.774\ g's$$

$$RLF_{Eff\ wt/RSS} = \frac{\left[((37.601\ g's)(0.80791\ lb))^2 + ((112.774\ g's)(0.0871\ lb))^2\right]^{1/2}}{1.0\ lb} = 31.93\ g's$$

From Static loads analysis:



Miles Eqn: $R_1 = R_2 = (37.601\ g's)(1\ lb)/2 = 18.801\ lbs$

RSS / Eff wt: $R_1 = R_2 = (31.93\ g's)(1\ lb)/2 = 15.965\ lbs$

From Random Response Analysis: $R_1 = R_2 = 15.836\ lbs$

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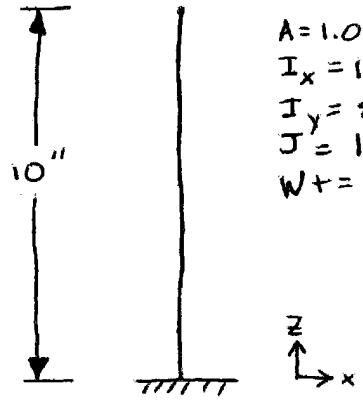
Cantilever Beam Example



$A = 1.0\ in^2$ $\quad E = 10 \cdot 10^6\ psi$
$I_x = 10.0\ in^4$ $\quad \rho = 0.10\ lb/in^3$
$I_y = 8.271E\text{-}3\ in^4$
$J = 10$
$Wt = 1,000\ lbs$

$F_{n1} = 99.849\ Hz$ Eff $wt_x = 0.61311\ lbs$

$F_{n2} = 623.764\ Hz$ Eff $wt_x = 0.18883\ lbs$

$F_{n3} = 1741.010\ Hz$ Eff $wt_x = 0.06527\ lbs$

Random Spectrum: 20 Hz – 2000 Hz $\quad 0.100\ g^2/Hz$ (Flat Spectrum)

$$RLF_1 = 3\sqrt{(\pi/2)(10)(0.10\ g^2/Hz)(99.849\ Hz)} = 37.571\ g's$$

$$RLF_2 = 3\sqrt{(\pi/2)(10)(0.10\ g^2/Hz)(623.764\ Hz)} = 93.906\ g's$$

$$RLF_3 = 3\sqrt{(\pi/2)(10)(0.10\ g^2/Hz)(1741.010\ Hz)} = 156.885\ g's$$

$$RLF_{eff\ wt/RSS} = \frac{\left[\left((37.571\ g's)(0.61311\ lbs)\right)^2 + \left((93.906\ g's)(0.18883\ lbs)\right)^2 + \left((156.885\ g's)(0.06527\ lb)\right)^2\right]^{1/2}}{1.0\ lb}$$

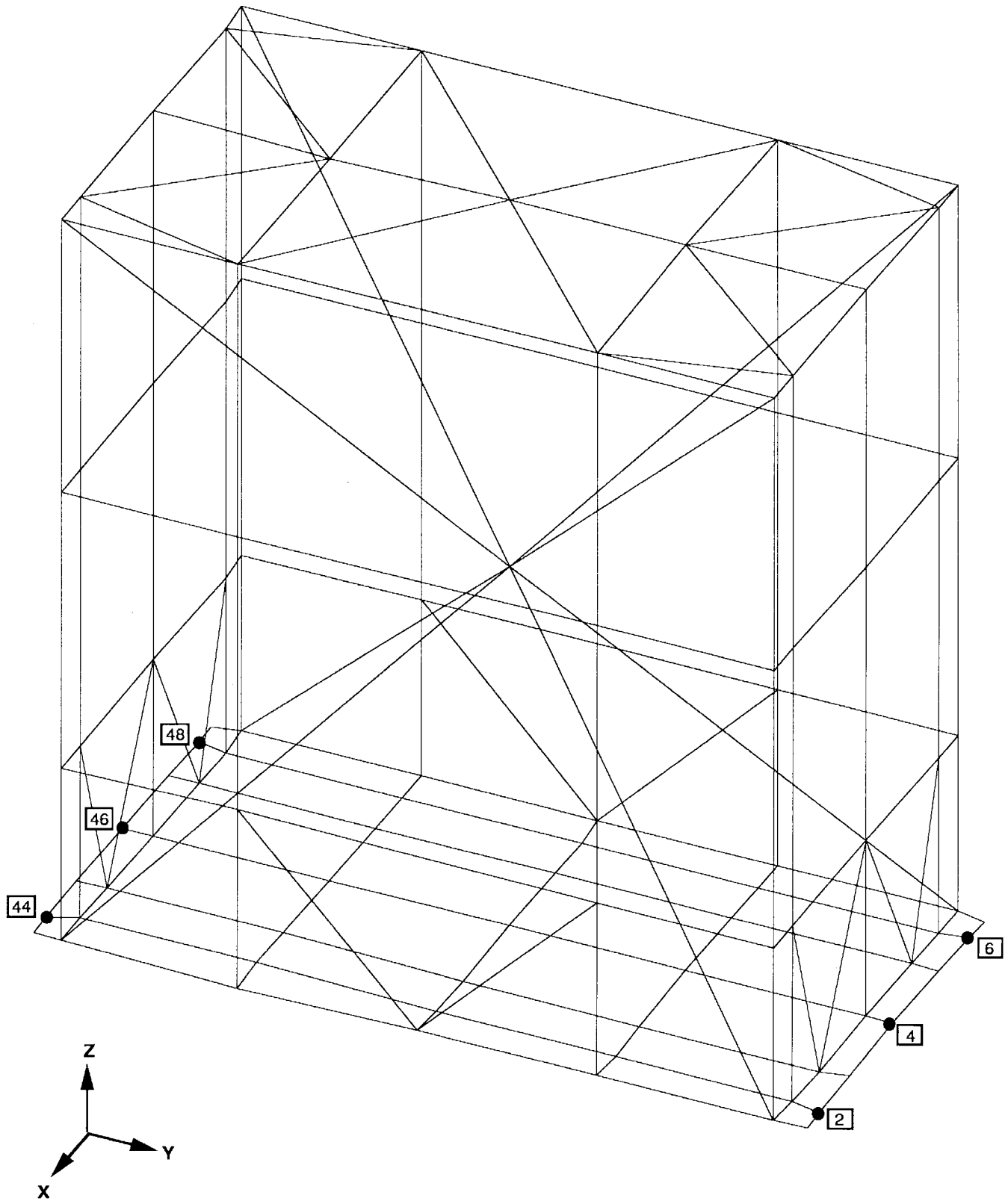
$$RLF_{eff\ wt/RSS} = 30.820\ g's$$

For Static loads Analysis:

w/Miles Equation: Boundary Forces: $F_x = (1^\#)(37.571\ g's) = 37.571\ lbs$
$M_y = (1^\#)(5")(37.571\ g's) = 187.855\ in\text{-}lb$

w/Eff wt-RSS: Boundary Forces: $F_x = 30.82\ lbs$
$M_y = 154.1\ in\text{-}lb$

From Random Response, Boundary Forces: $F_x = 30.477\ lbs$
$M_y = 170.646\ in\text{-}lb$


48
46
44
6
4
2
Z
Y
X

HI-PAC-DTV PDAC INTERFACE FORCE COMPARISON - MILES EQN, EFF WT/RSS, RANDOM RESPONSE

Axis	Grid No.	RLF Method	X (Lbs)	Y (Lbs)	Z (Lbs)	RSS Force
X-Axis		Miles Equation	-194.2	-166.1	527.1	585.8
	2	Eff. Wt./RSS	-141.9	-121.4	385.2	428.1
		Random Response	138.9	142.3	516.5	553.5
		Miles Equation	-263.6	0.0	0.0	263.6
	4	Eff. Wt./RSS	-192.7	0.0	0.0	192.7
		Random Response	195.9	0.0	0.0	195.9
		Miles Equation	-194.2	166.1	-527.1	585.8
	6	Eff. Wt./RSS	-141.9	121.4	-385.2	428.1
		Random Response	138.9	142.3	516.5	553.5
		Miles Equation	-194.2	166.1	527.1	585.8
	44	Eff. Wt./RSS	-141.9	121.4	385.2	428.1
		Random Response	138.9	142.3	516.5	553.5
		Miles Equation	-263.6	0.0	0.0	263.6
	46	Eff. Wt./RSS	-192.7	0.0	0.0	192.7
		Random Response	195.9	0.0	0.0	195.9
		Miles Equation	-194.2	-166.1	-527.1	585.8
	48	Eff. Wt./RSS	-141.9	-121.4	-385.2	428.1
		Random Response	138.9	142.3	516.5	553.5

Notes: 1. Miles Equation Loads RLFx=130.4 g; RLFy=65.1 g; RLFz=80.2 g
2. Effective Weight/RSS RLFx=95.3 g; RLFy=33.7 g; RLFz=67.9 g

HI-PAC-DTV PDAC INTERFACE FORCE COMPARISON - MILES EQN, EFF WT/RSS, RANDOM RESPONSE

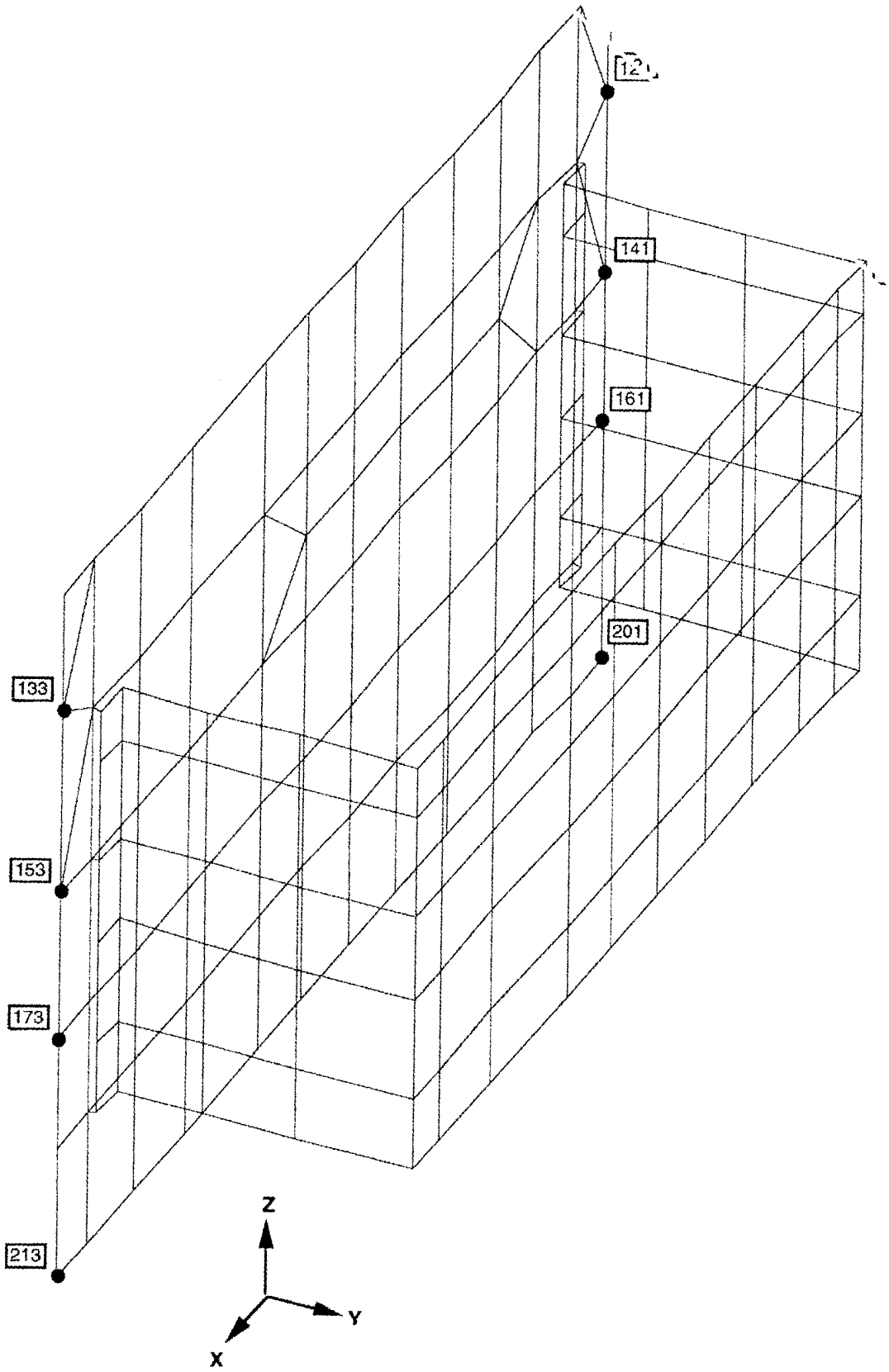
Axis	Grid No.	RLF Method	X (Lbs)	Y (Lbs)	Z (Lbs)	RSS Force
Y-Axis		Miles Equation	21.6	-120.9	71.5	142.1
	2	Eff. Wt./RSS	11.2	-62.6	37.0	73.6
		Random Response	21.1	98.5	84.8	131.7
		Miles Equation	0.0	-83.7	77.3	113.9
	4	Eff. Wt./RSS	0.0	-43.3	40.0	59.0
		Random Response	0.0	58.8	92.0	109.2
		Miles Equation	-21.6	-120.9	71.5	142.1
	6	Eff. Wt./RSS	-11.2	-62.6	37.0	73.6
		Random Response	21.1	98.5	84.8	131.7
		Miles Equation	-21.6	-120.9	-71.5	142.1
	44	Eff. Wt./RSS	-11.2	-62.6	-37.0	73.6
		Random Response	21.1	98.5	84.8	131.7
		Miles Equation	0.0	-83.7	-77.3	113.9
	46	Eff. Wt./RSS	0.0	-43.3	-40.0	59.0
		Random Response	0.0	58.8	92.0	109.2
		Miles Equation	21.6	-120.9	-71.5	142.1
	48	Eff. Wt./RSS	11.2	-62.6	-37.0	73.6
		Random Response	21.1	98.5	84.8	131.7

