# MENTORS-PEERS

# PRACTICAL APPROACHES FOR RANDOM LOAD FACTORS

November 21, 2008



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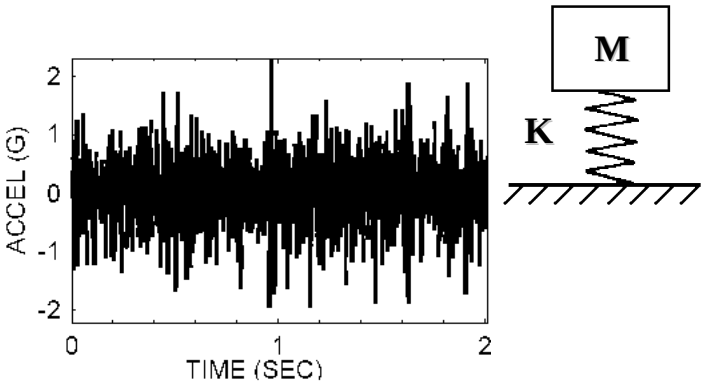
# MILES' EQUATION




$$RLF = 3 \times \sqrt{\frac{\pi}{2} \times f_n \times PSD_i \times Q}$$

- $3\sigma$: 3-Sigma RMS to Peak
- $f_n$: Natural Freq (Hz)
- $PSD_i$: Acceleration PSD ($g^2$/Hz)
- $Q$: Amplification Factor $\frac{1}{2 \times \zeta}$

- **In 1954 John Miles developed a method to calculate the Root Mean Square (RMS) acceleration for a Single Degree of Freedom (SDOF) system excited by a random vibration excitation.**
  - **Simplifying assumption that the system behaves as a SDOF (i.e., all of the system responds uniformly at a single natural frequency).**
  - **SDOF is excited by a "white-noise" random source (constant broadband acceleration Power Spectral Density (PSD)).**
  - **Q is the Amplification Factor, or 1/(2 x $C/C_o$)**



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# MILES' EQUATION GUIDELINES

- **Miles' Equation is a conservative approach for calculating an equivalent static load factor to account for a component's response to random vibration excitation.**
  - **Appropriate for calculating component interface loads.**
  - **Not applicable for calculating the internal responses (i.e., stresses, strains, deflections, or loads within that component).**
- **Random Response analysis is required to determine responses internal to the component resulting from random vibration excitation.**
  - **Miles' Equation assumes that the component responds uniformly as a Single Degree of Freedom system, and thus does not account for local responses to internal higher-order modes of the structure.**


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# MILES' EQUATION GUIDELINES

- **Calculating Random Load Factors using Miles' Equation (Per JA-418).**
  - **By calculation or test, determine the first natural frequency, $f_n$ in each axis.**
  - **Determine the resonant amplification factor, Q.**
    - **From test data, if available.**
    - **Estimated to be between 5 and 15 if no data is available. ($C/C_o$ of 3.33% - 5%).**
  - **Using the natural frequency calculated above, and the applicable random vibration input criteria, the acceleration Power Spectral Density (PSD) $g^2/Hz$ corresponding to the natural frequency $f_n$ can be determined. If $f_n$ falls on a sloped portion of the PSD spectrum, PSD can be interpolated using the following:**

$$PSD = PSD_1 \times 10^k$$

**Where:** $k = 0.3322 \times S \times \log\left(\frac{f_n}{f_1}\right)$

**S = Slope of the PSD function (dB per octave)**

**$F_1$ = Lowest freq. given for the portion of the PSD spectrum being interpolated.**

**log = logarithm to the base 10.**


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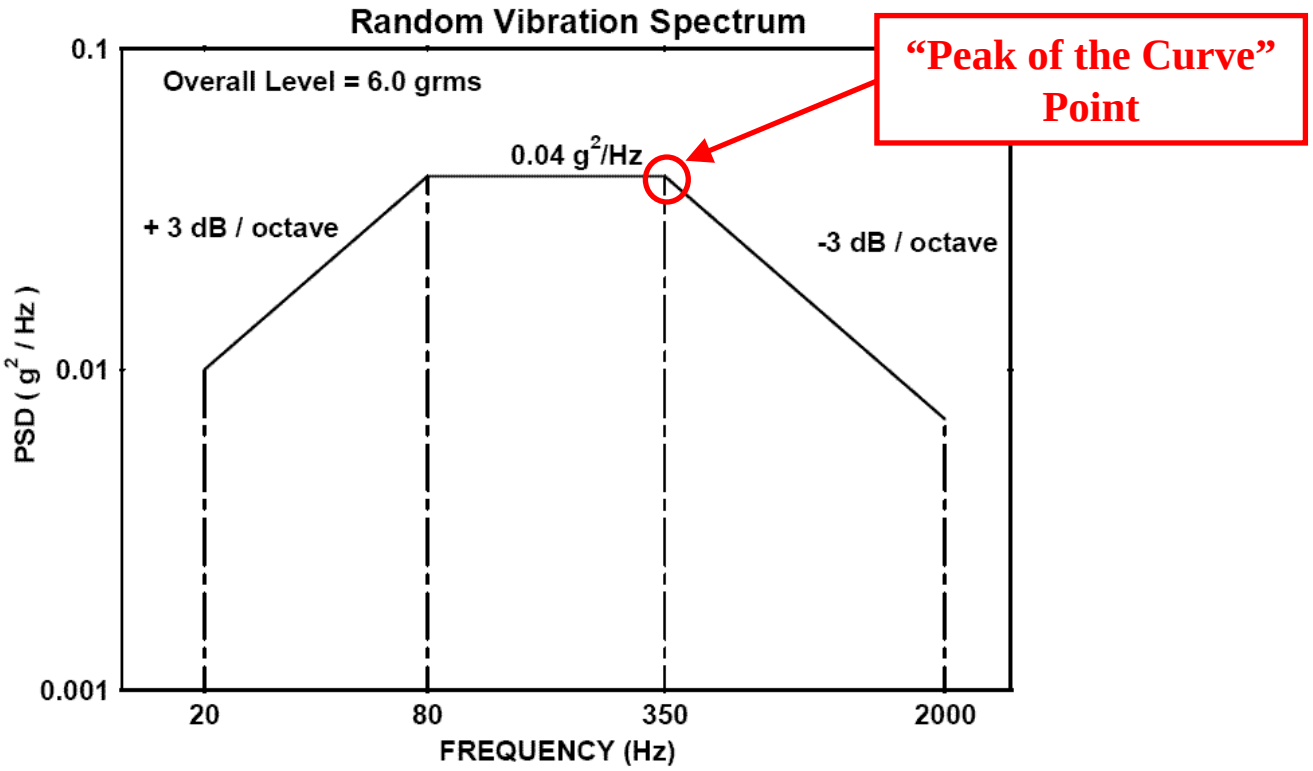
# "Peak-of-the-Curve" Random Load Factor




- **Preliminary structural analysis can be performed for Peak-of-the-Curve point (i.e., 350 Hz & 0.04 $g^2$/Hz in this case).**
  - **Use Miles' Equation to calculate a worst case Random Load Factor.**
  - **Appropriate for small/lightweight components where high random load factors won't drive the design.**
  - **Good for a large number of similar components, such as cabling, lines, plumbing.**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# "Peak-of-the-Curve" Random Load Factor

- **Random load factors were calculated for structural analysis of cabling used on Spacelab Pallet missions.**
  - **Large variation in configurations (small cable bundles, large wiring harnesses, rigid plumbing lines, wire-braided flex line …).**
  - **Attached to a variety of locations (pallet hardpoints, honeycomb panels), with different random vibration environments.**
  - **Used Peak-of-the-Curve load factors (envelopes all possible applications), with the worst-case random environment.**
- **Additional approaches used to resolve Margin of Safety issues:**
  - **Used acoustic test data for the OSS-1 pallet to show cable bundles exhibit high modal damping (Q=2.0 or C/Co = 25%).**
  - **Performed static loads test on cable attach hardware (standoffs, channels, cable ties) to allow use of Tested Factor of Safety (1.25 on yield/1.4 on ultimate, versus 1.4 on yield/2.0 on ultimate for untested structure).**
  - **Calculated specific Random Load Factors for problem components (i.e., specific cable spans, locations).**


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# “Peak-of-the-Curve” Random Load Factor

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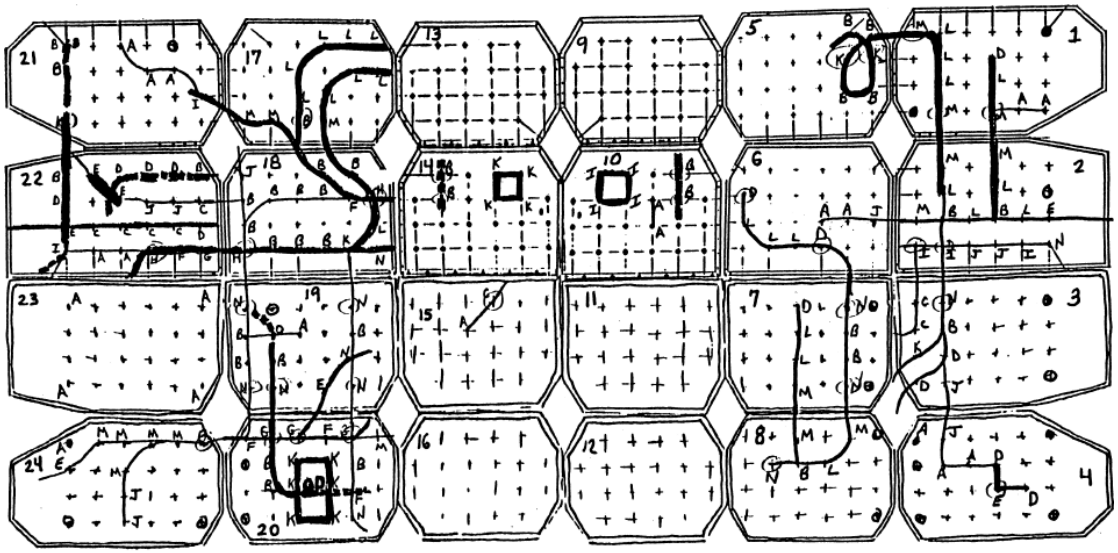
7.3 Acoustic Excitation Levels

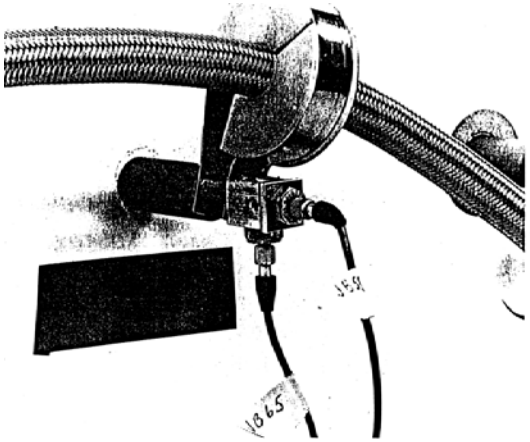
The Acoustic Noise Spectrum inside the Reverberation Test Chamber was controlled by the spatial average of 8 microphones, distributed around the test article. The specified qualification level noise spectrum was taken from Shuttle Vehicle/Spacelab Structural/Mechanical Interface Control Document ICD-2-05101, para. 3.3.1.2, Table 3.3.1.2-2.

| Frequency (Hz) | Sound Pressure Level (dB) re $2 \times 10^{-5}$ N/m² | Tolerances |
|---|---|---|
| 31,5 | 122 | ± 5 dB |
| 40 | 124 | ± 5 dB |
| 50 | 126 | ± 3 dB |
| 63 | 127,5 | ± 3 dB |
| 80 | 129,5 | ± 3 dB |
| 100 | 130,5 | ± 3 dB |
| 125 | 132 | ± 3 dB |
| 160 | 133 | ± 3 dB |
| 200 | 133,5 | ± 3 dB |
| 250 | 133 | ± 3 dB |
| 320 | 132 | ± 3 dB |
| 400 | 131 | ± 3 dB |
| 500 | 129 | ± 3 dB |
| 630 | 127,5 | ± 3 dB |
| 800 | 126 | ± 3 dB |
| 1000 | 124 | ± 3 dB |
| 1250 | 122 | ± 3 dB |
| 1600 | 120 | ± 3 dB |
| 2000 | 117,5 | ± 3 dB |
| 2500 | 115 | ± 3 dB |
| 3200 | 112,5 | ± 5 dB |
| 4000 | 110 | ± 5 dB |
| 5000 | 107 | ± 5 dB |
| 6300 | 103,5 | ± 5 dB |
| 8000 | 100 | ± 5 dB |
| 10000 | 96 | ± 5 dB |

142.2



- Structure
- Electrical Harness
- Freon Lines (SS)
- Freon Lines (Flex)
- MLI Attachment





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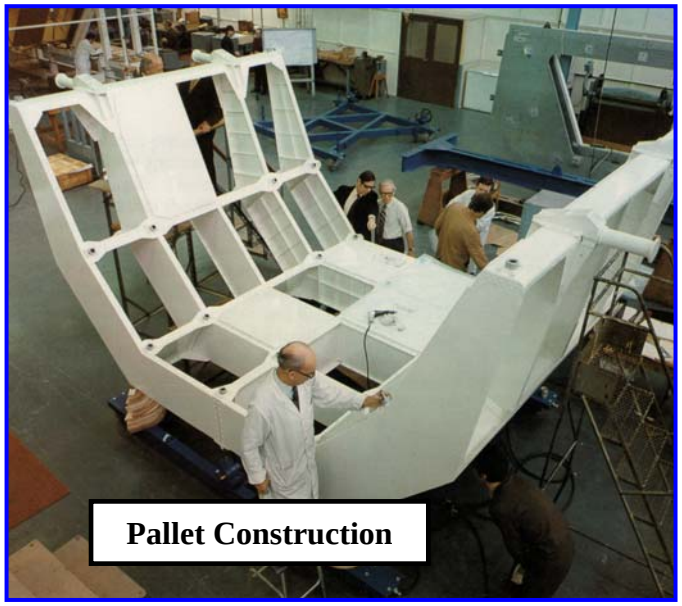