Notes: 1. Miles Equation Loads RLFx=130.4 g; RLFy=65.1 g; RLFz=80.2 g
2. Effective Weight/RSS RLFx=95.3 g; RLFy=33.7 g; RLFz=67.9 g

HI-PAC-DTV PDAC INTERFACE FORCE COMPARISON - MILES EQN, EFF WT/RSS, RANDOM RESPONSE

Axis	Grid No.	RLF Method	X (Lbs)	Y (Lbs)	Z (Lbs)	RSS Force
Z-Axis		Miles Equation	-12.2	42.7	-131.8	139.1
	2	Eff. Wt./RSS	-10.4	36.2	-111.6	117.7
		Random Response	13.6	46.2	141.5	149.4
		Miles Equation	0.0	11.2	-137.5	137.9
	4	Eff. Wt./RSS	0.0	9.5	-116.4	116.8
		Random Response	0.0	11.5	143.8	144.2
		Miles Equation	12.2	42.7	-131.8	139.1
	6	Eff. Wt./RSS	10.4	36.2	-111.6	117.7
		Random Response	13.6	46.2	141.5	149.4
		Miles Equation	-12.2	-42.7	-131.8	139.1
	44	Eff. Wt./RSS	-10.4	-36.2	-111.6	117.7
		Random Response	13.6	46.2	141.5	149.4
		Miles Equation	0.0	-11.2	-137.5	137.9
	46	Eff. Wt./RSS	0.0	-9.5	-116.4	116.8
		Random Response	0.0	11.5	143.8	144.2
		Miles Equation	12.2	-42.7	-131.8	139.1
	48	Eff. Wt./RSS	10.4	-36.2	-111.6	117.7
		Random Response	13.6	46.2	141.5	149.4

Notes: 1. Miles Equation Loads RLFx=130.4 g; RLFy=65.1 g; RLFz=80.2 g
2. Effective Weight/RSS RLFx=95.3 g; RLFy=33.7 g; RLFz=67.9 g



.125" thick

CIRCUIT BREAKER PANEL INTERFACE FORCE COMPARISON - MILES EQN, EFF WT/RSS, RANDOM RESP

Axis	Grid No.	RLF Method	X (Lbs)	Y (Lbs)	Z (Lbs)	RSS Force
X-Axis	121	Miles Equation	-10.8	-0.9	2.9	11.2
		Eff. Wt./RSS	-6.5	-0.6	1.7	6.8
		Random Response	4.0	1.9	2.4	5.1
	133	Miles Equation	-9.2	0.9	-2.6	9.6
		Eff. Wt./RSS	-5.6	0.6	-1.6	5.8
		Random Response	3.8	3.0	2.2	5.3
	141	Miles Equation	-10.8	-3.4	0.4	11.3
		Eff. Wt./RSS	-6.5	-2.1	0.2	6.8
		Random Response	4.5	3.0	0.5	5.4
	153	Miles Equation	-9.8	3.4	-0.3	10.4
		Eff. Wt./RSS	-5.9	2.0	-0.2	6.2
		Random Response	3.8	2.3	0.8	4.6
	161	Miles Equation	-7.2	-2.7	-0.4	7.7
		Eff. Wt./RSS	-4.3	-1.6	-0.2	4.6
		Random Response	2.6	2.5	0.7	3.7
	173	Miles Equation	-6.9	2.7	0.2	7.4
		Eff. Wt./RSS	-4.1	1.7	0.1	4.4
		Random Response	2.3	1.6	0.7	3.0
	201	Miles Equation	-5.6	-0.3	-3.4	6.6
		Eff. Wt./RSS	-3.4	-0.2	-2.1	3.9
		Random Response	2.4	0.8	2.2	3.3
	213	Miles Equation	-5.5	0.2	3.2	6.4
		Eff. Wt./RSS	-3.3	0.1	1.9	3.9
		Random Response	2.2	0.9	1.9	2.8

Notes: 1. Miles Equation Loads RLFx=11.13 g; RLFy=7.76 g; RLFz=13.35 g
2. Effective Weight/RSS RLFx=6.69 g; RLFy=5.79 g; RLFz=6.37 g

CIRCUIT BREAKER PANEL INTERFACE FORCE COMPARISON - MILES EQN, EFF WT/RSS, RANDOM RESP

Axis	Grid No.	RLF Method	X (Lbs)	Y (Lbs)	Z (Lbs)	RSS Force
Y-Axis	121	Miles Equation	-1.9	-6.5	1.4	6.9
		Eff. Wt./RSS	-1.4	-4.9	1.0	5.2
		Random Response	1.9	5.8	1.3	6.2
	133	Miles Equation	1.9	-6.0	1.4	6.5
		Eff. Wt./RSS	1.4	-4.5	1.0	4.8
		Random Response	2.5	6.7	1.6	7.4
	141	Miles Equation	-6.2	-7.7	1.0	10.0
		Eff. Wt./RSS	-4.6	-5.8	0.8	7.4
		Random Response	4.6	5.9	1.4	7.6
	153	Miles Equation	6.1	-7.5	0.7	9.6
		Eff. Wt./RSS	4.5	-5.6	0.5	7.2
		Random Response	5.0	6.2	1.4	8.1
	161	Miles Equation	-1.6	-7.0	-0.9	7.2
		Eff. Wt./RSS	-1.2	-5.2	-0.6	5.4
		Random Response	1.1	4.6	1.0	4.8
	173	Miles Equation	1.8	-7.1	-0.8	7.3
		Eff. Wt./RSS	1.3	-5.3	-0.6	5.5
		Random Response	1.6	5.1	1.0	5.4
	201	Miles Equation	-1.3	-2.0	-1.6	2.9
		Eff. Wt./RSS	-1.0	-1.5	-1.2	2.1
		Random Response	1.0	1.6	1.5	2.4
	213	Miles Equation	1.2	-2.1	-1.3	2.8
		Eff. Wt./RSS	0.9	-1.6	-1.0	2.1
		Random Response	1.1	1.8	1.4	2.6

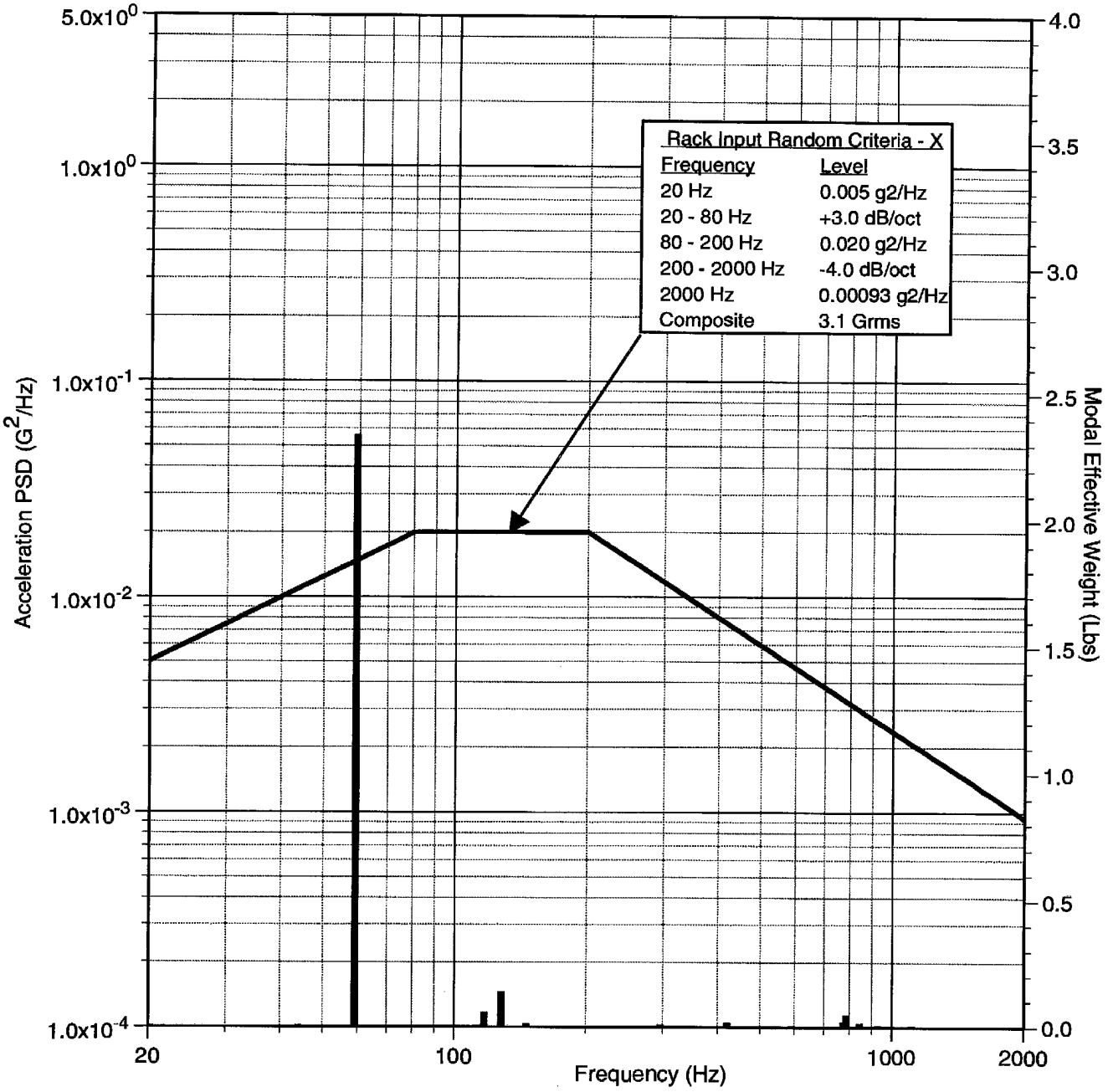
Notes: 1. Miles Equation Loads RLFx=11.13 g; RLFy=7.76 g; RLFz=13.35 g
2. Effective Weight/RSS RLFx=6.69 g; RLFy=5.79 g; RLFz=6.37 g

CIRCUIT BREAKER PANEL INTERFACE FORCE COMPARISON - MILES EQN, EFF WT/RSS, RANDOM RESP

Axis	Grid No.	RLF Method	X (Lbs)	Y (Lbs)	Z (Lbs)	RSS Force
Z-Axis	121	Miles Equation	14.9	12.2	-8.8	21.2
		Eff. Wt./RSS	7.1	5.8	-4.2	10.1
		Random Response	10.0	7.6	4.9	13.5
	133	Miles Equation	-14.6	14.4	-8.6	22.2
		Eff. Wt./RSS	-7.0	6.9	-4.1	10.6
		Random Response	8.6	8.0	3.9	12.4
	141	Miles Equation	0.4	1.8	-13.1	13.2
		Eff. Wt./RSS	0.2	0.9	-6.3	6.3
		Random Response	0.9	1.2	6.9	7.1
	153	Miles Equation	-0.5	2.1	-13.0	13.2
		Eff. Wt./RSS	-0.2	1.0	-6.2	6.3
		Random Response	0.8	1.1	5.7	5.8
	161	Miles Equation	-6.1	-6.9	-11.1	14.4
		Eff. Wt./RSS	-2.9	-3.3	-5.3	6.9
		Random Response	3.2	4.1	6.1	8.1
	173	Miles Equation	6.4	-8.0	-10.7	14.9
		Eff. Wt./RSS	3.1	-3.8	-5.1	7.1
		Random Response	3.5	5.0	4.9	7.8
	201	Miles Equation	-10.2	-7.2	-7.1	14.4
		Eff. Wt./RSS	-4.9	-3.4	-3.4	6.9
		Random Response	8.2	4.7	5.1	10.8
	213	Miles Equation	9.7	-8.5	-6.6	14.5
		Eff. Wt./RSS	4.6	-4.0	-3.2	6.9
		Random Response	7.7	5.3	4.3	10.3

Notes: 1. Miles Equation Loads RLFx=11.13 g; RLFy=7.76 g; RLFz=13.35 g
2. Effective Weight/RSS RLFx=6.69 g; RLFy=5.79 g; RLFz=6.37 g

LMS CIRCUIT BREAKER PANEL RANDOM INPUT
MODAL EFFECTIVE WEIGHTS - X-AXIS



LMS BDPU HVA CIRCUIT BREAKER PANEL RANDOM LOAD DERIVATION

RANDOM LOAD FACTOR IN X-AXIS								
Input at the standard Spacelab Rack Interfaces - X-Axis								
F01 =	20	PSD01 =	0.00500	n1 =	3		Grms1=	0.87
F02 =	80	PSD02 =	0.02000	n2 =	0		Grms2=	1.55
F03 =	200	PSD03 =	0.02000	n3 =	-4		Grms3=	2.54
F04 =	2000	PSD04 =	0.00093	n4 =	0			
Q =	**10**						**Grms=**	**3.10**

FREQUENCY	F0	PSD0	SLOPE	PSD	RLF(i)	EFFW	RLF*EFFW	Force^2	RLF
44.1	20	0.005	3	0.0110	8.28	0.006	0.0	0.	0.01
59.3	20	0.005	3	0.0148	**11.13**	**2.339**	26.0	677.	4.40
79.2	20	0.005	3	0.0197	14.86	0.005	0.1	0.	4.40
117.2	80	0.02	0	0.0200	18.20	0.057	1.0	1.	4.40
128.3	80	0.02	0	0.0200	19.05	0.137	2.6	7.	4.42
146.5	80	0.02	0	0.0200	20.35	0.013	0.3	0.	4.42
158.3	80	0.02	0	0.0200	21.16	0.000	0.0	0.	4.42
219.6	200	0.02	-4	0.0177	23.42	0.000	0.0	0.	4.42
237.6	200	0.02	-4	0.0159	23.12	0.001	0.0	0.	4.42
296.8	200	0.02	-4	0.0118	22.29	0.010	0.2	0.	4.42
335.2	200	0.02	-4	0.0101	21.84	0.006	0.1	0.	4.42
357.7	200	0.02	-4	0.0092	21.61	0.000	0.0	0.	4.42
420.8	200	0.02	-4	0.0074	21.04	0.017	0.4	0.	4.42
459.6	200	0.02	-4	0.0066	20.74	0.001	0.0	0.	4.42
508.7	200	0.02	-4	0.0058	20.40	0.002	0.0	0.	4.42
523.0	200	0.02	-4	0.0056	20.30	0.002	0.0	0.	4.42
545.7	200	0.02	-4	0.0053	20.16	0.002	0.0	0.	4.42
553.2	200	0.02	-4	0.0052	20.12	0.001	0.0	0.	4.42
592.2	200	0.02	-4	0.0047	19.89	0.006	0.1	0.	4.42
652.5	200	0.02	-4	0.0042	19.58	0.000	0.0	0.	4.42
675.0	200	0.02	-4	0.0040	19.47	0.002	0.0	0.	4.42
728.9	200	0.02	-4	0.0036	19.23	0.000	0.0	0.	4.42
776.8	200	0.02	-4	0.0033	19.03	0.022	0.4	0.	4.43
786.3	200	0.02	-4	0.0032	18.99	0.049	0.9	1.	4.43
823.4	200	0.02	-4	0.0031	18.84	0.001	0.0	0.	4.43
845.1	200	0.02	-4	0.0029	18.76	0.015	0.3	0.	4.43
871.1	200	0.02	-4	0.0028	18.67	0.001	0.0	0.	4.43
900.0	200	0.02	-4	0.0027	18.57	0.000	0.0	0.	4.43
930.0	200	0.02	-4	0.0026	18.47	0.008	0.1	0.	4.43
943.8	200	0.02	-4	0.0025	18.43	0.001	0.0	0.	4.43
959.7	200	0.02	-4	0.0025	18.38	0.004	0.1	0.	4.43
987.4	200	0.02	-4	0.0024	18.29	0.000	0.0	0.	4.43
1078.6	200	0.02	-4	0.0021	18.03	0.001	0.0	0.	4.43
1092.7	200	0.02	-4	0.0021	17.99	0.000	0.0	0.	4.43
1112.3	200	0.02	-4	0.0020	17.94	0.005	0.1	0.	4.43
1154.5	200	0.02	-4	0.0019	17.83	0.002	0.0	0.	4.43
1167.3	200	0.02	-4	0.0019	17.79	0.000	0.0	0.	4.43
1236.7	200	0.02	-4	0.0018	17.63	0.000	0.0	0.	4.43
1310.3	200	0.02	-4	0.0016	17.46	0.000	0.0	0.	4.43
1360.3	200	0.02	-4	0.0016	17.35	0.001	0.0	0.	4.43

LMS BDPU HVA CIRCUIT BREAKER PANEL RANDOM LOAD DERIVATION

RANDOM LOAD FACTOR IN X-AXIS

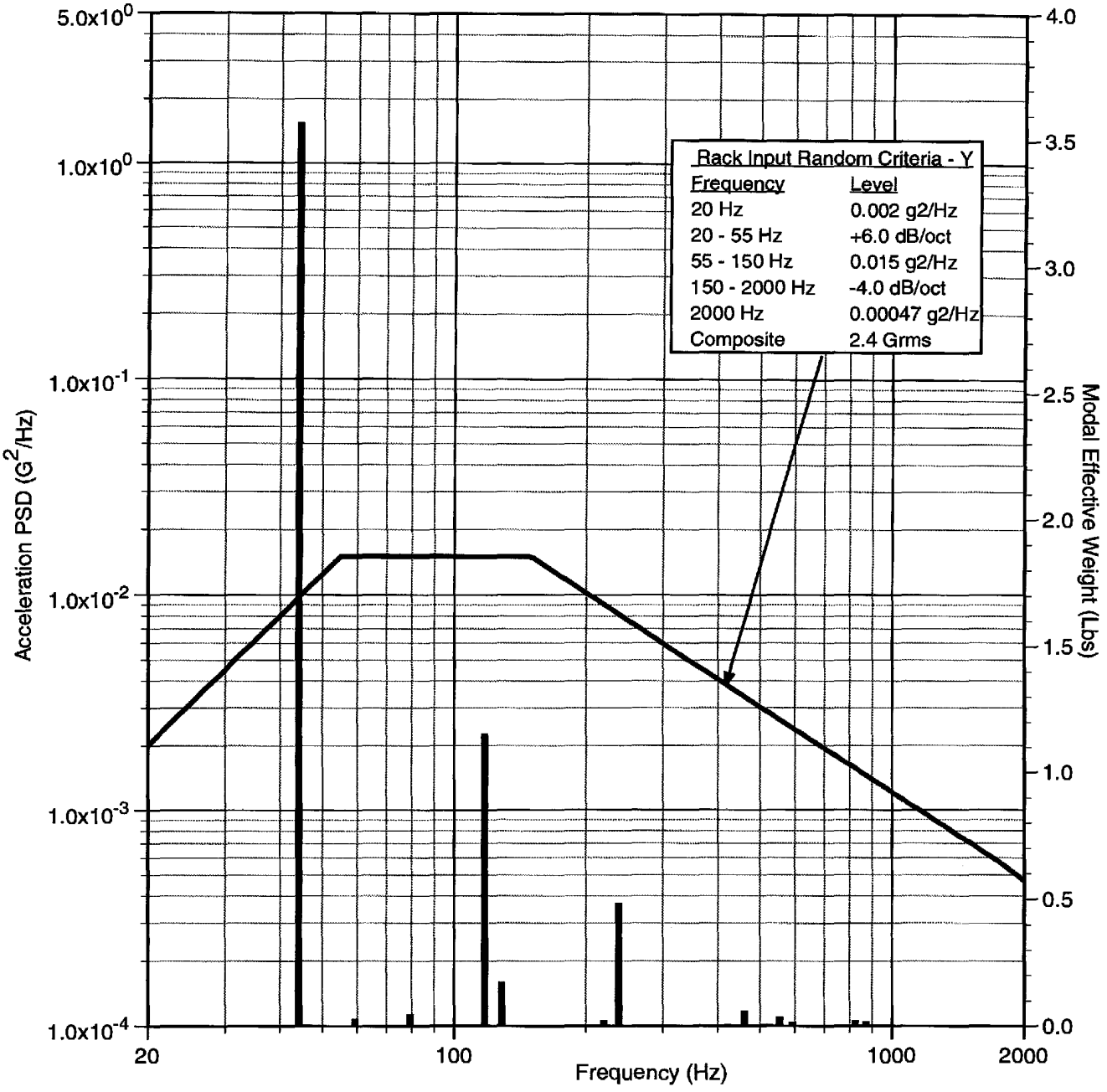
Input at the standard Spacelab Rack Interfaces - X-Axis

F01 =	20	PSD01 =	0.00500	n1 =	3		Grms1=	0.87
F02 =	80	PSD02 =	0.02000	n2 =	0		Grms2=	1.55
F03 =	200	PSD03 =	0.02000	n3 =	-4		Grms3=	2.54
F04 =	2000	PSD04 =	0.00093	n4 =	0			
Q =	**10**						**Grms=**	**3.10**