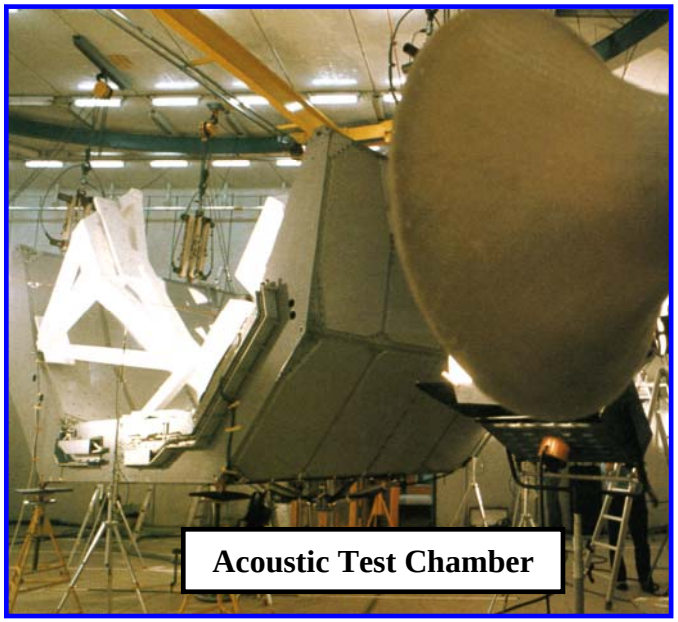


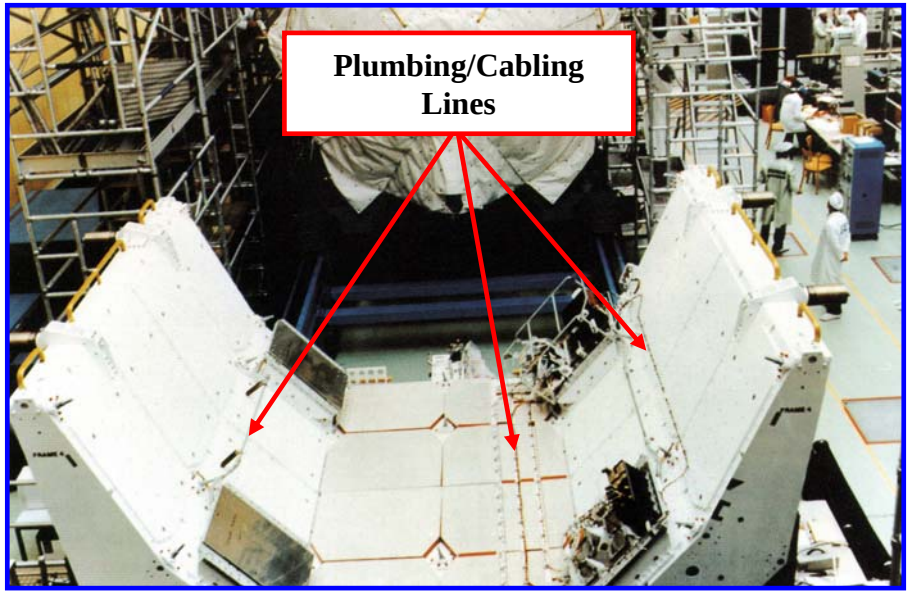




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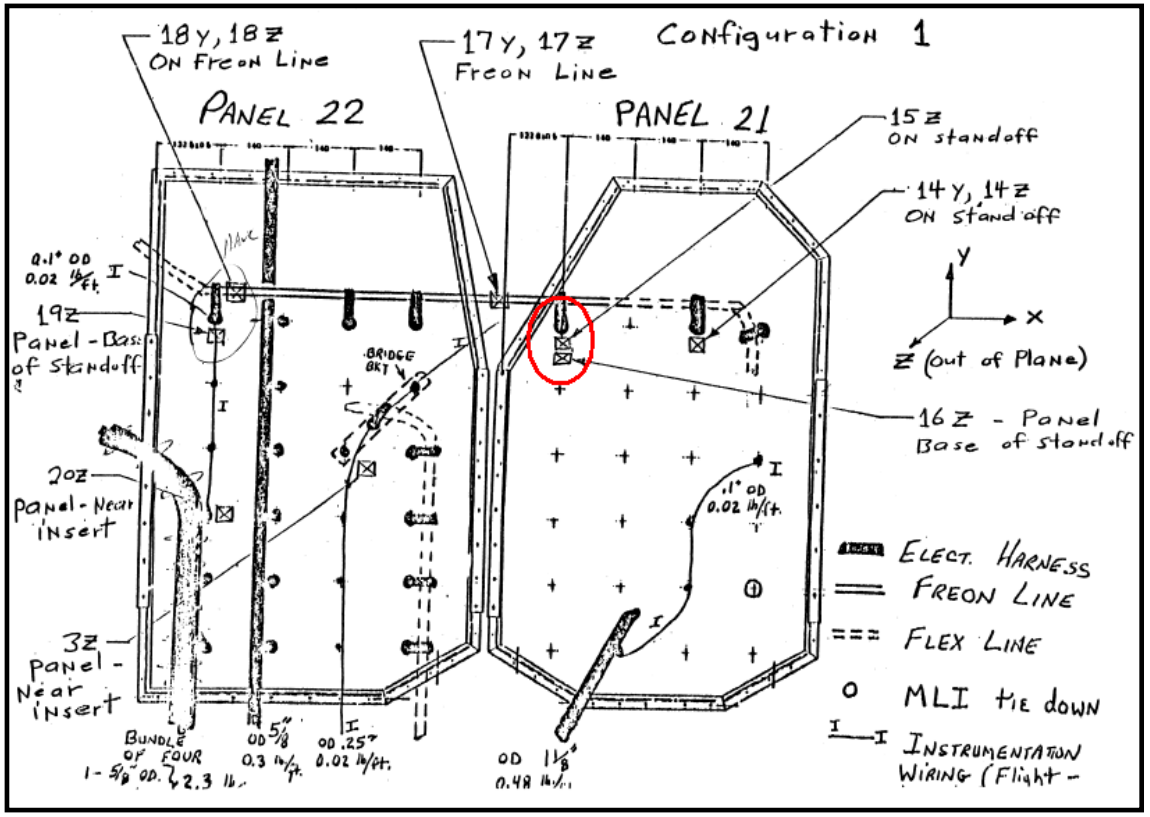


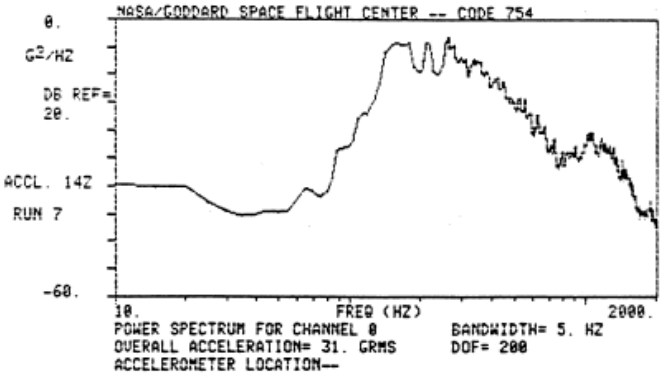


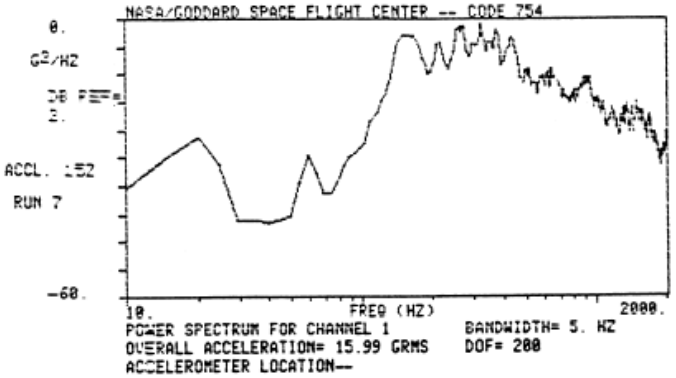


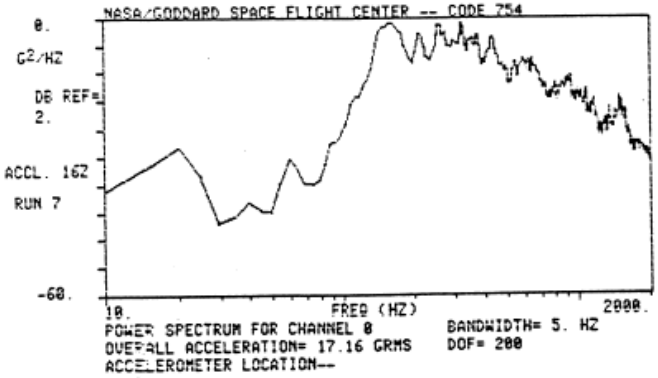




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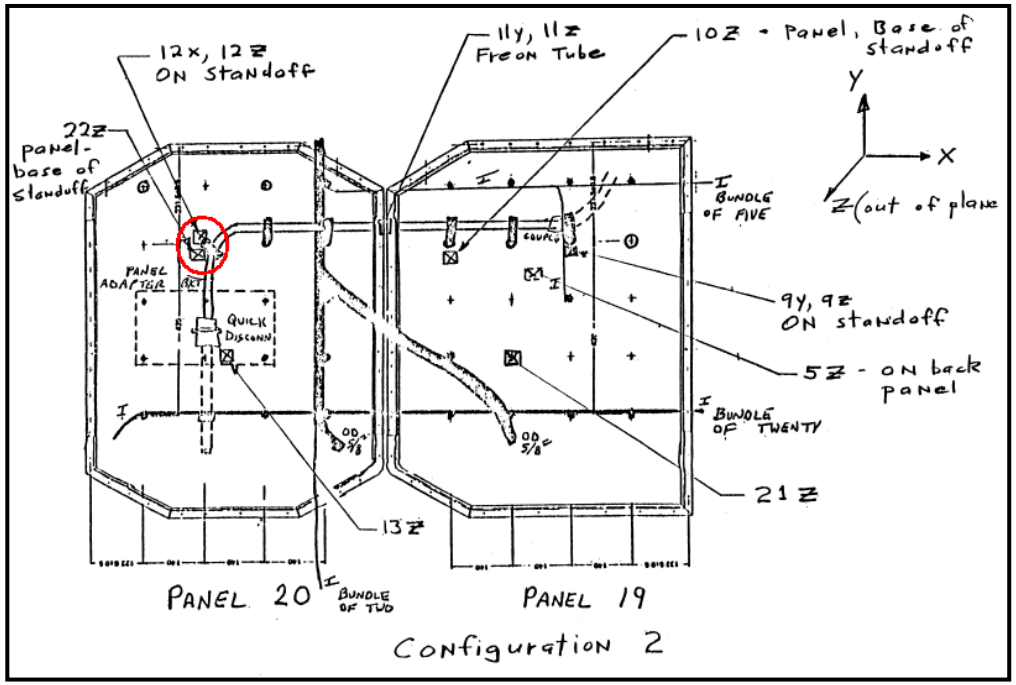


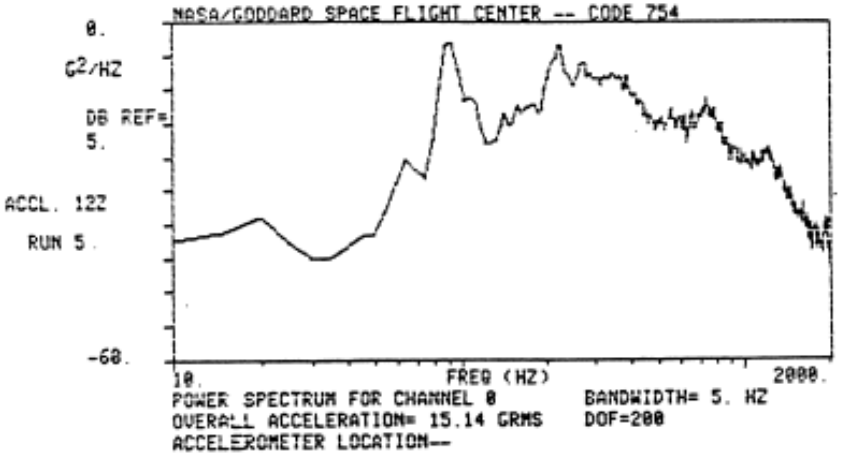


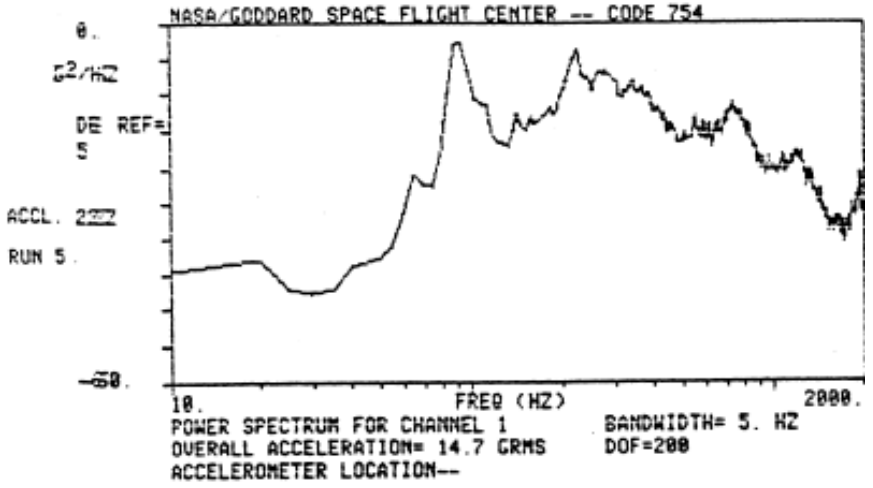




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# "Peak-of-the-Curve" Random Load Factor

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In plane worst-case:

$F_n = 400$ Hz
$Q = 2.0$
$PSD = 0.03\ g^2/Hz$

$$RLF_{x-y} = 3\sqrt{(\pi/2)(2.0)(400\ Hz)(0.03\ g^2/Hz)} = 18.42\ g's$$

out-of-plane 1 Kg ≤ wt ≤ 2 Kg worst-case:

$F_n = 300$ Hz
$Q = 2.0$
$PSD = 3.0\ g^2/Hz$

$$RLF_z = 3\sqrt{(\pi/2)(2.0)(300\ Hz)(3\ g^2/Hz)} = 159.5\ g's$$

out-of-plane 2 Kg ≤ wt ≤ 4 Kg worst-case:

$F_n = 376$ Hz
$Q = 2.0$
$PSD = 1.5\ g^2/Hz$

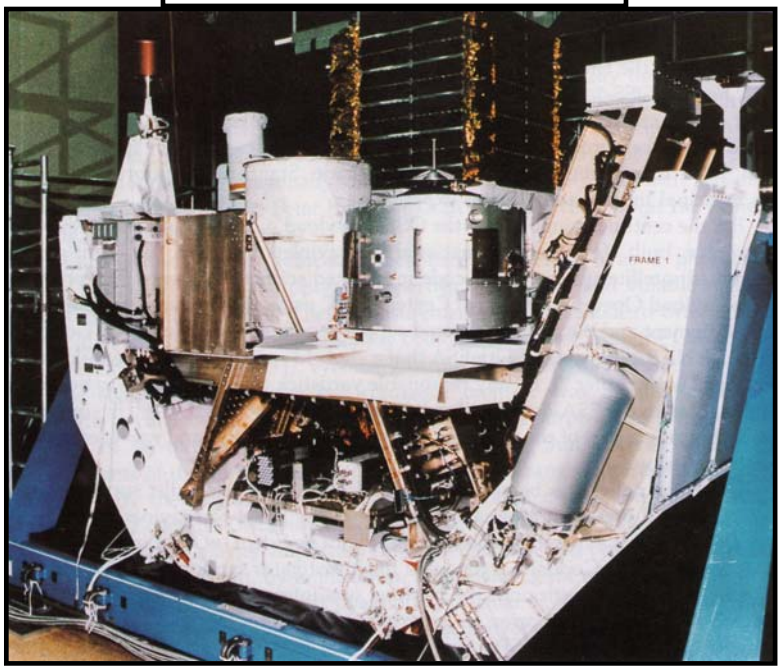
$$RLF_z = 3\sqrt{(\pi/2)(2.0)(376\ Hz)(1.5\ g^2/Hz)} = 126.3\ g's$$

out-of-plane 4Kg ≤ wt ≤ 8 Kg worst-case:

$F_n = 464$ Hz
$Q = 2.0$
$PSD = 0.8\ g^2/Hz$

$$RLF_z = 3\sqrt{(\pi/2)(2.0)(464\ Hz)(0.8\ g^2/Hz)} = 102.5\ g's$$

**OSS-1 Payload**



*The Goddard acoustic test of the OSS-1 pallet was used to determine damping for cabling and plumbing lines mounted to honeycomb panels that were lightly mass-loaded. Compared response of accelerometers mo the mounting bracket to an adjacent accelerometer mounted to the honeycomb panel. Test data showed the max amplification, Q < 2.0.*



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# RANDOM LOAD FACTORS

## MODAL EFFECTIVE WEIGHT CALCULATIONS

$$M_{eff} = \frac{([M]\times[\phi])^2}{[M]\times[\phi^2]}$$

- **NASTRAN calculates the modal effective mass matrix from a normal modes run (Sol 103).**
  - **Based on A. Chopra/E. Cruz formulation presented in "Evaluation of Building Code Formulas for Earthquake Forces" from the Journal of Earthquake Engineering, August 1986.**
- **Modal effective mass is a numerical technique used to identify the weight in each direction participating in a mode.**
  - **Summation of modal effective mass in *all* modes equals the total system mass (in each direction).**
  - **Useful for identifying system level modes, in which a large portion of the total system weight participates.**
  - **Applied in random load factor derivation to calculate net force contribution from individual natural frequencies.**


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# RANDOM LOAD FACTORS

## MODAL EFFECTIVE WEIGHT CALCULATIONS

- **Technique for calculating less severe random loads (but more realistic), is to use Miles' Equation to calculate the RLF at each natural frequency, multiply the RLF by the corresponding Modal Effective Mass to calculate an equivalent force contributed for each mode.**
- **The equivalent forces for each mode are Root-Sum-Square (RSS) together to calculate a net force due to the random loading.**
- **Divide the net RSS force by the component mass to determine a RLF.**

$$RLF_i = 3 \times \sqrt{\frac{\pi}{2} \times f_{ni} \times PSD_i \times Q_i}$$ ***- RLF calculated at mode i.***

$$Feff_i = RLF_i \times Meff_i$$ ***- Effective Force at mode i.***

$$F_{net} = \sqrt{\sum_{i=1}^{n} \left(F_{eff_i}\right)^2}$$ ***- Net Effective Force (for modes 1 through n).***

$$RLF = \frac{F_{net}}{M_{tot}}$$ **Overall Random Load Factor**


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# RANDOM LOAD FACTORS

## MODAL EFFECTIVE WEIGHT CALCULATIONS

- **Developed an Excel Spreadsheet for calculating Random Load Factors using the modal effective mass/RSS approach.**

**Calculates RMS Acceleration**

**Add Random Spectrum (i.e. frequency breakpoints, PSD levels, and slopes.**

**Add amplification factor, Q**

**Enter Overall Component Mass**

**Random Spectrum:**

| Freq (Hz) | PSD (g2/Hz) | n (dB/oct) | Composite Calc | | Verify Slopes/Breakpoints | | | |
|---|---|---|---|---|---|---|---|---|
| 20 | 0.00440 | 14.50 | rms-1= | 4.173 | n1= | 14.47 | PSD-1= | 0.0044 |
| 67 | 1.50000 | 0.00 | rms-2= | 6.481 | n2= | 0.00 | PSD-2= | 1.4878 |
| 95 | 1.50000 | -20.00 | rms-3= | 3.689 | n3= | -20.00 | PSD-3= | 1.5000 |
| 109 | 0.60000 | 0.00 | rms-4= | 9.198 | n4= | 0.00 | PSD-4= | 0.6018 |
| 250 | 0.60000 | -10.00 | rms-5= | 7.986 | n5= | -8.99 | PSD-5= | 0.6000 |
| 2000 | 0.00118 | 0.00 | rms-6= | 0.034 | n6= | 0.00 | PSD-6= | 0.0006 |
| 2001 | 0.00118 | 0.00 | **Grms=** | **14.880** | | | | |
| **Q= 10** | | | **Total Mass= 10.00** | | | | | |

Random Load Factor Calculation (Based on RSS of Random Forces using Modal Effective Weights)

| Mode | Fn | Eff Wt | Fo | PSDo | Slope | PSDi | RLFi | Force | Subtotal RLF |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 200.40 | 7.260 | 109 | 0.6000 | 0.0 | 0.60000 | 130.4 | 946.5 | 94.65 |
| 2 | 254.10 | 0.000 | 250 | 0.6000 | -10.0 | 0.56844 | 142.9 | 0.0 | 94.65 |
| 3 | 305.20 | 0.000 | 250 | 0.6000 | -10.0 | 0.30926 | 115.5 | 0.0 | 94.65 |
| 4 | 305.40 | 0.129 | 250 | 0.6000 | -10.0 | 0.30858 | 115.4 | 14.9 | 94.67 |
| 5 | 392.20 | 0.000 | 250 | 0.6000 | -10.0 | 0.13442 | 86.3 | 0.0 | 94.67 |
| 6 | 418.10 | 0.000 | 250 | 0.6000 | -10.0 | 0.10870 | 80.2 | 0.0 | 94.67 |
| Eff Wt Sum= | | 7.389 | | | | | Residual Force (Delta Wt x 3 x Grms)= | | 116.6 |
| Eff Wt Ratio= | | 73.89% | | | | | Primary Force-RSS= | | 946.7 |
| Delta Wt= | | 2.611 | | | | | | **RLF= 95.4** | |

**Enter Frequencies from NASTRAN run.**

**Enter modal effective mass from NASTRAN run.**

**Overall Random Load Factor**



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# RANDOM RESPONSE ANALYSIS

- **The analysis method that best predicts the response of a structure to a random vibration environment is a random response analysis (SOL 111).**
  - **Uses a modal frequency response analysis to include the dynamic characteristics of the structure.**
  - **Acceleration PSD spectrum is applied at the structural interfaces,**
  - **Responses are recovered as Root-Mean-Squared values of acceleration, displacement, element force, stress, strain, or numerous other physical responses to the random excitation.**
- **Random Response analysis allows for the recovery of internal responses of the structure, while Random Load Factors are only suitable for calculating interface loads.**
- **MSC/Random automates and expands the functionality of random response analysis via the Patran environment.**


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# Benchmark Comparisons (Sample Cases)


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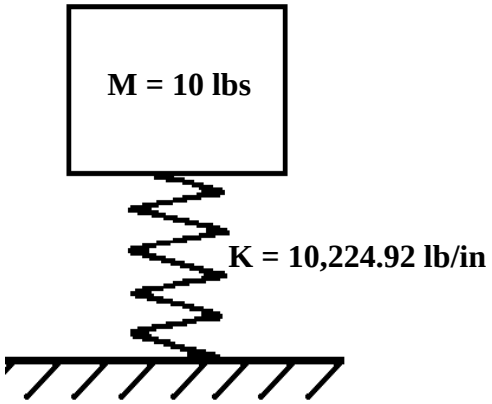
# RANDOM LOAD FACTORS

## Single Degree-of-Freedom Comparison




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

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

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

$\therefore$ 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
$Q = 10$

$$\text{Spring Force} = \underset{3\text{sigma}}{3} \cdot (386.1)(\underset{\text{NASTRAN RMS spring force}}{0.32249\ 23}) = 373.54\ lbs$$

$\therefore$ NASTRAN $= 375.54\ lbs$
miles $= 373.54\ lbs$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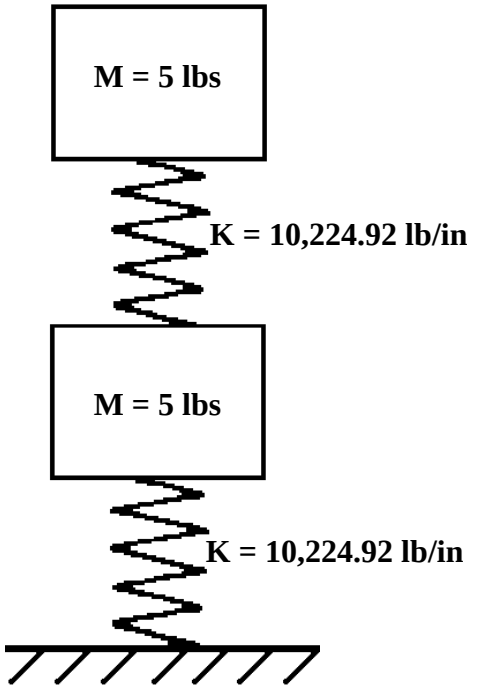
# RANDOM LOAD FACTORS

## Two Degree-of-Freedom Comparison




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

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

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

where

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

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

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

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

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

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

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

$$\omega_{n_1} = 87.40325 \text{ Hz}$$

$$\omega_{n_2} = 228.8247 \text{ Hz}$$



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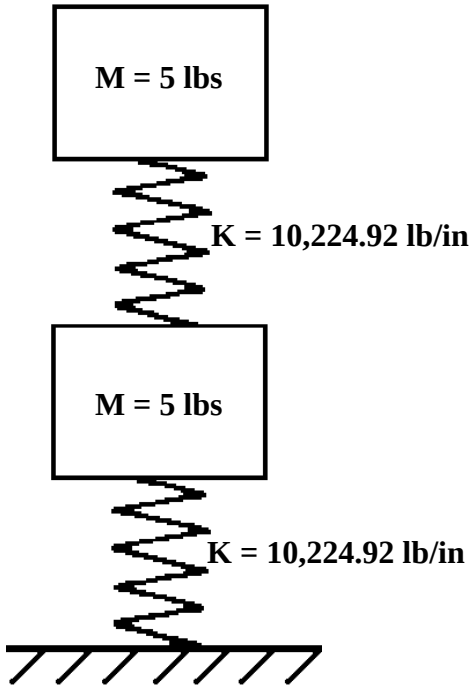
# RANDOM LOAD FACTORS

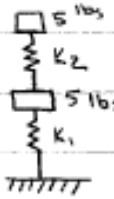
## Two Degree-of-Freedom Comparison




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

$$W_{eff} = \frac{([M][\Phi])^2}{[M][\Phi^2]}$$




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

$$[\Phi] = \begin{bmatrix} \Phi_1 & \Phi_2 \\ 4.61986 & -7.47509 \\ 7.47509 & 4.61986 \end{bmatrix}$$

$$\text{Eff } W_{t_1} = \frac{[(5.0^{\#})(4.61986) + (5^{\#})(7.47509)]^2}{(4.61986)^2(5) + (7.47509)^2(5)} = 9.4721 \text{ lbs}$$

$$\text{Eff } W_{t_2} = \frac{[(5.0^{\#})(-7.47509) + (5^{\#})(4.61986)]^2}{(5^{\#})(-7.47509)^2 + (5^{\#})(4.61986)^2} = 0.5279 \text{ lbs}$$



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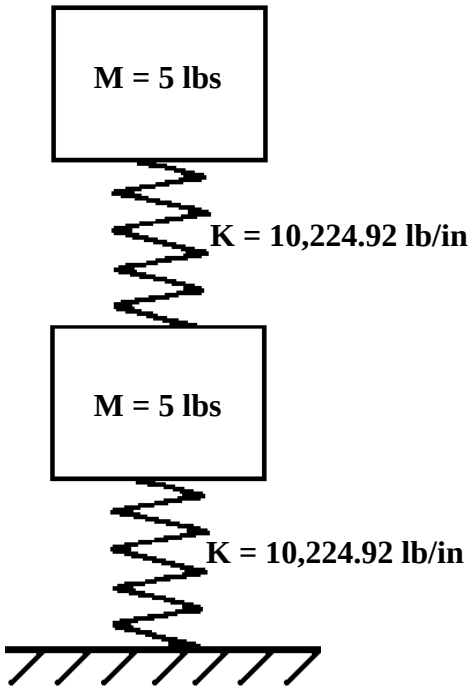
## Two Degree-of-Freedom Comparison




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

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

$RLF_1 = 3\sqrt{(\pi/2)(10)(89.403\,Hz)(0.100\,g^2/Hz)} = 35.1515$ 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

$F_{rss} = \sqrt{((35.1515\,g's)(9.4795\,lbs))^2 + ((56.8765\,g's)(0.3283\,lbs))^2} = 334.57$ lbs

---

From NASTRAN random response:

Spring Force = $3 \cdot (386.1)(0.2864468) = 331.79$

($3\sigma$; NASTRAN RMS spring force)

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



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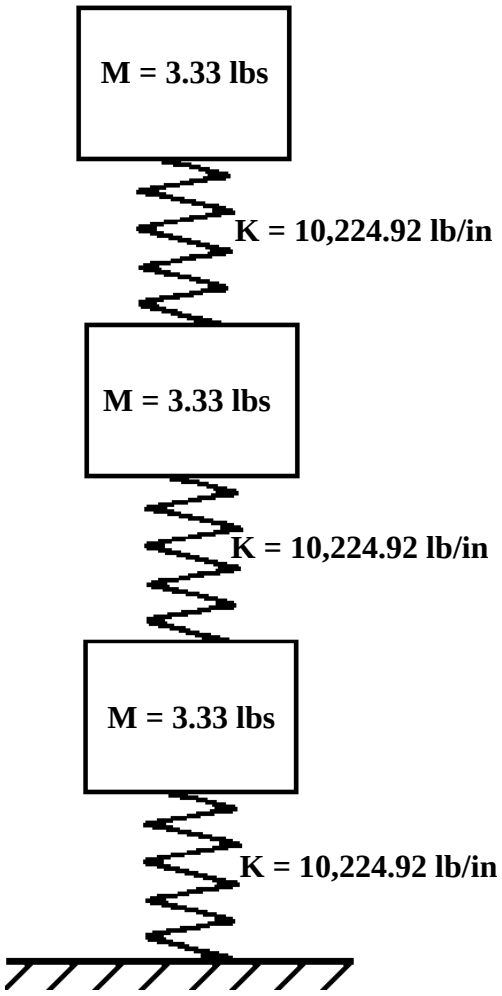
# RANDOM LOAD FACTORS