FREQUENCY	F0	PSD0	SLOPE	PSD	RLF(i)	EFFW	RLF*EFFW	Force^2	RLF
1392.0	200	0.02	-4	0.0015	17.29	0.000	0.0	0.	4.43
1419.9	200	0.02	-4	0.0015	17.23	0.000	0.0	0.	4.43
1516.7	200	0.02	-4	0.0014	17.04	0.000	0.0	0.	4.43
1522.2	200	0.02	-4	0.0013	17.03	0.000	0.0	0.	4.43
1570.1	200	0.02	-4	0.0013	16.95	0.000	0.0	0.	4.43
1591.8	200	0.02	-4	0.0013	16.91	0.000	0.0	0.	4.43
1646.1	200	0.02	-4	0.0012	16.82	0.001	0.0	0.	4.43
1713.4	200	0.02	-4	0.0012	16.71	0.000	0.0	0.	4.43
1717.0	200	0.02	-4	0.0011	16.70	0.000	0.0	0.	4.43
1770.6	200	0.02	-4	0.0011	16.62	0.000	0.0	0.	4.43
1830.7	200	0.02	-4	0.0011	16.52	0.000	0.0	0.	4.43
1909.3	200	0.02	-4	0.0010	16.41	0.000	0.0	0.	4.43
1918.6	200	0.02	-4	0.0010	16.40	0.002	0.0	0.	4.43
1939.5	200	0.02	-4	0.0010	16.37	0.000	0.0	0.	4.43
1960.2	200	0.02	-4	0.0010	16.34	0.001	0.0	0.	4.43
2000.0	2000	0.0009	0	0.0009	9.29	3.196	29.7	881.	6.69

EFFWSUM	2.72		RLF (RSS) =	39.6
EFFWRATIO	0.46		MASS =	5.92
			RLF =	**6.69**
Delta Wt.=	3.196			

LMS CIRCUIT BREAKER PANEL RANDOM INPUT
MODAL EFFECTIVE WEIGHTS - Y-AXIS



LMS BDPU HVA CIRCUIT BREAKER PANEL RANDOM LOAD DERIVATION

RANDOM LOAD FACTOR IN Y-AXIS

Input at the standard Spacelab Rack Interfaces - Y-Axis

F01 =	20	PSD01 =	0.00200	n1 =	6		Grms1=	0.51
F02 =	55	PSD02 =	0.01500	n2 =	0		Grms2=	1.19
F03 =	150	PSD03 =	0.01500	n3 =	-4		Grms3=	1.98
F04 =	2000	PSD04 =	0.00047	n4 =	0			
Q =	**10**						**Grms=**	**2.36**

FREQUENCY	F0	PSD0	SLOPE	PSD	RLF(i)	EFFW	RLF*EFFW	Force^2	RLF
44.1	20	0.002	6	0.0097	**7.76**	**3.567**	27.7	766.	4.68
59.3	55	0.015	0	0.0150	11.21	0.030	0.3	0.	4.68
79.2	55	0.015	0	0.0150	12.96	0.047	0.6	0.	4.68
117.2	55	0.015	0	0.0150	15.76	1.156	18.2	332.	5.60
128.3	55	0.015	0	0.0150	16.50	0.173	2.9	8.	5.62
146.5	55	0.015	0	0.0150	17.62	0.001	0.0	0.	5.62
158.3	150	0.015	-4	0.0140	17.68	0.002	0.0	0.	5.62
219.6	150	0.015	-4	0.0090	16.75	0.021	0.4	0.	5.62
237.6	150	0.015	-4	0.0081	16.54	0.484	8.0	64.	5.78
296.8	150	0.015	-4	0.0061	15.94	0.004	0.1	0.	5.78
335.2	150	0.015	-4	0.0052	15.63	0.001	0.0	0.	5.78
357.7	150	0.015	-4	0.0047	15.46	0.006	0.1	0.	5.78
420.8	150	0.015	-4	0.0038	15.05	0.007	0.1	0.	5.78
459.6	150	0.015	-4	0.0034	14.84	0.061	0.9	1.	5.79
508.7	150	0.015	-4	0.0030	14.59	0.008	0.1	0.	5.79
523.0	150	0.015	-4	0.0029	14.52	0.005	0.1	0.	5.79
545.7	150	0.015	-4	0.0027	14.42	0.002	0.0	0.	5.79
553.2	150	0.015	-4	0.0026	14.39	0.036	0.5	0.	5.79
592.2	150	0.015	-4	0.0024	14.23	0.014	0.2	0.	5.79
652.5	150	0.015	-4	0.0021	14.01	0.005	0.1	0.	5.79
675.0	150	0.015	-4	0.0020	13.93	0.002	0.0	0.	5.79
728.9	150	0.015	-4	0.0018	13.75	0.000	0.0	0.	5.79
776.8	150	0.015	-4	0.0017	13.61	0.001	0.0	0.	5.79
786.3	150	0.015	-4	0.0017	13.58	0.001	0.0	0.	5.79
823.4	150	0.015	-4	0.0016	13.48	0.022	0.3	0.	5.79
845.1	150	0.015	-4	0.0015	13.42	0.004	0.1	0.	5.79
871.1	150	0.015	-4	0.0014	13.36	0.019	0.3	0.	5.79
900.0	150	0.015	-4	0.0014	13.28	0.007	0.1	0.	5.79
930.0	150	0.015	-4	0.0013	13.21	0.004	0.1	0.	5.79
943.8	150	0.015	-4	0.0013	13.18	0.000	0.0	0.	5.79
959.7	150	0.015	-4	0.0013	13.14	0.002	0.0	0.	5.79
987.4	150	0.015	-4	0.0012	13.08	0.000	0.0	0.	5.79
1078.6	150	0.015	-4	0.0011	12.89	0.000	0.0	0.	5.79
1092.7	150	0.015	-4	0.0011	12.87	0.000	0.0	0.	5.79
1112.3	150	0.015	-4	0.0010	12.83	0.002	0.0	0.	5.79
1154.5	150	0.015	-4	0.0010	12.75	0.002	0.0	0.	5.79
1167.3	150	0.015	-4	0.0010	12.73	0.001	0.0	0.	5.79
1236.7	150	0.015	-4	0.0009	12.61	0.000	0.0	0.	5.79
1310.3	150	0.015	-4	0.0008	12.49	0.000	0.0	0.	5.79
1360.3	150	0.015	-4	0.0008	12.41	0.000	0.0	0.	5.79

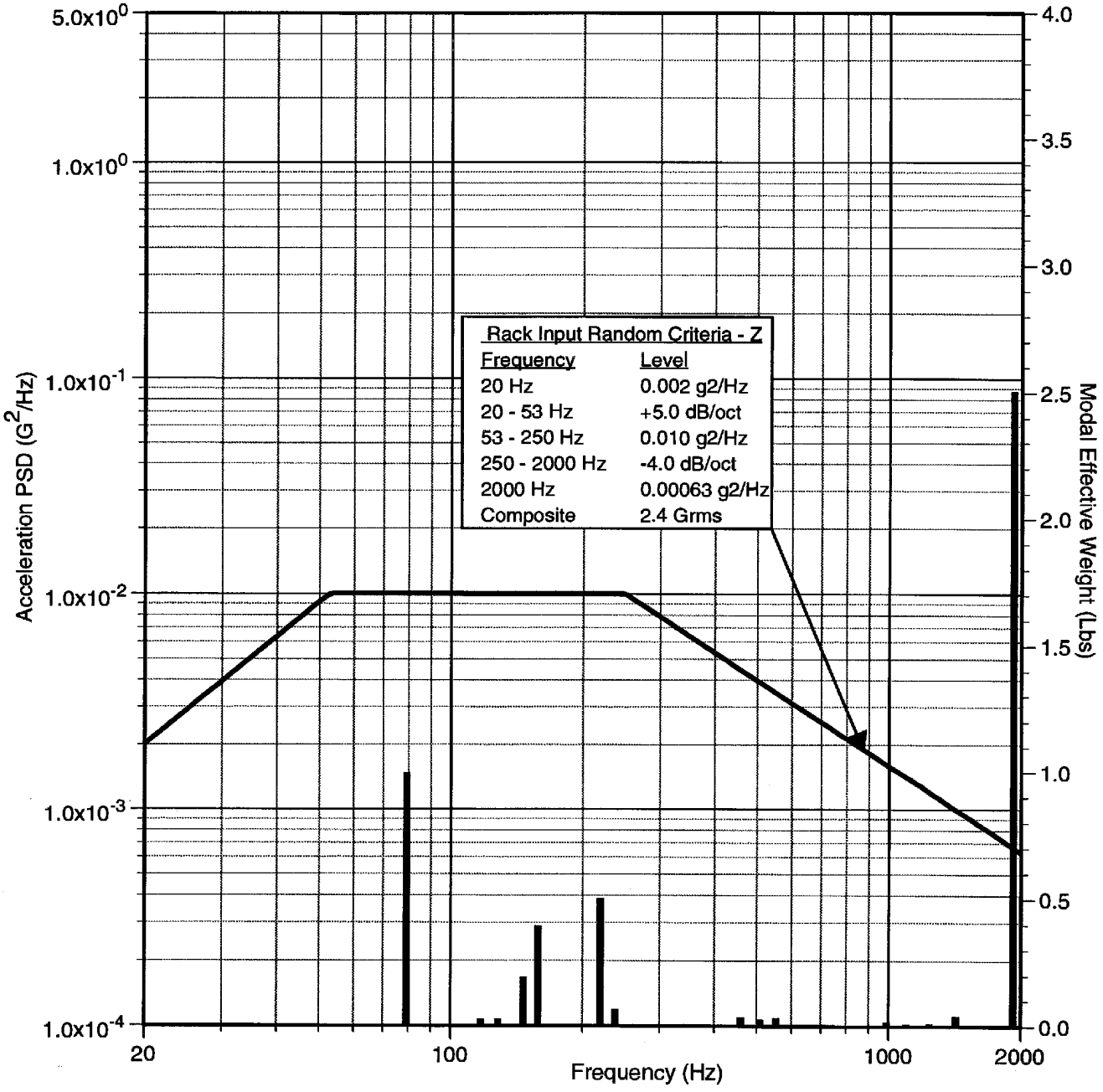
LMS BDPU HVA CIRCUIT BREAKER PANEL RANDOM LOAD DERIVATION

RANDOM LOAD FACTOR IN Y-AXIS									
Input at the standard Spacelab Rack Interfaces - Y-Axis									
F01 =	20	PSD01 =	0.00200	n1 =	6		Grms1=	0.51	
F02 =	55	PSD02 =	0.01500	n2 =	0		Grms2=	1.19	
F03 =	150	PSD03 =	0.01500	n3 =	-4		Grms3=	1.98	
F04 =	2000	PSD04 =	0.00047	n4 =	0				
Q =	**10**						**Grms=**	**2.36**	

FREQUENCY	F0	PSD0	SLOPE	PSD	RLF(i)	EFFW	RLF*EFFW	Force^2	RLF
1392.0	150	0.015	-4	0.0008	12.37	0.005	0.1	0.	5.79
1419.9	150	0.015	-4	0.0008	12.33	0.000	0.0	0.	5.79
1516.7	150	0.015	-4	0.0007	12.19	0.004	0.0	0.	5.79
1522.2	150	0.015	-4	0.0007	12.18	0.000	0.0	0.	5.79
1570.1	150	0.015	-4	0.0007	12.12	0.000	0.0	0.	5.79
1591.8	150	0.015	-4	0.0007	12.10	0.000	0.0	0.	5.79
1646.1	150	0.015	-4	0.0006	12.03	0.002	0.0	0.	5.79
1713.4	150	0.015	-4	0.0006	11.95	0.001	0.0	0.	5.79
1717.0	150	0.015	-4	0.0006	11.95	0.001	0.0	0.	5.79
1770.6	150	0.015	-4	0.0006	11.89	0.000	0.0	0.	5.79
1830.7	150	0.015	-4	0.0005	11.82	0.000	0.0	0.	5.79
1909.3	150	0.015	-4	0.0005	11.74	0.000	0.0	0.	5.79
1918.6	150	0.015	-4	0.0005	11.73	0.000	0.0	0.	5.79
1939.5	150	0.015	-4	0.0005	11.71	0.000	0.0	0.	5.79
1960.2	150	0.015	-4	0.0005	11.69	0.000	0.0	0.	5.79
2000.0	2000	0.0005	0	0.0005	7.09	0.207	1.5	2.	5.79

EFFWSUM	5.71		RLF (RSS) =	34.3
EFFWRATIO	0.97		MASS =	5.92
			RLF =	**5.79**
Delta Wt.=	0.207			

LMS CIRCUIT BREAKER PANEL RANDOM INPUT
MODAL EFFECTIVE WEIGHTS - Z-AXIS



LMS BDPU HVA CIRCUIT BREAKER PANEL RANDOM LOAD DERIVATION

RANDOM LOAD FACTOR IN Z-AXIS

Input at the standard Spacelab Rack Interfaces - Z-Axis

F01 =	20	PSD01 =	0.00200	n1 =	5		Grms1=	0.43
F02 =	53	PSD02 =	0.01000	n2 =	0		Grms2=	1.40
F03 =	250	PSD03 =	0.01000	n3 =	-4		Grms3=	1.94
F04 =	2000	PSD04 =	0.00063	n4 =	0			
Q =	**10**						**Grms=**	**2.43**

FREQUENCY	F0	PSD0	SLOPE	PSD	RLF(i)	EFFW	RLF*EFFW	Force^2	RLF
44.1	20	0.002	5	0.0074	6.81	0.002	0.0	0.	0.00
59.3	53	0.01	0	0.0100	9.16	0.000	0.0	0.	0.00
79.2	53	0.01	0	0.0100	**10.58**	**0.997**	10.6	111.	1.78
117.2	53	0.01	0	0.0100	12.87	0.028	0.4	0.	1.78
128.3	53	0.01	0	0.0100	13.47	0.030	0.4	0.	1.79
146.5	53	0.01	0	0.0100	14.39	0.194	2.8	8.	1.85
158.3	53	0.01	0	0.0100	14.96	0.396	5.9	35.	2.10
219.6	53	0.01	0	0.0100	17.62	0.504	8.9	79.	2.58
237.6	53	0.01	0	0.0100	18.33	0.065	1.2	1.	2.59
296.8	250	0.01	-4	0.0080	18.28	0.000	0.0	0.	2.59
335.2	250	0.01	-4	0.0068	17.91	0.001	0.0	0.	2.59
357.7	250	0.01	-4	0.0062	17.72	0.003	0.1	0.	2.59
420.8	250	0.01	-4	0.0050	17.26	0.005	0.1	0.	2.59
459.6	250	0.01	-4	0.0045	17.01	0.037	0.6	0.	2.59
508.7	250	0.01	-4	0.0039	16.73	0.026	0.4	0.	2.59
523.0	250	0.01	-4	0.0038	16.65	0.000	0.0	0.	2.59
545.7	250	0.01	-4	0.0035	16.54	0.006	0.1	0.	2.59
553.2	250	0.01	-4	0.0035	16.50	0.035	0.6	0.	2.59
592.2	250	0.01	-4	0.0032	16.31	0.002	0.0	0.	2.59
652.5	250	0.01	-4	0.0028	16.06	0.000	0.0	0.	2.59
675.0	250	0.01	-4	0.0027	15.97	0.002	0.0	0.	2.59
728.9	250	0.01	-4	0.0024	15.77	0.000	0.0	0.	2.59
776.8	250	0.01	-4	0.0022	15.60	0.000	0.0	0.	2.59
786.3	250	0.01	-4	0.0022	15.57	0.000	0.0	0.	2.59
823.4	250	0.01	-4	0.0021	15.45	0.001	0.0	0.	2.59
845.1	250	0.01	-4	0.0020	15.39	0.001	0.0	0.	2.59
871.1	250	0.01	-4	0.0019	15.31	0.001	0.0	0.	2.59
900.0	250	0.01	-4	0.0018	15.23	0.000	0.0	0.	2.59
930.0	250	0.01	-4	0.0017	15.15	0.000	0.0	0.	2.59
943.8	250	0.01	-4	0.0017	15.11	0.000	0.0	0.	2.59
959.7	250	0.01	-4	0.0017	15.07	0.001	0.0	0.	2.59
987.4	250	0.01	-4	0.0016	15.00	0.020	0.3	0.	2.60
1078.6	250	0.01	-4	0.0014	14.78	0.000	0.0	0.	2.60
1092.7	250	0.01	-4	0.0014	14.75	0.010	0.1	0.	2.60
1112.3	250	0.01	-4	0.0014	14.71	0.000	0.0	0.	2.60
1154.5	250	0.01	-4	0.0013	14.62	0.001	0.0	0.	2.60
1167.3	250	0.01	-4	0.0013	14.59	0.000	0.0	0.	2.60
1236.7	250	0.01	-4	0.0012	14.45	0.011	0.2	0.	2.60
1310.3	250	0.01	-4	0.0011	14.32	0.001	0.0	0.	2.60
1360.3	250	0.01	-4	0.0011	14.23	0.000	0.0	0.	2.60

LMS BDPU HVA CIRCUIT BREAKER PANEL RANDOM LOAD DERIVATION

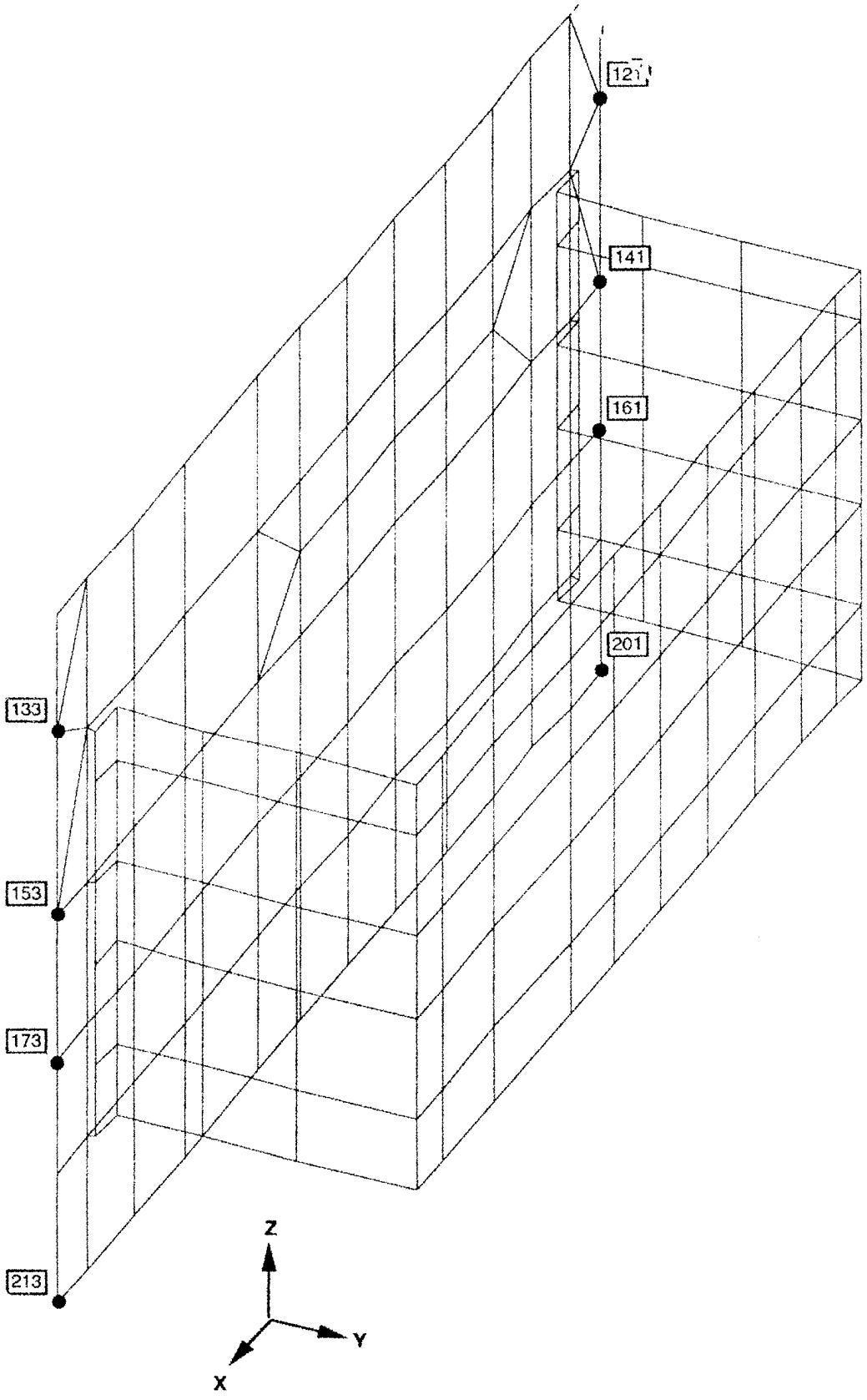
RANDOM LOAD FACTOR IN Z-AXIS

Input at the standard Spacelab Rack Interfaces - Z-Axis

F01 =	20	PSD01 =	0.00200	n1 =	5		Grms1=	0.43
F02 =	53	PSD02 =	0.01000	n2 =	0		Grms2=	1.40
F03 =	250	PSD03 =	0.01000	n3 =	-4		Grms3=	1.94
F04 =	2000	PSD04 =	0.00063	n4 =	0			
Q =	**10**						**Grms=**	**2.43**

FREQUENCY	F0	PSD0	SLOPE	PSD	RLF(i)	EFFW	RLF*EFFW	Force^2	RLF
1392.0	250	0.01	-4	0.0010	14.18	0.001	0.0	0.	2.60
1419.9	250	0.01	-4	0.0010	14.13	0.042	0.6	0.	2.60
1516.7	250	0.01	-4	0.0009	13.98	0.003	0.0	0.	2.60
1522.2	250	0.01	-4	0.0009	13.97	0.001	0.0	0.	2.60
1570.1	250	0.01	-4	0.0009	13.90	0.000	0.0	0.	2.60
1591.8	250	0.01	-4	0.0009	13.87	0.002	0.0	0.	2.60
1646.1	250	0.01	-4	0.0008	13.79	0.000	0.0	0.	2.60
1713.4	250	0.01	-4	0.0008	13.70	0.004	0.1	0.	2.60
1717.0	250	0.01	-4	0.0008	13.70	0.002	0.0	0.	2.60
1770.6	250	0.01	-4	0.0007	13.63	0.000	0.0	0.	2.60
1830.7	250	0.01	-4	0.0007	13.55	0.000	0.0	0.	2.60
1909.3	250	0.01	-4	0.0007	13.46	0.006	0.1	0.	2.60
1918.6	250	0.01	-4	0.0007	**13.45**	**2.508**	33.7	1138.	6.26
1939.5	250	0.01	-4	0.0007	13.42	0.006	0.1	0.	6.26
1960.2	250	0.01	-4	0.0006	13.40	0.001	0.0	0.	6.26
2000.0	2000	0.0006	0	0.0006	7.29	0.961	7.0	49.	6.37

EFFWSUM	4.96		RLF (RSS) =	37.7
EFFWRATIO	0.84		MASS =	5.92
			RLF =	**6.37**
Delta Wt.=	0.961			



Panel = 0.190" thick

CIRCUIT BREAKER PANEL INTERFACE FORCE COMPARISON - MILES EQN, EFF WT/RSS, RANDOM RESP
(RE-DESIGN OF CIRCUIT BREAKER PANEL WITH 0.19 INCH THICKNESS)