## Three Degree-of-Freedom Comparison




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

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

$F_{n_3} = 312.6018$ 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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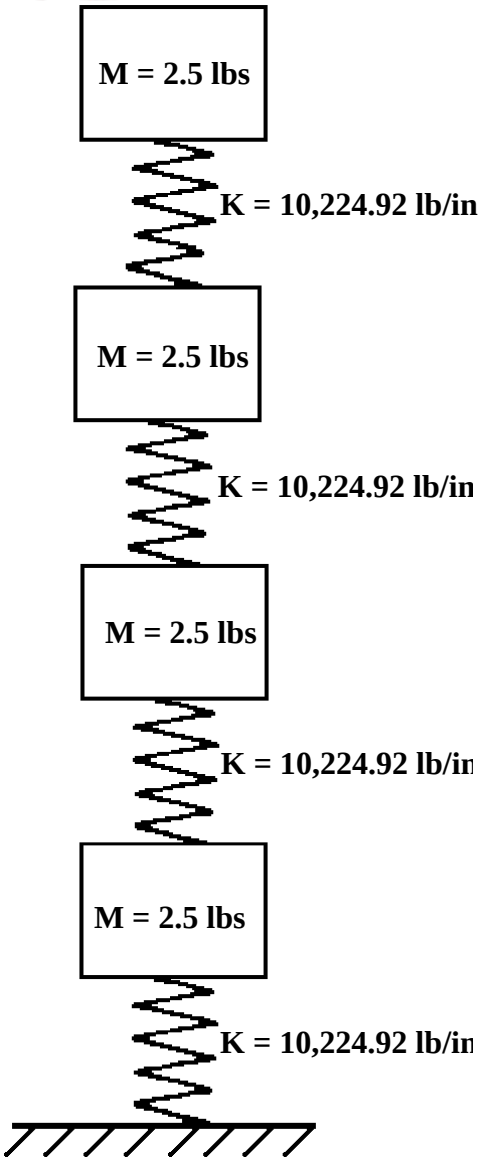
# RANDOM LOAD FACTORS

## Four Degree-of-Freedom Comparison




$F_{n_1} = 69.459$ 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:

Spring Force $= 3 \cdot (386.1) \cdot (0.24251) = 280.899$ lbs

($3$: 3 sigma; $386.1$: 1; $0.24251$: NASTRAN RMS spring Force)

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



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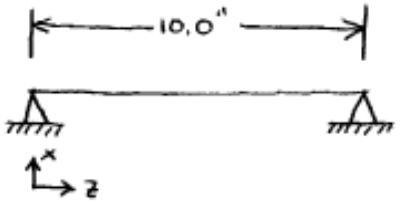
# RANDOM LOAD FACTORS

## Simply Supported Beam Comparison




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

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

$F_{n_1} = 100.009\ Hz$ 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: $R_1 = R_2 = (37.601\ g's)(1\ lb)/2 = \underline{18.801\ lbs}$

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

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

***Interface loads are close.***



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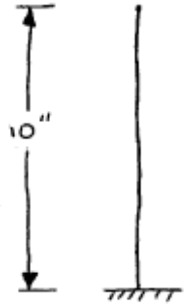
# RANDOM LOAD FACTORS

## Cantilever Beam Comparison




$A = 1.0\ in^2$ $\quad E = 10 \cdot 10^6\ psi$

$I_x = 10.0\ in^4$ $\quad \rho = 0.10\ lb/in^3$

$I_y = 8.271E\text{-}3\ in^4$

$J = 10$

$Wt = 1,000\ lbs$

$F_{n_1} = 99.849\ Hz$ $\quad$ Eff $wt_x = 0.61311\ lbs$

$F_{n_2} = 623.764\ Hz$ $\quad$ Eff $wt_x = 0.18883\ lbs$

$F_{n_3} = 1741.010\ Hz$ $\quad$ 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: $F_x = 30.82\ lbs$, $M_y = 154.1\ in\text{-}lb$

***Note, moment unconservative***

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



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# Practical Examples

## LMS Circuit Breaker Panel


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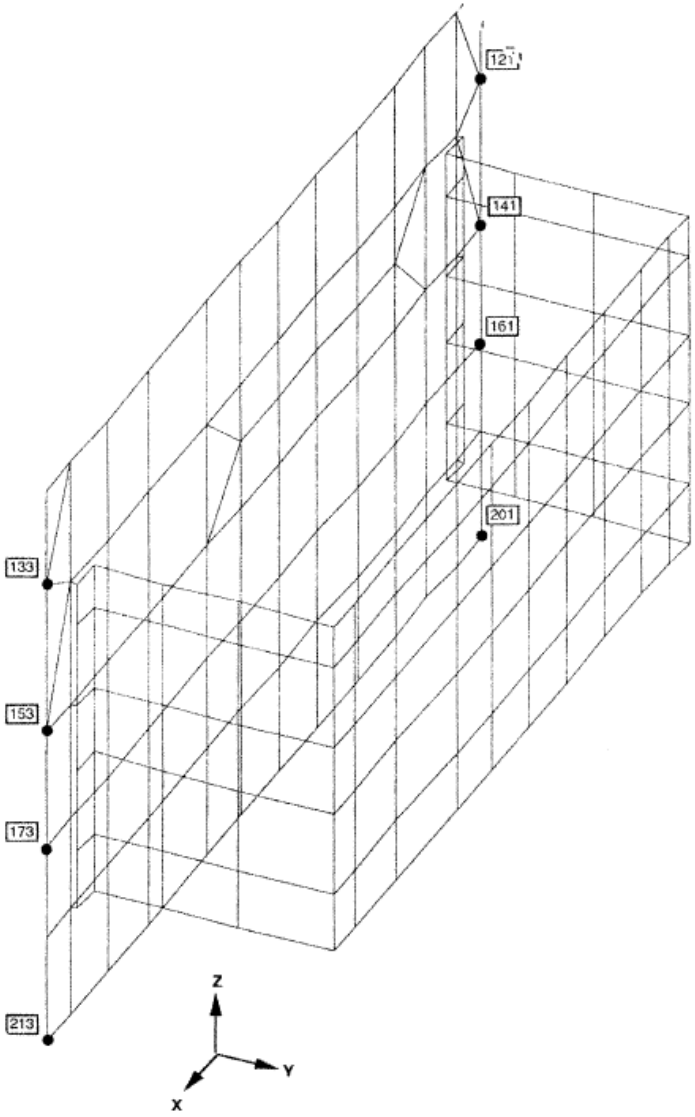
# RANDOM LOAD FACTORS

## LMS Circuit Breaker Panel



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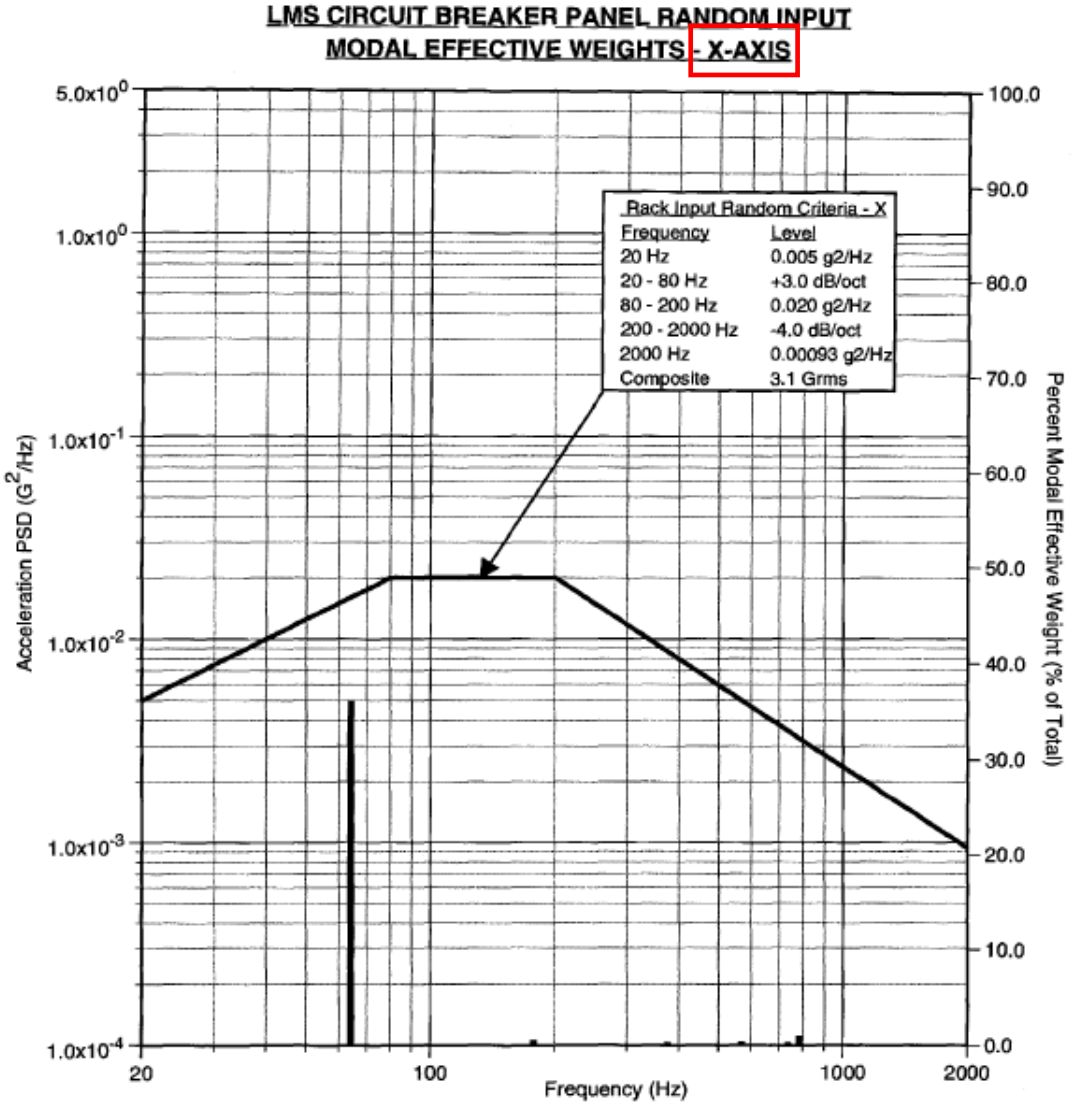
# RANDOM LOAD FACTORS

## LMS Circuit Breaker Panel



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# RANDOM LOAD FACTORS

## LMS Circuit Breaker Panel

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 | | Miles Equation | -13.8 | -0.4 | 3.5 | 14.2 |
| | 121 | Eff. Wt./RSS | -5.0 | -0.1 | 1.3 | 5.1 |
| | | Random Response | 4.6 | 1.2 | 2.8 | 5.5 |
| | | Miles Equation | -12.1 | 0.4 | -3.2 | 12.5 |
| | 133 | Eff. Wt./RSS | -4.4 | 0.1 | -1.2 | 4.5 |
| | | Random Response | 4.4 | 1.8 | 2.7 | 5.4 |
| | | Miles Equation | -13.2 | -4.7 | 0.6 | 14.0 |
| | 141 | Eff. Wt./RSS | -4.8 | -1.7 | 0.2 | 5.1 |
| | | Random Response | 4.9 | 4.3 | 0.5 | 6.5 |
| | | Miles Equation | -12.1 | 4.6 | -0.5 | 13.0 |
| | 153 | Eff. Wt./RSS | -4.4 | 1.7 | -0.2 | 4.7 |
| | | Random Response | 4.6 | 3.7 | 0.5 | 6.0 |
| | | Miles Equation | -9.4 | -3.2 | -0.4 | 9.9 |
| | 161 | Eff. Wt./RSS | -3.4 | -1.1 | -0.1 | 3.6 |
| | | Random Response | 2.9 | 2.8 | 0.8 | 4.1 |
| | | Miles Equation | -8.9 | 3.3 | 0.2 | 9.5 |
| | 173 | Eff. Wt./RSS | -3.2 | 1.2 | 0.1 | 3.4 |
| | | Random Response | 2.8 | 2.3 | 0.8 | 3.7 |
| | | Miles Equation | -7.4 | 0.0 | -4.3 | 8.6 |
| | 201 | Eff. Wt./RSS | -2.7 | 0.0 | -1.6 | 3.1 |
| | | Random Response | 2.8 | 0.5 | 2.5 | 3.8 |
| | | Miles Equation | -7.4 | 0.0 | 4.2 | 8.5 |
| | 213 | 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


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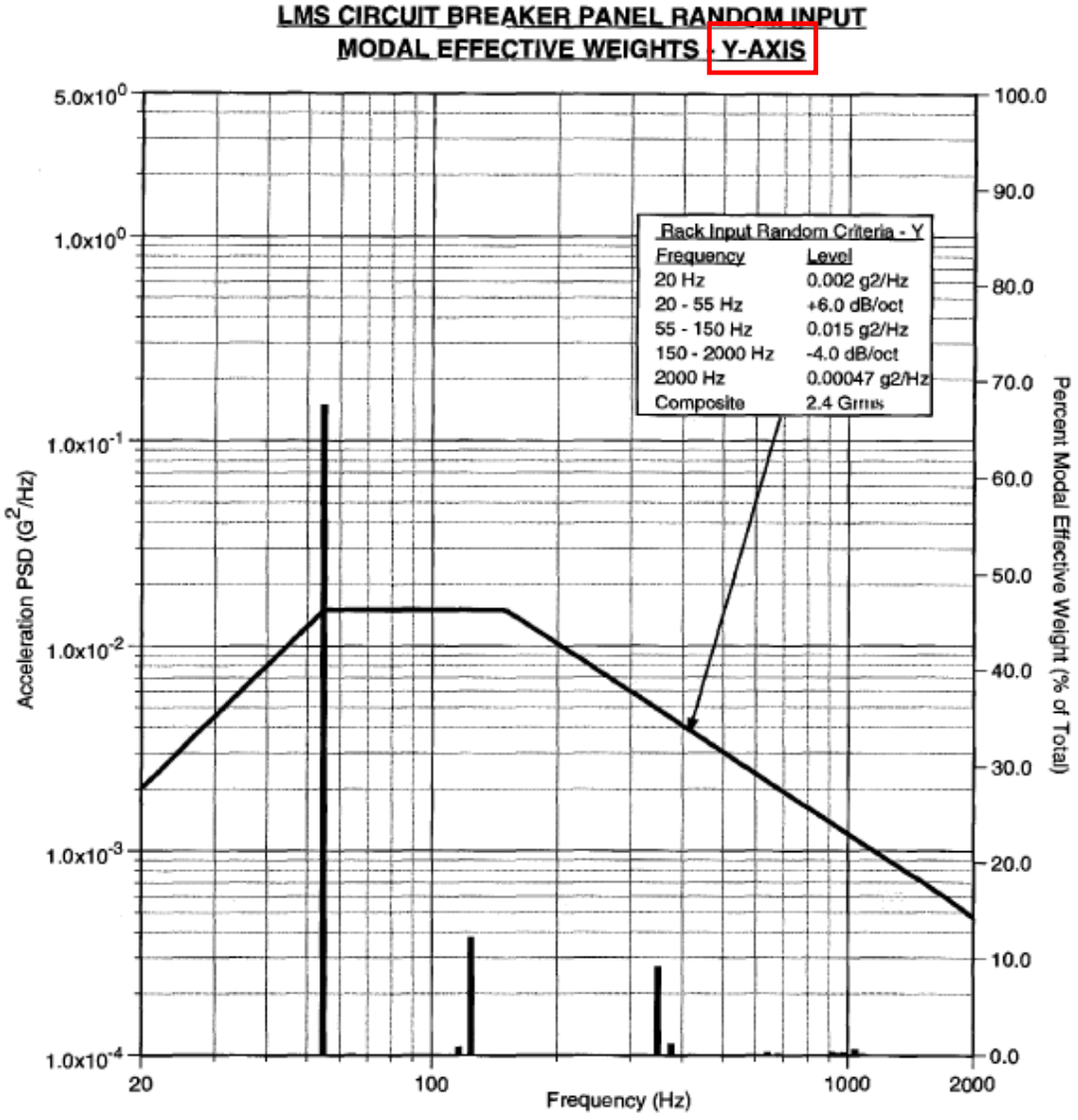
# RANDOM LOAD FACTORS

## LMS Circuit Breaker Panel



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# RANDOM LOAD FACTORS

## LMS Circuit Breaker Panel

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



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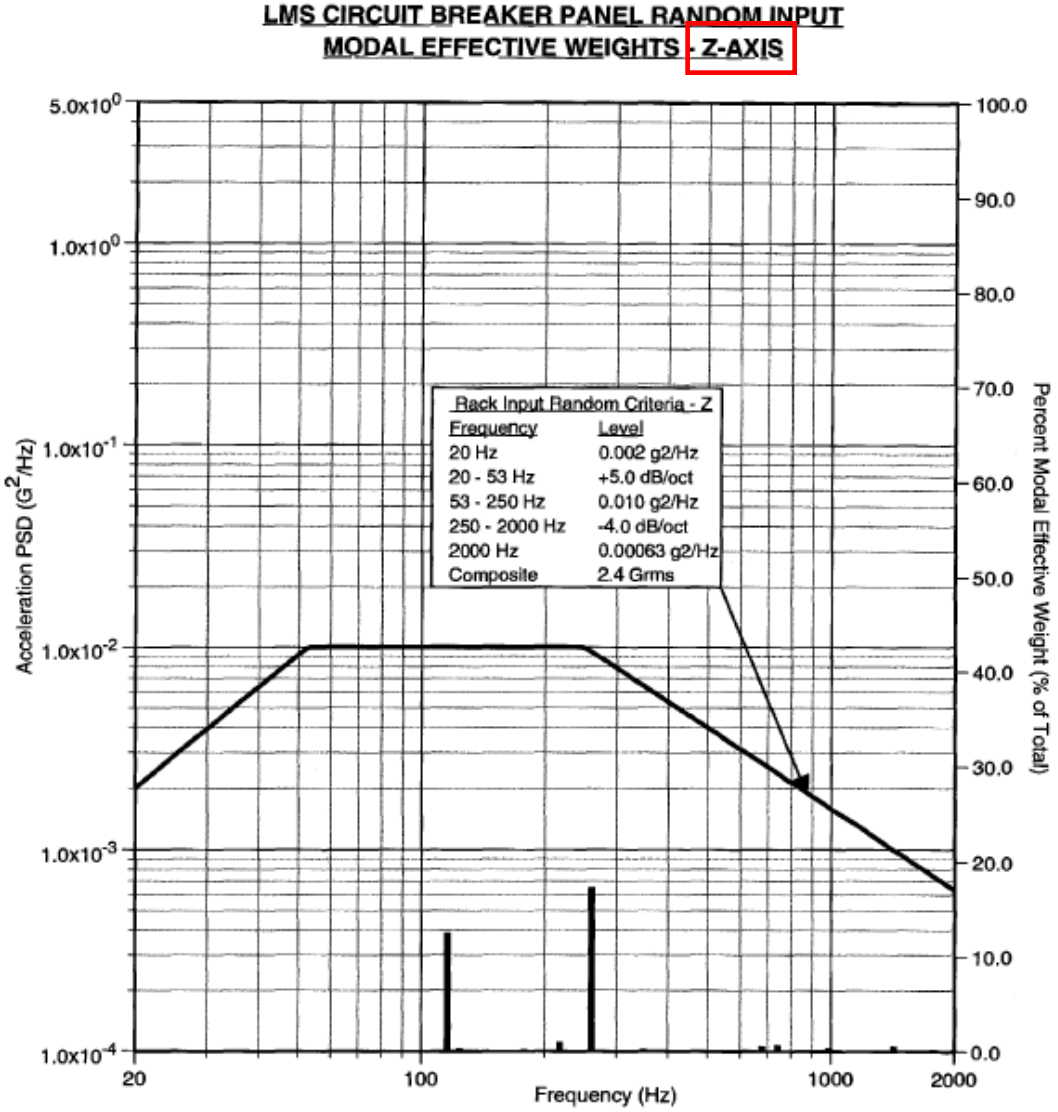
# RANDOM LOAD FACTORS

## LMS Circuit Breaker Panel



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# RANDOM LOAD FACTORS

## LMS Circuit Breaker Panel

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


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# Practical Examples

## Middeck Glovebox Assy - Spacelab Rack-Mounted Configuration


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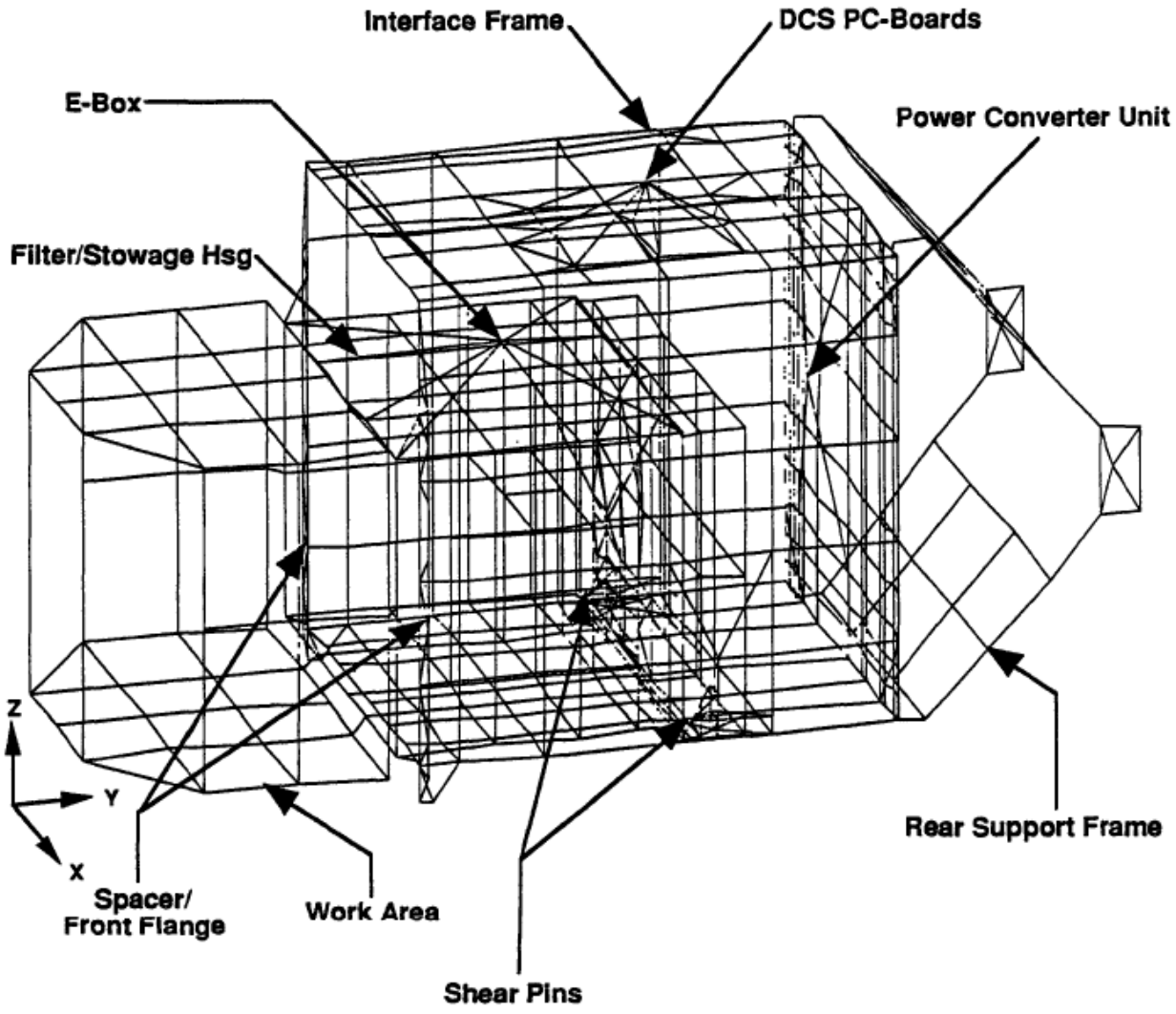
# RANDOM LOAD FACTORS

## Middeck Glovebox Assembly - Spacelab Rack-Mounted Configuration



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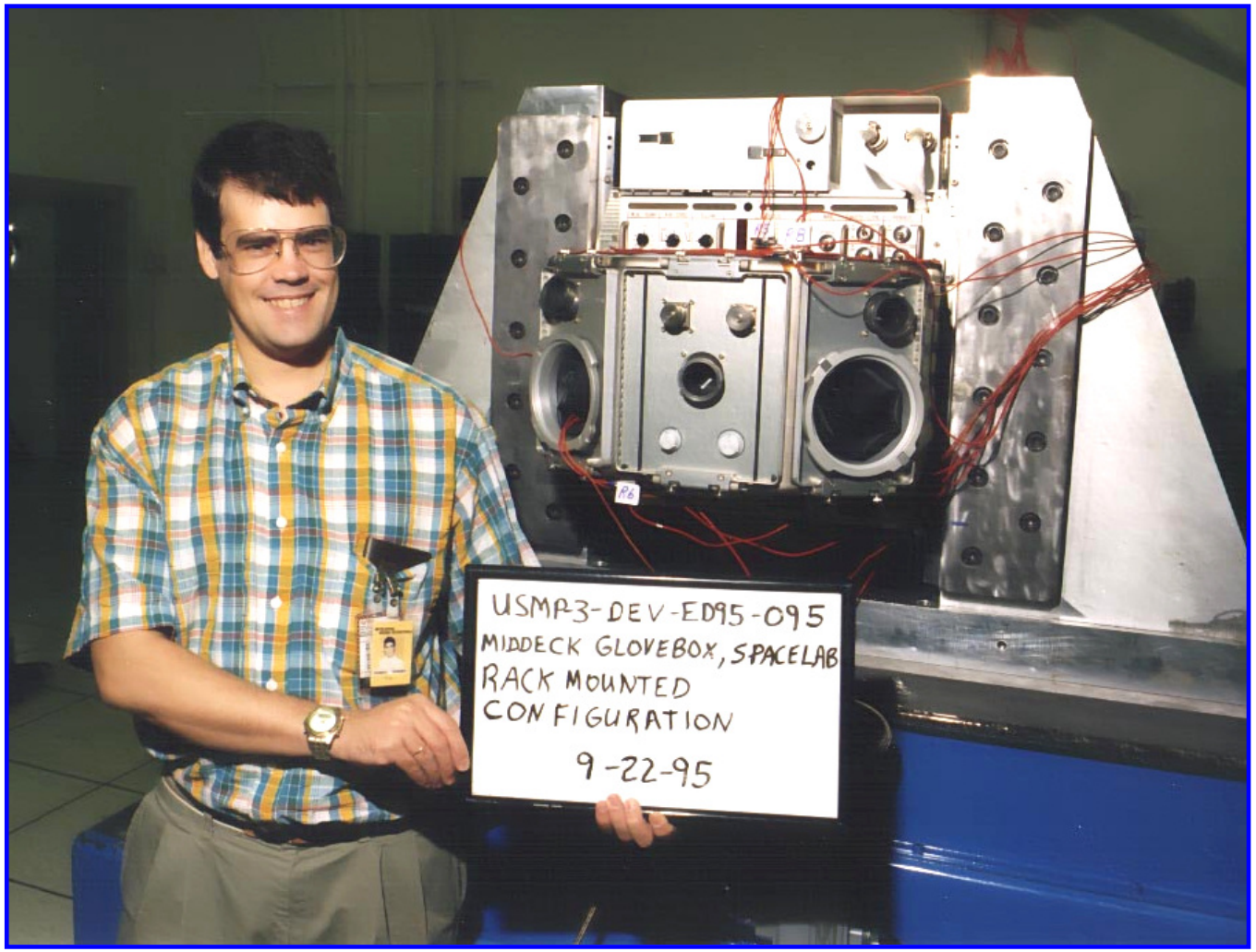
# RANDOM LOAD FACTORS

## Middeck Glovebox Assembly - Spacelab Rack-Mounted Configuration



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# RANDOM LOAD FACTORS

## Middeck Glovebox Assembly - Spacelab Rack-Mounted Configuration

| Mode No. | Freq. (Hz) | Mode Shape Description | Modal Weight X (Lbm) | Y (Lbm) | Z (Lbm) |
|---|---|---|---|---|---|
| Model Weight = 115.7 Lbs. | | | | | |
| 1 | 74.4 | Work Area Z-mode. | 0.000 | 0.028 | 3.551 |
| 2 | 76.1 | Local mode of rear support frame panels. | 0.000 | 0.917 | 0.009 |
| 3 | 77.1 | Local mode of rear support frame panels. | 0.000 | 0.000 | 1.834 |
| 4 | 81.2 | Local mode of Interface Frame bottom panel. | 0.008 | 0.084 | 0.548 |
| 5 | 88.2 | Local mode of Interface Frame top panel. | 1.465 | 0.283 | 2.591 |
| 6 | 102.0 | MGBX system X-mode. | 57.321 | 0.462 | 0.039 |
| 7 | 112.4 | Local in-phase mode of Filter Frames. | 0.635 | 2.154 | 0.005 |
| 8 | 122.3 | Local mode of I/F bottom and back panels. | 0.303 | 13.219 | 2.811 |
| 9 | 125.9 | Local I/F bottom panel/rear supt frame panel. | 0.035 | 4.626 | 7.911 |
| 10 | 126.1 | Local mode of Work Area bottom panel. | 0.000 | 0.001 | 0.028 |
| 11 | 126.5 | Local mode of rear support frame panels. | 0.000 | 0.012 | 0.010 |
| 12 | 127.4 | Local I/F bottom panel/rear supt frame panel. | 0.031 | 4.085 | 5.379 |
| 13 | 138.8 | Local mode of Work Area top panel. | 0.132 | 0.002 | 0.242 |
| 14 | 141.1 | Local mode of Work Area top panel. | 0.096 | 0.000 | 0.412 |
| 17 | 160.5 | Bending of filter/stowage hsg rear baseplate. | 0.026 | 26.637 | 15.680 |
| 20 | 175.1 | Bending of filter/stowage hsg rear baseplate. | 0.231 | 9.002 | 7.919 |
| 24 | 184.1 | Work Area twisting about the Y-axis. | 3.544 | 0.040 | 0.057 |
| 26 | 200.1 | MGBX system Y-mode. | 0.033 | 39.860 | 5.018 |