Axis	Grid No.	RLF Method	X (Lbs)	Y (Lbs)	Z (Lbs)	RSS Force
X-Axis	121	Miles Equation	-13.8	-0.4	3.5	14.2
		Eff. Wt./RSS	-5.0	-0.1	1.3	5.1
		Random Response	4.6	1.2	2.8	5.5
	133	Miles Equation	-12.1	0.4	-3.2	12.5
		Eff. Wt./RSS	-4.4	0.1	-1.2	4.5
		Random Response	4.4	1.8	2.7	5.4
	141	Miles Equation	-13.2	-4.7	0.6	14.0
		Eff. Wt./RSS	-4.8	-1.7	0.2	5.1
		Random Response	4.9	4.3	0.5	6.5
	153	Miles Equation	-12.1	4.6	-0.5	13.0
		Eff. Wt./RSS	-4.4	1.7	-0.2	4.7
		Random Response	4.6	3.7	0.5	6.0
	161	Miles Equation	-9.4	-3.2	-0.4	9.9
		Eff. Wt./RSS	-3.4	-1.1	-0.1	3.6
		Random Response	2.9	2.8	0.8	4.1
	173	Miles Equation	-8.9	3.3	0.2	9.5
		Eff. Wt./RSS	-3.2	1.2	0.1	3.4
		Random Response	2.8	2.3	0.8	3.7
	201	Miles Equation	-7.4	0.0	-4.3	8.6
		Eff. Wt./RSS	-2.7	0.0	-1.6	3.1
		Random Response	2.8	0.5	2.5	3.8
	213	Miles Equation	-7.4	0.0	4.2	8.5
		Eff. Wt./RSS	-2.7	0.0	1.5	3.1
		Random Response	2.7	0.7	2.4	3.6

Notes: 1. Miles Equation Loads RLFx=12.05 g; RLFy=10.76 g; RLFz=12.80 g
2. Effective Weight/RSS RLFx=4.35 g; RLFy=7.69 g; RLFz=3.63 g

CIRCUIT BREAKER PANEL INTERFACE FORCE COMPARISON - MILES EQN, EFF WT/RSS, RANDOM RESP
(RE-DESIGN OF CIRCUIT BREAKER PANEL WITH 0.19 INCH THICKNESS)

Axis	Grid No.	RLF Method	X (Lbs)	Y (Lbs)	Z (Lbs)	RSS Force
Y-Axis	121	Miles Equation	-1.7	-12.3	-0.1	12.4
		Eff. Wt./RSS	-1.2	-8.8	-0.1	8.9
		Random Response	1.6	9.3	0.6	9.5
	133	Miles Equation	1.8	-11.6	-0.2	11.7
		Eff. Wt./RSS	1.3	-8.3	-0.1	8.4
		Random Response	1.9	8.4	0.6	8.7
	141	Miles Equation	-7.2	-10.1	0.7	12.4
		Eff. Wt./RSS	-5.2	-7.2	0.5	8.9
		Random Response	5.2	7.3	1.1	9.0
	153	Miles Equation	7.1	-9.8	0.6	12.2
		Eff. Wt./RSS	5.1	-7.0	0.4	8.7
		Random Response	5.3	7.2	1.0	9.0
	161	Miles Equation	-2.3	-11.1	0.1	11.3
		Eff. Wt./RSS	-1.6	-7.9	0.1	8.1
		Random Response	1.6	7.2	0.6	7.4
	173	Miles Equation	2.4	-11.1	0.2	11.3
		Eff. Wt./RSS	1.7	-7.9	0.1	8.1
		Random Response	1.9	7.2	0.5	7.5
	201	Miles Equation	-1.1	-4.5	-0.7	4.7
		Eff. Wt./RSS	-0.8	-3.2	-0.5	3.4
		Random Response	0.8	2.9	0.6	3.1
	213	Miles Equation	1.1	-4.8	-0.6	4.9
		Eff. Wt./RSS	0.8	-3.4	-0.4	3.5
		Random Response	1.0	3.1	0.7	3.3

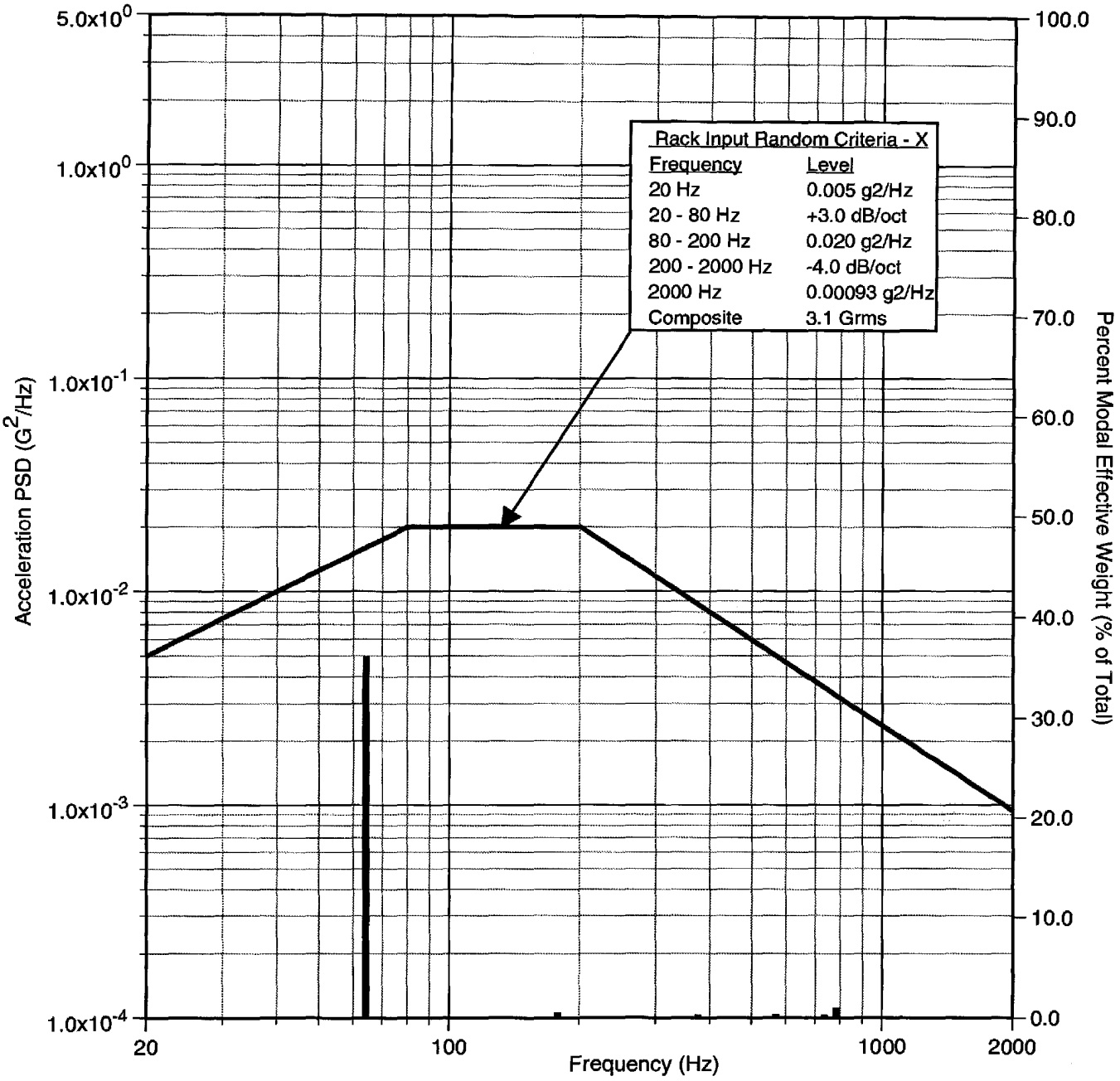
Notes: 1. Miles Equation Loads RLFx=12.05 g; RLFy=10.76 g; RLFz=12.80 g
2. Effective Weight/RSS RLFx=4.35 g; RLFy=7.69 g; RLFz=3.63 g

CIRCUIT BREAKER PANEL INTERFACE FORCE COMPARISON - MILES EQN, EFF WT/RSS, RANDOM RESP
(RE-DESIGN OF CIRCUIT BREAKER PANEL WITH 0.19 INCH THICKNESS)

Axis	Grid No.	RLF Method	X (Lbs)	Y (Lbs)	Z (Lbs)	RSS Force
Z-Axis	121	Miles Equation	15.9	12.2	-10.3	22.5
		Eff. Wt./RSS	4.5	3.5	-2.9	6.4
		Random Response	3.5	11.0	3.4	12.0
	133	Miles Equation	-15.5	14.5	-10.1	23.5
		Eff. Wt./RSS	-4.4	4.1	-2.9	6.7
		Random Response	3.5	10.5	3.3	11.5
	141	Miles Equation	0.5	0.7	-13.8	13.8
		Eff. Wt./RSS	0.1	0.2	-3.9	3.9
		Random Response	0.5	1.5	4.1	4.4
	153	Miles Equation	-0.6	0.9	-13.4	13.5
		Eff. Wt./RSS	-0.2	0.3	-3.8	3.8
		Random Response	0.4	1.4	4.0	4.2
	161	Miles Equation	-5.4	-5.2	-12.3	14.4
		Eff. Wt./RSS	-1.5	-1.5	-3.5	4.1
		Random Response	1.7	4.6	3.7	6.2
	173	Miles Equation	5.5	-6.3	-11.9	14.6
		Eff. Wt./RSS	1.6	-1.8	-3.4	4.1
		Random Response	1.7	4.7	3.6	6.2
	201	Miles Equation	-12.1	-7.7	-9.0	16.9
		Eff. Wt./RSS	-3.4	-2.2	-2.5	4.8
		Random Response	2.0	6.8	2.1	7.4
	213	Miles Equation	11.9	-9.1	-8.8	17.3
		Eff. Wt./RSS	3.4	-2.6	-2.5	4.9
		Random Response	2.1	7.0	2.2	7.7

Notes: 1. Miles Equation Loads RLFx=12.05 g; RLFy=10.76 g; RLFz=12.80 g
2. Effective Weight/RSS RLFx=4.35 g; RLFy=7.69 g; RLFz=3.63 g

LMS CIRCUIT BREAKER PANEL RANDOM INPUT
MODAL EFFECTIVE WEIGHTS - X-AXIS



LMS BDPU HVA CIRCUIT BREAKER PANEL RLF DERIVATION (0.19" THICK PANEL)

RANDOM LOAD FACTOR IN X-AXIS

Input at the standard Spacelab Rack Interfaces - X-Axis

F01 =	20	PSD01 =	0.00500	n1 =	3		Grms1=	0.87
F02 =	80	PSD02 =	0.02000	n2 =	0		Grms2=	1.55
F03 =	200	PSD03 =	0.02000	n3 =	-4		Grms3=	2.54
F04 =	2000	PSD04 =	0.00093	n4 =	0			
Q =	**10**						**Grms=**	**3.10**

FREQUENCY	F0	PSD0	SLOPE	PSD	RLF(i)	EFFW	RLF*EFFW	Force^2	RLF
54.8	20	0.005	3	0.0137	10.29	0.002	0.0	0.	0.00
64.2	20	0.005	3	0.0160	**12.05**	**2.522**	30.4	923.	4.34
116.0	80	0.02	0	0.0200	18.11	0.001	0.0	0.	4.34
124.1	80	0.02	0	0.0200	18.73	0.006	0.1	0.	4.34
178.6	80	0.02	0	0.0200	22.47	0.034	0.8	1.	4.35
200.1	200	0.02	-4	0.0200	23.78	0.001	0.0	0.	4.35
218.1	200	0.02	-4	0.0178	23.44	0.001	0.0	0.	4.35
260.5	200	0.02	-4	0.0141	22.77	0.000	0.0	0.	4.35
349.7	200	0.02	-4	0.0095	21.69	0.004	0.1	0.	4.35
377.1	200	0.02	-4	0.0086	21.43	0.022	0.5	0.	4.35
465.7	200	0.02	-4	0.0065	20.69	0.001	0.0	0.	4.35
522.2	200	0.02	-4	0.0056	20.31	0.000	0.0	0.	4.35
536.2	200	0.02	-4	0.0054	20.22	0.001	0.0	0.	4.35
546.3	200	0.02	-4	0.0053	20.16	0.000	0.0	0.	4.35
570.3	200	0.02	-4	0.0050	20.02	0.024	0.5	0.	4.35
641.3	200	0.02	-4	0.0043	19.63	0.000	0.0	0.	4.35
680.7	200	0.02	-4	0.0039	19.44	0.001	0.0	0.	4.35
737.0	200	0.02	-4	0.0035	19.19	0.020	0.4	0.	4.35
740.7	200	0.02	-4	0.0035	19.17	0.000	0.0	0.	4.35
785.7	200	0.02	-4	0.0032	18.99	0.069	1.3	2.	4.35
852.8	200	0.02	-4	0.0029	18.74	0.000	0.0	0.	4.35
868.2	200	0.02	-4	0.0028	18.68	0.002	0.0	0.	4.35
915.4	200	0.02	-4	0.0027	18.52	0.002	0.0	0.	4.35
932.5	200	0.02	-4	0.0026	18.46	0.001	0.0	0.	4.35
976.7	200	0.02	-4	0.0024	18.32	0.002	0.0	0.	4.35
988.5	200	0.02	-4	0.0024	18.29	0.000	0.0	0.	4.35
1041.0	200	0.02	-4	0.0022	18.13	0.003	0.1	0.	4.35
1077.9	200	0.02	-4	0.0021	18.03	0.000	0.0	0.	4.35
1119.7	200	0.02	-4	0.0020	17.92	0.000	0.0	0.	4.35
1125.6	200	0.02	-4	0.0020	17.90	0.003	0.1	0.	4.35
1160.0	200	0.02	-4	0.0019	17.81	0.000	0.0	0.	4.35
1259.3	200	0.02	-4	0.0017	17.57	0.007	0.1	0.	4.35
1292.6	200	0.02	-4	0.0017	17.50	0.000	0.0	0.	4.35
1338.6	200	0.02	-4	0.0016	17.40	0.000	0.0	0.	4.35
1356.1	200	0.02	-4	0.0016	17.36	0.000	0.0	0.	4.35
1396.9	200	0.02	-4	0.0015	17.28	0.000	0.0	0.	4.35
1423.2	200	0.02	-4	0.0015	17.22	0.000	0.0	0.	4.35
1509.0	200	0.02	-4	0.0014	17.06	0.000	0.0	0.	4.35
1591.9	200	0.02	-4	0.0013	16.91	0.000	0.0	0.	4.35
1610.3	200	0.02	-4	0.0013	16.88	0.000	0.0	0.	4.35
1643.1	200	0.02	-4	0.0012	16.82	0.001	0.0	0.	4.35

LMS BDPU HVA CIRCUIT BREAKER PANEL RLF DERIVATION (0.19" THICK PANEL)

RANDOM LOAD FACTOR IN X-AXIS

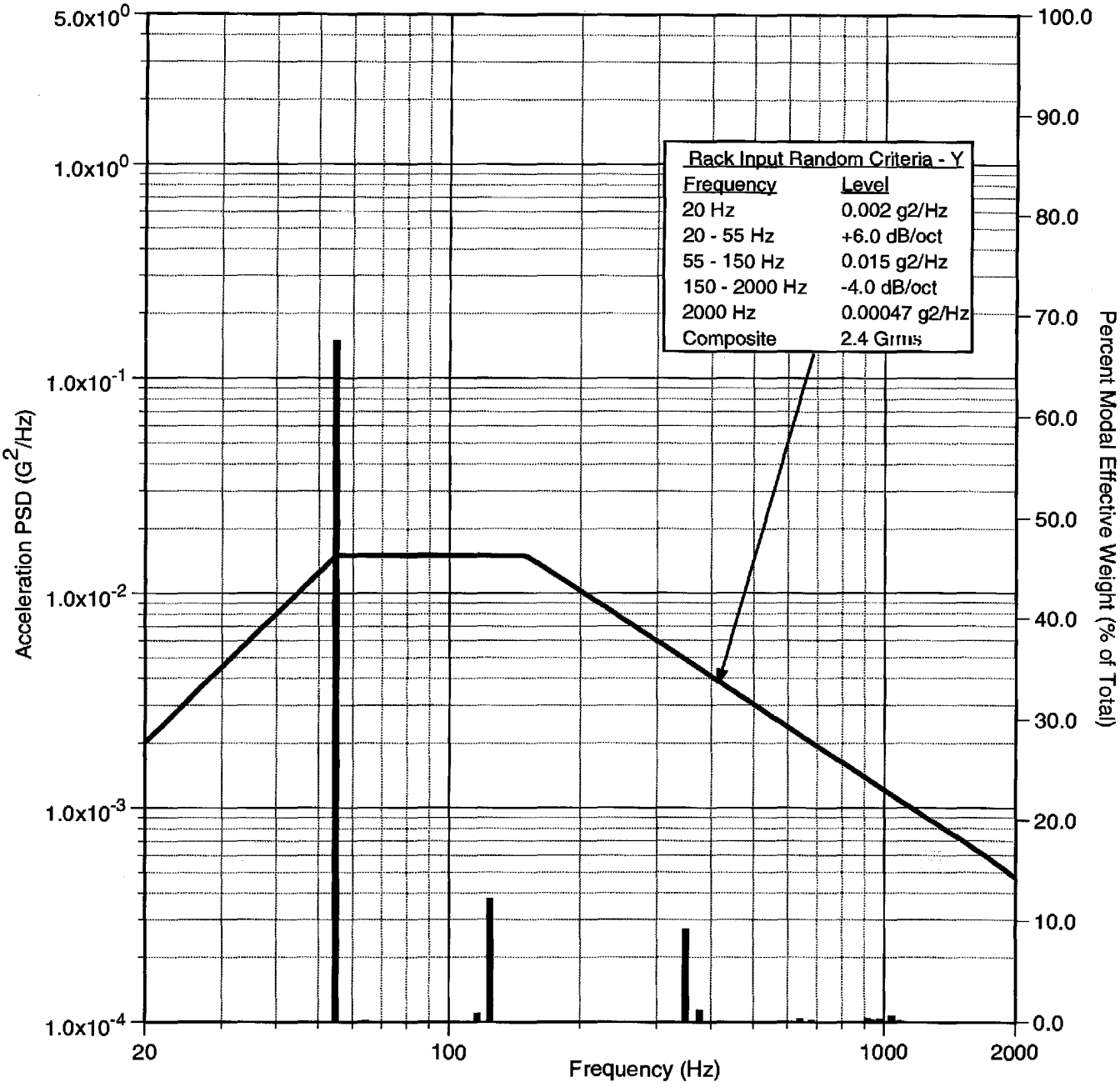
Input at the standard Spacelab Rack Interfaces - X-Axis

F01 =	20	PSD01 =	0.00500	n1 =	3		Grms1=	0.87
F02 =	80	PSD02 =	0.02000	n2 =	0		Grms2=	1.55
F03 =	200	PSD03 =	0.02000	n3 =	-4		Grms3=	2.54
F04 =	2000	PSD04 =	0.00093	n4 =	0			
Q =	**10**						**Grms=**	**3.10**

FREQUENCY	F0	PSD0	SLOPE	PSD	RLF(i)	EFFW	RLF*EFFW	Force^2	RLF
1691.4	200	0.02	-4	0.0012	16.74	0.000	0.0	0.	4.35
1750.4	200	0.02	-4	0.0011	16.65	0.000	0.0	0.	4.35
1773.0	200	0.02	-4	0.0011	16.61	0.000	0.0	0.	4.35
1993.8	200	0.02	-4	0.0009	16.29	0.000	0.0	0.	4.35

EFFWSUM	2.73		RLF (RSS) =	30.4
EFFWRATIO	0.39		MASS =	6.99
			RLF =	**4.35**
Delta Wt.=	4.2619			

LMS CIRCUIT BREAKER PANEL RANDOM INPUT
MODAL EFFECTIVE WEIGHTS - Y-AXIS



LMS BDPU HVA CIRCUIT BREAKER PANEL RLF DERIVATION (0.19" THICK PANEL)

RANDOM LOAD FACTOR IN Y-AXIS

Input at the standard Spacelab Rack Interfaces - Y-Axis

F01 =	20	PSD01 =	0.00200	n1 =	6		Grms1=	0.51
F02 =	55	PSD02 =	0.01500	n2 =	0		Grms2=	1.19
F03 =	150	PSD03 =	0.01500	n3 =	-4		Grms3=	1.98
F04 =	2000	PSD04 =	0.00047	n4 =	0			
Q =	**10**						**Grms=**	**2.36**

FREQUENCY	F0	PSD0	SLOPE	PSD	RLF(i)	EFFW	RLF*EFFW	Force^2	RLF
54.8	20	0.002	6	0.0149	**10.76**	**4.727**	50.9	2587.	7.27
64.2	55	0.015	0	0.0150	11.67	0.012	0.1	0.	7.27
116.0	55	0.015	0	0.0150	15.68	0.061	1.0	1.	7.28
124.1	55	0.015	0	0.0150	16.22	0.863	14.0	196.	7.55
178.6	150	0.015	-4	0.0119	17.33	0.004	0.1	0.	7.55
200.1	150	0.015	-4	0.0102	17.01	0.002	0.0	0.	7.55
218.1	150	0.015	-4	0.0091	16.77	0.000	0.0	0.	7.55
260.5	150	0.015	-4	0.0072	16.29	0.009	0.1	0.	7.55
349.7	150	0.015	-4	0.0049	15.52	0.646	10.0	100.	7.68
377.1	150	0.015	-4	0.0044	15.33	0.087	1.3	2.	7.68
465.7	150	0.015	-4	0.0033	14.80	0.002	0.0	0.	7.68
522.2	150	0.015	-4	0.0029	14.53	0.001	0.0	0.	7.68
536.2	150	0.015	-4	0.0028	14.47	0.002	0.0	0.	7.68
546.3	150	0.015	-4	0.0027	14.42	0.003	0.0	0.	7.68
570.3	150	0.015	-4	0.0025	14.32	0.000	0.0	0.	7.68
641.3	150	0.015	-4	0.0022	14.05	0.031	0.4	0.	7.68
680.7	150	0.015	-4	0.0020	13.91	0.012	0.2	0.	7.68
737.0	150	0.015	-4	0.0018	13.73	0.000	0.0	0.	7.68
740.7	150	0.015	-4	0.0018	13.72	0.000	0.0	0.	7.68
785.7	150	0.015	-4	0.0017	13.58	0.000	0.0	0.	7.68
852.8	150	0.015	-4	0.0015	13.40	0.005	0.1	0.	7.68
868.2	150	0.015	-4	0.0015	13.36	0.008	0.1	0.	7.68
915.4	150	0.015	-4	0.0014	13.25	0.028	0.4	0.	7.68
932.5	150	0.015	-4	0.0013	13.21	0.020	0.3	0.	7.68
976.7	150	0.015	-4	0.0012	13.11	0.030	0.4	0.	7.68
988.5	150	0.015	-4	0.0012	13.08	0.002	0.0	0.	7.68
1041.0	150	0.015	-4	0.0011	12.97	0.052	0.7	0.	7.69
1077.9	150	0.015	-4	0.0011	12.90	0.012	0.2	0.	7.69
1119.7	150	0.015	-4	0.0010	12.82	0.001	0.0	0.	7.69
1125.6	150	0.015	-4	0.0010	12.80	0.005	0.1	0.	7.69
1160.0	150	0.015	-4	0.0010	12.74	0.000	0.0	0.	7.69
1259.3	150	0.015	-4	0.0009	12.57	0.000	0.0	0.	7.69
1292.6	150	0.015	-4	0.0009	12.52	0.002	0.0	0.	7.69
1338.6	150	0.015	-4	0.0008	12.45	0.000	0.0	0.	7.69
1356.1	150	0.015	-4	0.0008	12.42	0.003	0.0	0.	7.69
1396.9	150	0.015	-4	0.0008	12.36	0.004	0.0	0.	7.69
1423.2	150	0.015	-4	0.0008	12.32	0.001	0.0	0.	7.69
1509.0	150	0.015	-4	0.0007	12.20	0.004	0.0	0.	7.69
1591.9	150	0.015	-4	0.0007	12.10	0.000	0.0	0.	7.69
1610.3	150	0.015	-4	0.0006	12.07	0.000	0.0	0.	7.69
1643.1	150	0.015	-4	0.0006	12.03	0.003	0.0	0.	7.69