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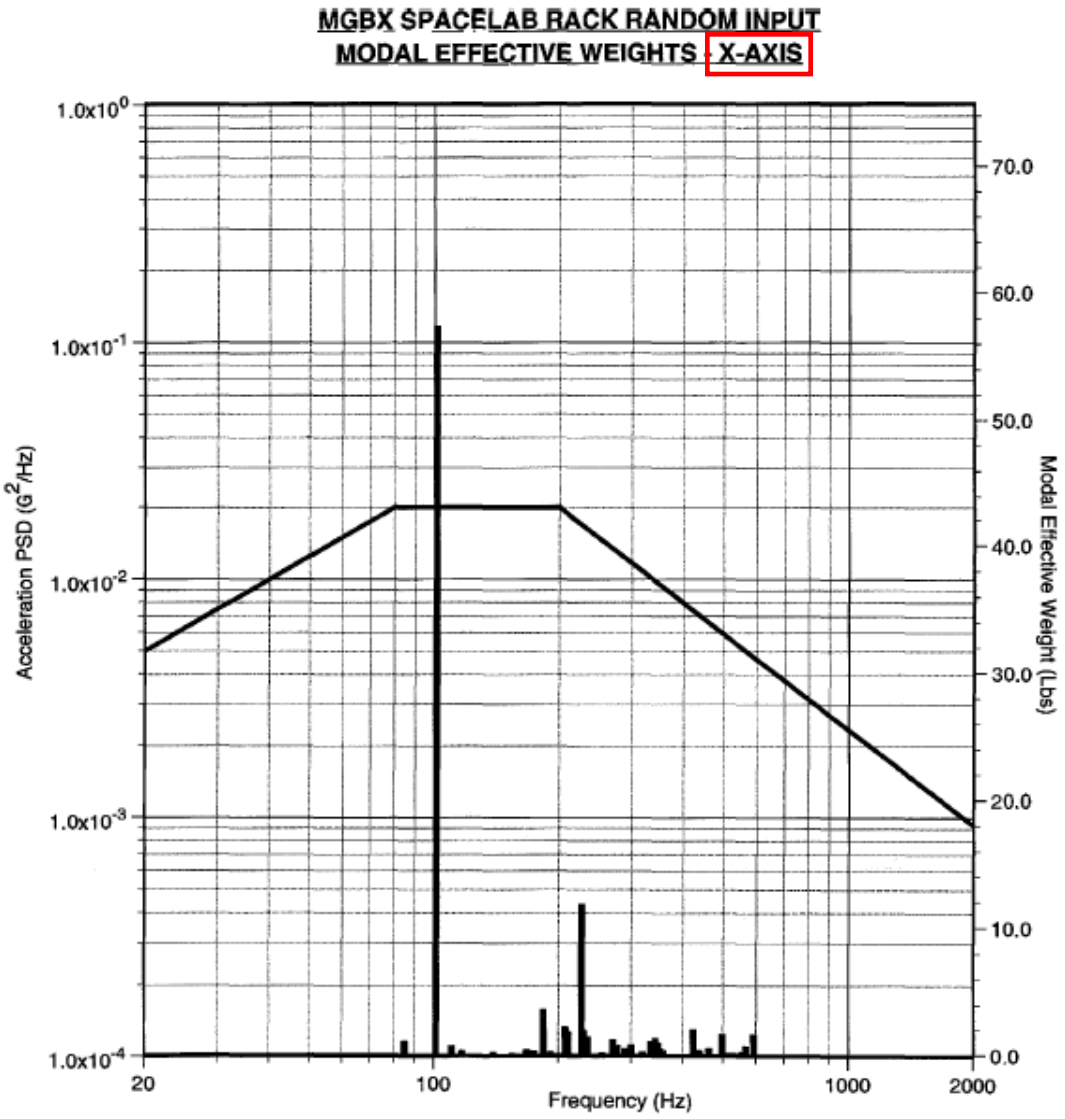
# RANDOM LOAD FACTORS

## Middeck Glovebox Assembly - Spacelab Rack-Mounted Configuration



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# RANDOM LOAD FACTORS

## Middeck Glovebox Assembly - Spacelab Rack-Mounted Configuration

MGBX INTERFACE FORCE COMPARISON - MILES EQN, EFF WT/RSS, RANDOM RESP (STD SL-RACK)

| Axis | Grid No. | RLF Method | X (Lbs) | Y (Lbs) | Z (Lbs) | RSS Force |
|---|---|---|---|---|---|---|
| X-Axis | 624 | Miles Equation | -622.3 | -126.1 | -207.9 | 668.1 |
| | | Eff. Wt./RSS | -331.8 | -67.2 | -110.8 | 356.2 |
| | | Random Response | 498.5 | 203.6 | 434.7 | 692.0 |
| | 625 | Miles Equation | 198.1 | -62.7 | 52.1 | 214.2 |
| | | Eff. Wt./RSS | 105.6 | -33.4 | 27.8 | 356.2 |
| | | Random Response | 167.2 | 142.2 | 86.7 | 236.0 |
| | 626 | Miles Equation | 45.0 | -68.1 | -25.3 | 85.5 |
| | | Eff. Wt./RSS | 24.0 | -36.3 | -13.5 | 45.6 |
| | | Random Response | 52.1 | 176.5 | 89.6 | 204.7 |
| | 627 | Miles Equation | 19.3 | -45.2 | 33.9 | 59.7 |
| | | Eff. Wt./RSS | 10.3 | -24.1 | 18.1 | 31.8 |
| | | Random Response | 34.2 | 70.0 | 30.9 | 83.8 |
| | 628 | Miles Equation | 97.4 | -67.4 | 91.5 | 149.6 |
| | | Eff. Wt./RSS | 51.9 | -35.9 | 48.8 | 79.8 |
| | | Random Response | 82.2 | 173.4 | 58.1 | 200.5 |
| | 629 | Miles Equation | -637.9 | -267.3 | -14.2 | 691.8 |
| | | Eff. Wt./RSS | -340.1 | -142.5 | -7.6 | 368.8 |
| | | Random Response | 402.1 | 259.4 | 163.7 | 505.7 |
| | 644 | Miles Equation | -626.4 | 125.3 | 201.8 | 669.9 |
| | | Eff. Wt./RSS | -333.9 | 66.8 | 107.6 | 357.1 |
| | | Random Response | 491.4 | 197.0 | 420.3 | 676.0 |
| | 645 | Miles Equation | 194.7 | 61.7 | -50.7 | 210.5 |
| | | Eff. Wt./RSS | 103.8 | 32.9 | -27.0 | 112.2 |
| | | Random Response | 159.5 | 140.4 | 79.2 | 226.8 |
| | 646 | Miles Equation | 43.6 | 67.2 | 25.8 | 84.1 |
| | | Eff. Wt./RSS | 23.2 | 35.8 | 13.8 | 44.8 |
| | | Random Response | 48.7 | 176.1 | 81.6 | 200.1 |
| | 647 | Miles Equation | 22.2 | 45.3 | -31.9 | 59.7 |
| | | Eff. Wt./RSS | 11.8 | 24.2 | -17.0 | 31.8 |
| | | Random Response | 32.7 | 71.0 | 25.4 | 82.2 |
| | 648 | Miles Equation | 104.5 | 68.8 | -90.5 | 154.4 |
| | | Eff. Wt./RSS | 55.7 | 36.7 | -48.2 | 82.3 |
| | | Random Response | 88.2 | 176.8 | 50.8 | 204.0 |
| | 649 | Miles Equation | -644.2 | 268.3 | 16.0 | 698.0 |
| | | Eff. Wt./RSS | -343.4 | 143.0 | 8.5 | 372.1 |
| | | Random Response | 405.8 | 267.5 | 157.4 | 510.9 |
| | 700 | Miles Equation | -75.9 | 12.8 | -43.1 | 88.2 |
| | | Eff. Wt./RSS | -40.5 | 6.8 | -23.0 | 47.0 |
| | | Random Response | 30.9 | 22.9 | 47.6 | 61.2 |
| | 800 | Miles Equation | -75.8 | -12.6 | 42.5 | 87.8 |
| | | Eff. Wt./RSS | -40.4 | -6.7 | 22.7 | 46.8 |
| | | Random Response | 31.1 | 30.8 | 58.8 | 73.3 |

Notes: 1. Miles Equation Loads RLFx=16.9 g; RLFy=21.1 g; RLFz=18.5 g
2. Effective Weight/RSS RLFx=9.0 g; RLFy=8.8 g; RLFz=6.4 g



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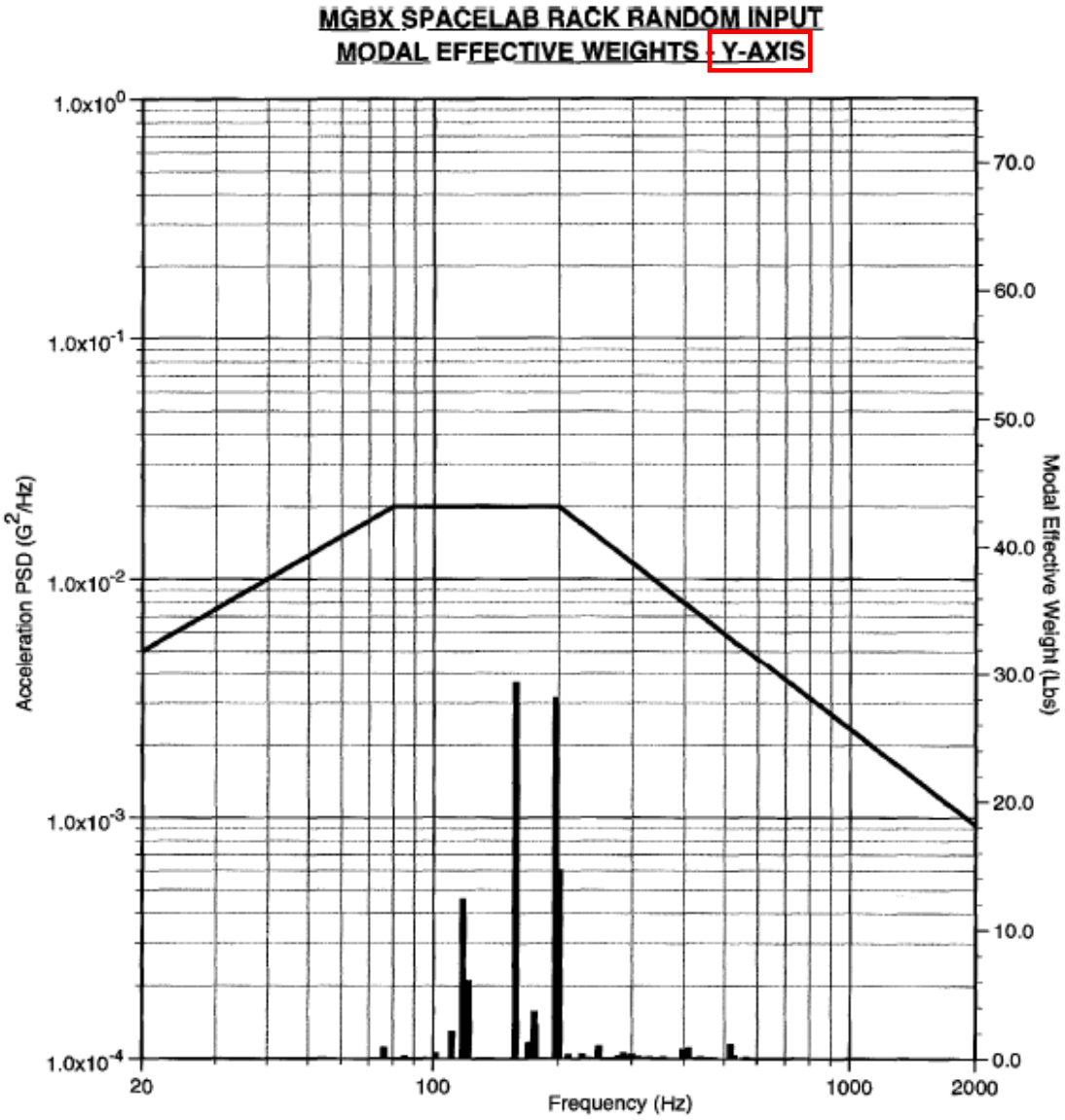
# RANDOM LOAD FACTORS

## Middeck Glovebox Assembly - Spacelab Rack-Mounted Configuration



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# RANDOM LOAD FACTORS

## Middeck Glovebox Assembly - Spacelab Rack-Mounted Configuration

MGBX INTERFACE FORCE COMPARISON - MILES EQN, EFF WT/RSS, RANDOM RESP (STD SL-RACK)

| Axis | Grid No. | RLF Method | X (Lbs) | Y (Lbs) | Z (Lbs) | RSS Force |
|---|---|---|---|---|---|---|
| Y-Axis | 624 | Miles Equation | 322.3 | -476.5 | 57.0 | 578.1 |
| | | Eff. Wt./RSS | 133.8 | -197.8 | 23.7 | 240.0 |
| | | Random Response | 85.8 | 173.2 | 156.6 | 248.8 |
| | 625 | Miles Equation | 17.3 | -31.2 | 1.4 | 35.8 |
| | | Eff. Wt./RSS | 7.2 | -13.0 | 0.6 | 14.8 |
| | | Random Response | 52.4 | 60.9 | 30.4 | 85.9 |
| | 626 | Miles Equation | -53.3 | -35.9 | -64.3 | 90.9 |
| | | Eff. Wt./RSS | -22.1 | -14.9 | -26.7 | 37.8 |
| | | Random Response | 17.3 | 76.8 | 30.0 | 84.2 |
| | 627 | Miles Equation | -94.3 | -21.4 | 66.6 | 117.4 |
| | | Eff. Wt./RSS | -39.1 | -8.9 | 27.7 | 48.7 |
| | | Random Response | 19.3 | 34.9 | 33.4 | 52.0 |
| | 628 | Miles Equation | 19.1 | -29.8 | 142.1 | 146.5 |
| | | Eff. Wt./RSS | 7.9 | -12.4 | 59.0 | 60.8 |
| | | Random Response | 50.1 | 90.1 | 47.1 | 113.3 |
| | 629 | Miles Equation | 578.8 | -596.1 | -250.7 | 867.9 |
| | | Eff. Wt./RSS | 240.3 | -247.5 | -104.1 | 360.3 |
| | | Random Response | 152.3 | 204.4 | 69.0 | 264.0 |
| | 644 | Miles Equation | -318.4 | -459.6 | 55.0 | 561.8 |
| | | Eff. Wt./RSS | -132.2 | -190.8 | 22.8 | 233.2 |
| | | Random Response | 103.1 | 174.9 | 140.6 | 247.0 |
| | 645 | Miles Equation | -18.0 | -31.7 | -0.8 | 36.4 |
| | | Eff. Wt./RSS | -7.5 | -13.1 | -0.3 | 15.1 |
| | | Random Response | 63.2 | 59.4 | 35.4 | 93.7 |
| | 646 | Miles Equation | 51.4 | -33.1 | -63.7 | 88.3 |
| | | Eff. Wt./RSS | 21.4 | -13.7 | -26.5 | 36.7 |
| | | Random Response | 20.6 | 79.6 | 34.6 | 89.2 |
| | 647 | Miles Equation | 94.9 | -19.6 | 65.4 | 116.9 |
| | | Eff. Wt./RSS | 39.4 | -8.1 | 27.1 | 48.5 |
| | | Random Response | 17.5 | 36.6 | 34.4 | 53.2 |
| | 648 | Miles Equation | -10.8 | -25.7 | 134.8 | 137.6 |
| | | Eff. Wt./RSS | -4.5 | -10.7 | 55.9 | 57.1 |
| | | Random Response | 47.3 | 94.4 | 47.9 | 115.9 |
| | 649 | Miles Equation | -587.4 | -572.2 | -243.2 | 855.3 |
| | | Eff. Wt./RSS | -243.9 | -237.5 | -101.0 | 355.1 |
| | | Random Response | 143.8 | 208.9 | 71.1 | 263.4 |
| | 700 | Miles Equation | 9.1 | -54.7 | 46.2 | 72.1 |
| | | Eff. Wt./RSS | 3.8 | -22.7 | 19.2 | 29.9 |
| | | Random Response | 6.4 | 51.0 | 94.1 | 107.2 |
| | 800 | Miles Equation | -10.7 | -53.9 | 54.2 | 77.2 |
| | | Eff. Wt./RSS | -4.5 | -22.4 | 22.5 | 32.0 |
| | | Random Response | 6.2 | 49.1 | 83.6 | 97.1 |

Notes: 1. Miles Equation Loads RLFx=16.9 g; RLFy=21.1 g; RLFz=18.5 g
2. Effective Weight/RSS RLFx=9.0 g; RLFy=8.8 g; RLFz=6.4 g


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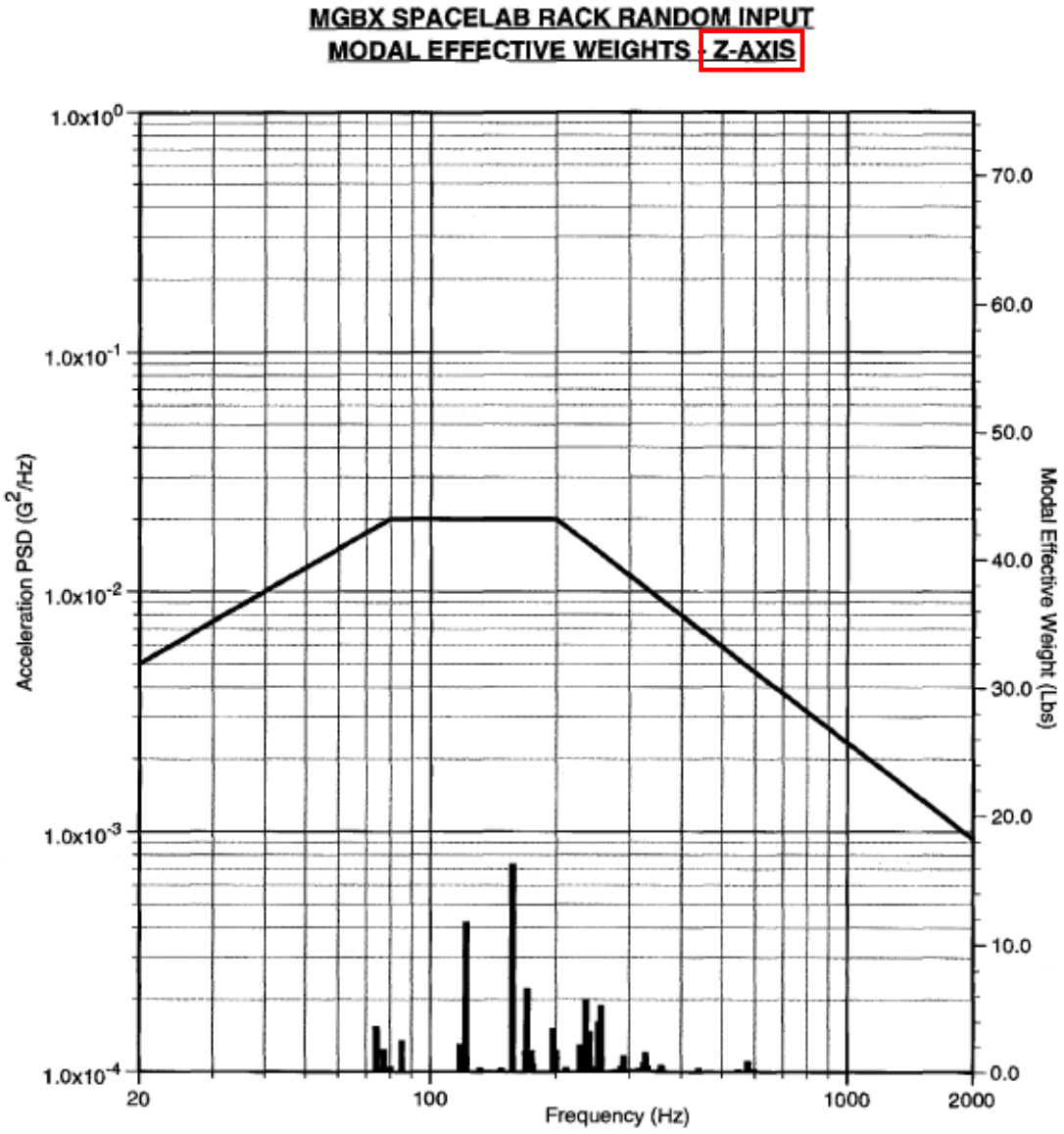
# RANDOM LOAD FACTORS

## Middeck Glovebox Assembly - Spacelab Rack-Mounted Configuration



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# RANDOM LOAD FACTORS

## Middeck Glovebox Assembly - Spacelab Rack-Mounted Configuration

MGBX INTERFACE FORCE COMPARISON - MILES EQN, EFF WT/RSS, RANDOM RESP (STD SL-RACK)

| Axis | Grid No. | RLF Method | X (Lbs) | Y (Lbs) | Z (Lbs) | RSS Force |
|---|---|---|---|---|---|---|
| Z-Axis | 624 | Miles Equation | -43.2 | 101.9 | -182.4 | 213.3 |
| | | Eff. Wt./RSS | -14.9 | 35.2 | -63.0 | 73.7 |
| | | Random Response | 71.0 | 204.9 | 148.2 | 262.7 |
| | 625 | Miles Equation | -21.9 | 16.8 | -121.3 | 124.4 |
| | | Eff. Wt./RSS | -7.6 | 5.8 | -41.9 | 73.7 |
| | | Random Response | 46.1 | 60.7 | 44.9 | 88.4 |
| | 626 | Miles Equation | -6.1 | 8.7 | -81.0 | 81.7 |
| | | Eff. Wt./RSS | -2.1 | 3.0 | -28.0 | 28.2 |
| | | Random Response | 21.0 | 27.4 | 50.5 | 61.2 |
| | 627 | Miles Equation | 13.3 | 0.7 | -108.4 | 109.2 |
| | | Eff. Wt./RSS | 4.6 | 0.2 | -37.5 | 37.7 |
| | | Random Response | 10.6 | 12.3 | 58.2 | 60.4 |
| | 628 | Miles Equation | 31.7 | -1.1 | -86.9 | 92.5 |
| | | Eff. Wt./RSS | 11.0 | -0.4 | -30.0 | 32.0 |
| | | Random Response | 25.5 | 54.2 | 55.4 | 81.6 |
| | 629 | Miles Equation | 82.0 | -131.8 | -235.2 | 281.8 |
| | | Eff. Wt./RSS | 28.3 | -45.6 | -81.3 | 97.4 |
| | | Random Response | 63.5 | 144.7 | 131.3 | 205.5 |
| | 644 | Miles Equation | 22.4 | 90.8 | -171.4 | 195.2 |
| | | Eff. Wt./RSS | 7.7 | 31.4 | -59.2 | 67.5 |
| | | Random Response | 116.5 | 201.9 | 120.1 | 262.2 |
| | 645 | Miles Equation | 27.8 | 16.0 | -119.7 | 124.0 |
| | | Eff. Wt./RSS | 9.6 | 5.5 | -41.4 | 42.8 |
| | | Random Response | 67.3 | 57.4 | 46.8 | 100.0 |
| | 646 | Miles Equation | 9.1 | 8.2 | -82.9 | 83.8 |
| | | Eff. Wt./RSS | 3.2 | 2.8 | -28.6 | 29.0 |
| | | Random Response | 28.2 | 24.0 | 50.9 | 62.9 |
| | 647 | Miles Equation | -13.7 | 0.5 | -106.1 | 107.0 |
| | | Eff. Wt./RSS | -4.7 | 0.2 | -36.7 | 37.0 |
| | | Random Response | 10.7 | 11.9 | 56.0 | 58.2 |
| | 648 | Miles Equation | -33.9 | -1.5 | -84.5 | 91.1 |
| | | Eff. Wt./RSS | -11.7 | -0.5 | -29.2 | 31.5 |
| | | Random Response | 23.1 | 56.1 | 51.3 | 79.4 |
| | 649 | Miles Equation | -67.0 | -120.3 | -222.6 | 261.8 |
| | | Eff. Wt./RSS | -23.1 | -41.6 | -76.9 | 90.5 |
| | | Random Response | 47.0 | 144.1 | 121.2 | 194.1 |
| | 700 | Miles Equation | -2.4 | 5.6 | -272.9 | 273.0 |
| | | Eff. Wt./RSS | -0.8 | 1.9 | -94.3 | 94.3 |
| | | Random Response | 1.9 | 22.1 | 155.0 | 156.6 |
| | 800 | Miles Equation | 1.9 | 5.5 | -267.7 | 267.7 |
| | | Eff. Wt./RSS | 0.7 | 1.9 | -92.5 | 92.5 |
| | | Random Response | 2.7 | 22.8 | 151.4 | 153.2 |

Notes: 1. Miles Equation Loads RLFx=16.9 g; RLFy=21.1 g; RLFz=18.5 g
2. Effective Weight/RSS RLFx=9.0 g; RLFy=8.8 g; RLFz=6.4 g



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# Practical Examples

## Highly Packed Digital Television (HI-PAC DTV)


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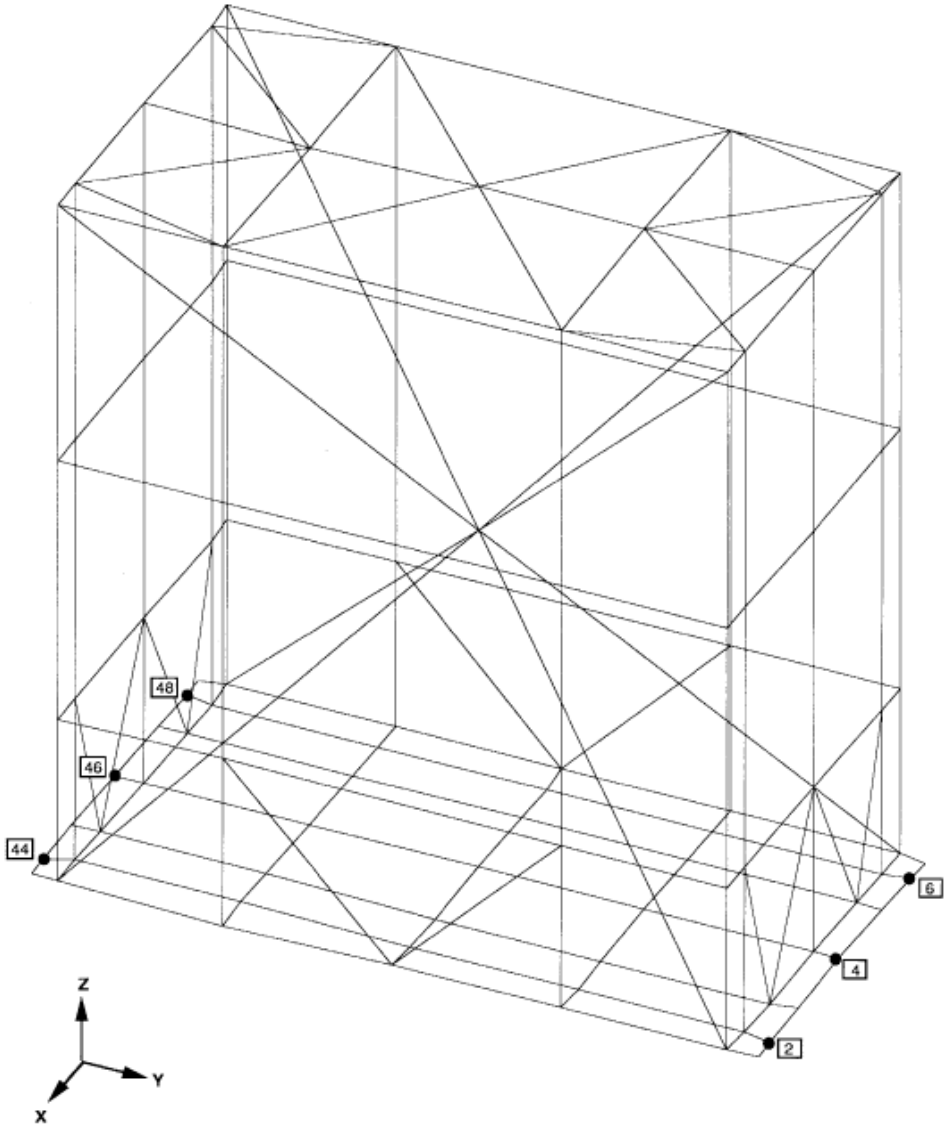
# RANDOM LOAD FACTORS