LMS BDPU HVA CIRCUIT BREAKER PANEL RLF DERIVATION (0.19" THICK PANEL)

RANDOM LOAD FACTOR IN Y-AXIS

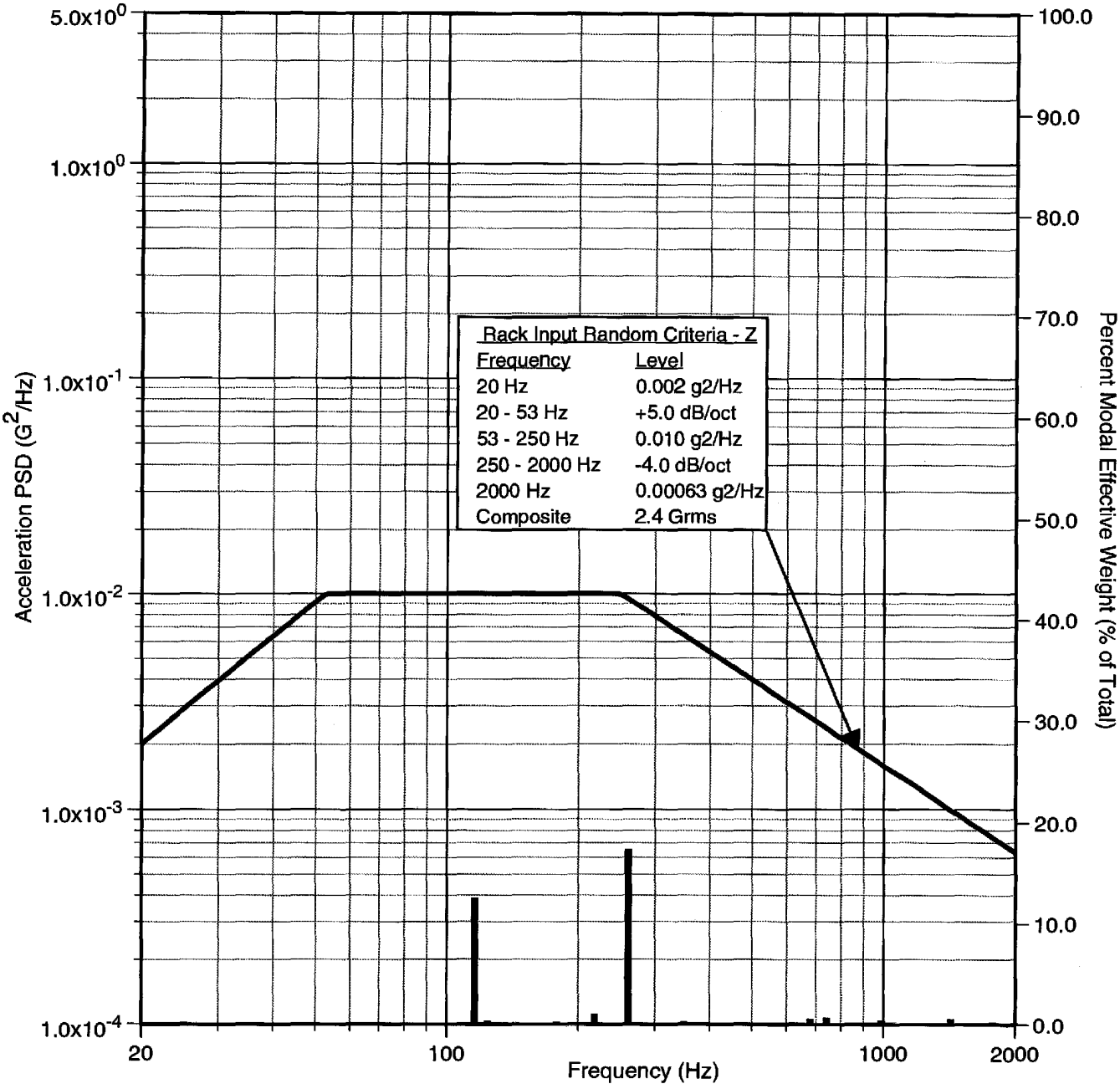
Input at the standard Spacelab Rack Interfaces - Y-Axis

F01 =	20	PSD01 =	0.00200	n1 =	6		Grms1=	0.51
F02 =	55	PSD02 =	0.01500	n2 =	0		Grms2=	1.19
F03 =	150	PSD03 =	0.01500	n3 =	-4		Grms3=	1.98
F04 =	2000	PSD04 =	0.00047	n4 =	0			
Q =	10						**Grms=**	**2.36**

FREQUENCY	F0	PSD0	SLOPE	PSD	RLF(i)	EFFW	RLF*EFFW	Force^2	RLF
1691.4	150	0.015	-4	0.0006	11.98	0.001	0.0	0.	7.69
1750.4	150	0.015	-4	0.0006	11.91	0.002	0.0	0.	7.69
1773.0	150	0.015	-4	0.0006	11.88	0.000	0.0	0.	7.69
1993.8	150	0.015	-4	0.0005	11.66	0.000	0.0	0.	7.69

EFFWSUM	6.65		RLF (RSS) =	53.7
EFFWRATIO	0.95		MASS =	6.99
			RLF =	**7.69**
Delta Wt.=	0.3469			

LMS CIRCUIT BREAKER PANEL RANDOM INPUT MODAL EFFECTIVE WEIGHTS - Z-AXIS



LMS BDPU HVA CIRCUIT BREAKER PANEL RLF DERIVATION (0.19" THICK PANEL)

RANDOM LOAD FACTOR IN Z-AXIS

Input at the standard Spacelab Rack Interfaces - Z-Axis

F01 =	20	PSD01 =	0.00200	n1 =	5		Grms1=	0.43
F02 =	53	PSD02 =	0.01000	n2 =	0		Grms2=	1.40
F03 =	250	PSD03 =	0.01000	n3 =	-4		Grms3=	1.94
F04 =	2000	PSD04 =	0.00063	n4 =	0			
Q =	**10**						**Grms=**	**2.43**

FREQUENCY	F0	PSD0	SLOPE	PSD	RLF(i)	EFFW	RLF*EFFW	Force^2	RLF
54.8	53	0.01	0	0.0100	8.81	0.001	0.0	0.	0.00
64.2	53	0.01	0	0.0100	9.53	0.000	0.0	0.	0.00
116.0	53	0.01	0	0.0100	**12.80**	**0.879**	11.3	127.	1.61
124.1	53	0.01	0	0.0100	13.25	0.025	0.3	0.	1.61
178.6	53	0.01	0	0.0100	15.89	0.024	0.4	0.	1.61
200.1	53	0.01	0	0.0100	16.82	0.010	0.2	0.	1.61
218.1	53	0.01	0	0.0100	17.56	0.073	1.3	2.	1.62
260.5	250	0.01	-4	0.0095	**18.67**	**1.216**	22.7	516.	3.63
349.7	250	0.01	-4	0.0064	17.79	0.018	0.3	0.	3.63
377.1	250	0.01	-4	0.0058	17.57	0.002	0.0	0.	3.63
465.7	250	0.01	-4	0.0044	16.97	0.000	0.0	0.	3.63
522.2	250	0.01	-4	0.0038	16.66	0.000	0.0	0.	3.63
536.2	250	0.01	-4	0.0036	16.58	0.002	0.0	0.	3.63
546.3	250	0.01	-4	0.0035	16.53	0.001	0.0	0.	3.63
570.3	250	0.01	-4	0.0033	16.42	0.000	0.0	0.	3.63
641.3	250	0.01	-4	0.0029	16.10	0.001	0.0	0.	3.63
680.7	250	0.01	-4	0.0026	15.95	0.039	0.6	0.	3.63
737.0	250	0.01	-4	0.0024	15.74	0.005	0.1	0.	3.63
740.7	250	0.01	-4	0.0024	15.73	0.048	0.8	1.	3.63
785.7	250	0.01	-4	0.0022	15.57	0.004	0.1	0.	3.63
852.8	250	0.01	-4	0.0020	15.37	0.003	0.0	0.	3.63
868.2	250	0.01	-4	0.0019	15.32	0.000	0.0	0.	3.63
915.4	250	0.01	-4	0.0018	15.19	0.000	0.0	0.	3.63
932.5	250	0.01	-4	0.0017	15.14	0.000	0.0	0.	3.63
976.7	250	0.01	-4	0.0016	15.03	0.008	0.1	0.	3.63
988.5	250	0.01	-4	0.0016	15.00	0.030	0.4	0.	3.63
1041.0	250	0.01	-4	0.0015	14.87	0.005	0.1	0.	3.63
1077.9	250	0.01	-4	0.0014	14.78	0.007	0.1	0.	3.63
1119.7	250	0.01	-4	0.0014	14.69	0.002	0.0	0.	3.63
1125.6	250	0.01	-4	0.0014	14.68	0.000	0.0	0.	3.63
1160.0	250	0.01	-4	0.0013	14.61	0.000	0.0	0.	3.63
1259.3	250	0.01	-4	0.0012	14.41	0.000	0.0	0.	3.63
1292.6	250	0.01	-4	0.0011	14.35	0.001	0.0	0.	3.63
1338.6	250	0.01	-4	0.0011	14.27	0.000	0.0	0.	3.63
1356.1	250	0.01	-4	0.0011	14.24	0.000	0.0	0.	3.63
1396.9	250	0.01	-4	0.0010	14.17	0.000	0.0	0.	3.63
1423.2	250	0.01	-4	0.0010	14.12	0.040	0.6	0.	3.63
1509.0	250	0.01	-4	0.0009	13.99	0.002	0.0	0.	3.63
1591.9	250	0.01	-4	0.0009	13.87	0.001	0.0	0.	3.63
1610.3	250	0.01	-4	0.0008	13.84	0.005	0.1	0.	3.63
1643.1	250	0.01	-4	0.0008	13.79	0.004	0.1	0.	3.63

LMS BDPU HVA CIRCUIT BREAKER PANEL RLF DERIVATION (0.19" THICK PANEL)

RANDOM LOAD FACTOR IN Z-AXIS

Input at the standard Spacelab Rack Interfaces - Z-Axis

F01 =	20	PSD01 =	0.00200	n1 =	5		Grms1=	0.43
F02 =	53	PSD02 =	0.01000	n2 =	0		Grms2=	1.40
F03 =	250	PSD03 =	0.01000	n3 =	-4		Grms3=	1.94
F04 =	2000	PSD04 =	0.00063	n4 =	0			
Q =	**10**						**Grms=**	**2.43**

FREQUENCY	F0	PSD0	SLOPE	PSD	RLF(i)	EFFW	RLF*EFFW	Force^2	RLF
1691.4	250	0.01	-4	0.0008	13.73	0.001	0.0	0.	3.63
1750.4	250	0.01	-4	0.0008	13.65	0.003	0.0	0.	3.63
1773.0	250	0.01	-4	0.0007	13.62	0.019	0.3	0.	3.63
1993.8	250	0.01	-4	0.0006	13.36	0.014	0.2	0.	3.63

EFFWSUM	2.49		RLF (RSS) =	25.4
EFFWRATIO	0.36		MASS =	6.99
			RLF =	**3.63**
Delta Wt.=	4.4989			