## Hi-Pac DTV Comparison (Electronics box with a base flange)



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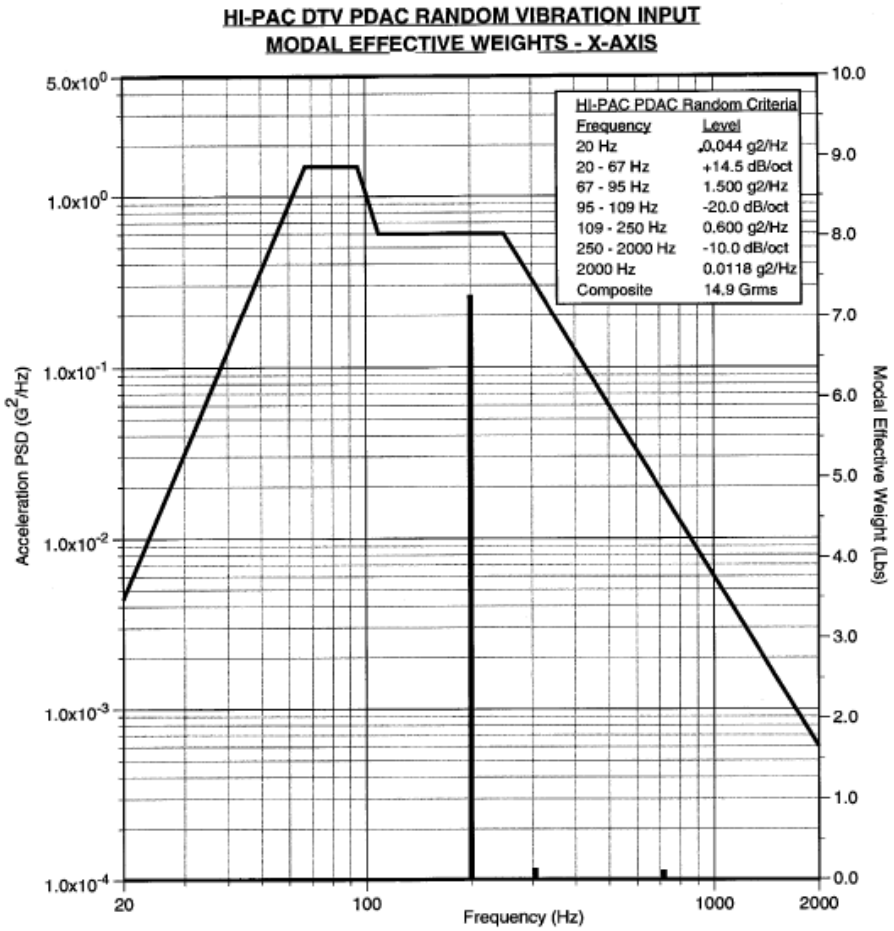
# RANDOM LOAD FACTORS

## Hi-Pac DTV Comparison (Electronics box with a base flange)

### X-Axis Input




| Input at the interface with HFSS (Ref. PDAC CFI Spec/410SPC0327 Table 3-5) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| F01 = | 20 | PSD01 = | 0.0044 | n1 = | 14.5 | | Grms1= | 4.17 | 14.88 | |
| F02 = | 67 | PSD02 = | 1.500 | n2 = | 0 | | Grms2= | 6.48 | | |
| F03 = | 95 | PSD03 = | 1.500 | n3 = | -20 | | Grms3= | 3.69 | | |
| F04 = | 109 | PSD04 = | 0.600 | n4 = | 0 | | Grms4= | 9.20 | | |
| F05 = | 250 | PSD05 = | 0.600 | n5 = | -10 | | Grms5= | 7.99 | | |
| F06 = | 2000 | PSD06 = | 0.001 | n6 = | 0 | | | | | |
| | | | | | | | Grms= | 14.88 | | |
| Q = | 10 | | | | | | | | | |

Analysis results from USML-2 HI-PAC DTV PDAC Module Model (Run 4 27/95 on CSA '94)

| FREQUENCY | F0 | PSD0 | SLOPE | PSD | RLF(i) | EFFW | RLF(RMS) | RLF(SQ) | RLF(RSS) | RLF/(EFFW) |
|---|---|---|---|---|---|---|---|---|---|---|
| **200.4** | 109 | 0.600 | 0.000 | 0.600 | **130.36** | **7.260** | 946.4 | 8.9573E+05 | 946.4 | 94.6 |
| 254.1 | 250 | 0.600 | -10.000 | 0.569 | 142.92 | 0.000 | 0.0 | 0.0000E+00 | 946.4 | 94.6 |
| 305.2 | 250 | 0.600 | -10.000 | 0.309 | 115.50 | 0.000 | 0.0 | 0.0000E+00 | 946.4 | 94.6 |
| 305.4 | 250 | 0.600 | -10.000 | 0.309 | 115.42 | 0.129 | 14.9 | 2.2168E+02 | 946.5 | 94.7 |
| 392.2 | 250 | 0.600 | -10.000 | 0.134 | 86.34 | 0.000 | 0.0 | 0.0000E+00 | 946.5 | 94.7 |
| 418.1 | 250 | 0.600 | -10.000 | 0.109 | 80.16 | 0.000 | 0.0 | 0.0000E+00 | 946.5 | 94.7 |
| 448.1 | 250 | 0.600 | -10.000 | 0.086 | 73.95 | 0.000 | 0.0 | 0.0000E+00 | 946.5 | 94.7 |
| 458.5 | 250 | 0.600 | -10.000 | 0.080 | 72.01 | 0.000 | 0.0 | 0.0000E+00 | 946.5 | 94.7 |
| 463.9 | 250 | 0.600 | -10.000 | 0.077 | 71.04 | 0.000 | 0.0 | 0.0000E+00 | 946.5 | 94.7 |
| 499.9 | 250 | 0.600 | -10.000 | 0.060 | 65.13 | 0.000 | 0.0 | 0.0000E+00 | 946.5 | 94.7 |
| 523.5 | 250 | 0.600 | -10.000 | 0.052 | 61.75 | 0.000 | 0.0 | 0.0000E+00 | 946.5 | 94.7 |
| 577.1 | 250 | 0.600 | -10.000 | 0.037 | 55.14 | 0.000 | 0.0 | 0.0000E+00 | 946.5 | 94.7 |
| 697.2 | 250 | 0.600 | -10.000 | 0.020 | 44.27 | 0.000 | 0.0 | 0.0000E+00 | 946.5 | 94.7 |
| 716.1 | 250 | 0.600 | -10.000 | 0.018 | 42.91 | 0.100 | 4.3 | 1.8415E+01 | 946.6 | 94.7 |
| 755.3 | 250 | 0.600 | -10.000 | 0.015 | 40.34 | 0.000 | 0.0 | 0.0000E+00 | 946.6 | 94.7 |
| 756.4 | 250 | 0.600 | -10.000 | 0.015 | 40.27 | 0.000 | 0.0 | 0.0000E+00 | 946.6 | 94.7 |
| 867.1 | 250 | 0.600 | -10.000 | 0.010 | 34.37 | 0.000 | 0.0 | 0.0000E+00 | 946.6 | 94.7 |
| 962.6 | 250 | 0.600 | -10.000 | 0.007 | 30.44 | 0.000 | 0.0 | 0.0000E+00 | 946.6 | 94.7 |
| 968.9 | 250 | 0.600 | -10.000 | 0.007 | 30.21 | 0.000 | 0.0 | 0.0000E+00 | 946.6 | 94.7 |
| 1230.1 | 250 | 0.600 | -10.000 | 0.003 | 22.90 | 0.000 | 0.0 | 0.0000E+00 | 946.6 | 94.7 |
| 1616.9 | 250 | 0.600 | -10.000 | 0.001 | 16.67 | 0.002 | 0.0 | 1.1116E-03 | 946.6 | 94.7 |
| 1735.8 | 250 | 0.600 | -10.000 | 0.001 | 15.35 | 0.000 | 0.0 | 0.0000E+00 | 946.6 | 94.7 |
| 1795.1 | 250 | 0.600 | -10.000 | 0.001 | 14.77 | 0.000 | 0.0 | 0.0000E+00 | 946.6 | 94.7 |
| 1970.7 | 250 | 0.600 | -10.000 | 0.001 | 13.25 | 0.000 | 0.0 | 0.0000E+00 | 946.6 | 94.7 |
| | | | | | EFFWSUM | 7.5 | | RLF (RSS) = | 946.6 | |
| | | | | | EFFWRATIO | 0.75 | | MASS = | 10 | |
| | | | | | | | | RLF = | 94.7 | |
| | | | | | Delta Wt.= | 2.509 | | | | |
| | | | | | 3xGrms= | 44.639 | | RLF'= | **95.3** | |



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# RANDOM LOAD FACTORS

## Hi-Pac DTV Comparison (Electronics box with a base flange)

### X-Axis Input

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


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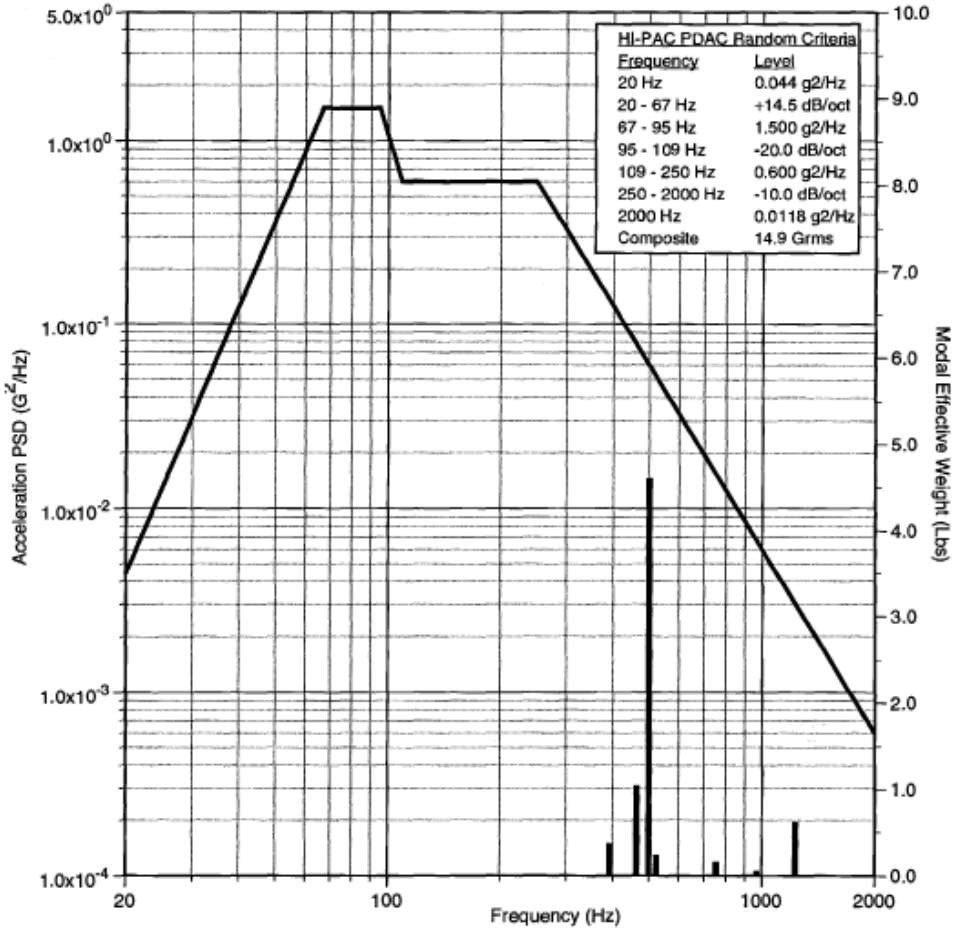
# RANDOM LOAD FACTORS

## Hi-Pac DTV Comparison (Electronics box with a base flange)

### Y-Axis Input




Input at the interface with HFSS (Ref. PDAC CEI Spec/410SPC0327 Table 3-5)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| F01 = | 20 | PSD01 = | 0.004 | n1 = | 14.5 | Grms1= | 4.17 | 14.88 | |
| F02 = | 67 | PSD02 = | 1.500 | n2 = | 0 | Grms2= | 6.48 | | |
| F03 = | 95 | PSD03 = | 1.500 | n3 = | -20 | Grms3= | 3.69 | | |
| F04 = | 109 | PSD04 = | 0.600 | n4 = | 0 | Grms4= | 9.20 | | |
| F05 = | 250 | PSD05 = | 0.600 | n5 = | -10 | Grms5= | 7.99 | | |
| F06 = | 2000 | PSD06 = | 0.001 | n6 = | 0 | | | | |
| | | | | | | Grms= | 14.88 | | |
| Q = | 10 | | | | | | | | |

Analysis results from USML-2 HI-PAC DTV PDAC Module Model (Run 4/27/95 on CSA '94)

| FREQUENCY | F0 | PSD0 | SLOPE | PSD | RLF(I) | EFFW | Force | RLF(SQ) | RLF(RSS) | RLF(IEFFW) |
|---|---|---|---|---|---|---|---|---|---|---|
| 200.4 | 109 | 0.600 | 0.000 | 0.600 | 130.36 | 0.000 | 0.0 | 0.0000E+00 | 0.0 | 0.0 |
| 254.1 | 250 | 0.600 | -10.000 | 0.569 | 142.92 | 0.000 | 0.0 | 0.0000E+00 | 0.0 | 0.0 |
| 305.2 | 250 | 0.600 | -10.000 | 0.309 | 115.50 | 0.000 | 0.0 | 0.0000E+00 | 0.0 | 0.0 |
| 305.4 | 250 | 0.600 | -10.000 | 0.309 | 115.42 | 0.000 | 0.0 | 0.0000E+00 | 0.0 | 0.0 |
| 392.2 | 250 | 0.600 | -10.000 | 0.134 | 86.34 | 0.371 | 32.0 | 1.0261E+03 | 32.0 | 3.2 |
| 418.1 | 250 | 0.600 | -10.000 | 0.109 | 80.16 | 0.000 | 0.0 | 0.0000E+00 | 32.0 | 3.2 |
| 448.1 | 250 | 0.600 | -10.000 | 0.086 | 73.95 | 0.000 | 0.0 | 0.0000E+00 | 32.0 | 3.2 |
| 458.5 | 250 | 0.600 | -10.000 | 0.080 | 72.01 | 0.000 | 0.0 | 0.0000E+00 | 32.0 | 3.2 |
| 463.9 | 250 | 0.600 | -10.000 | 0.077 | 71.04 | 1.048 | 74.5 | 5.5431E+03 | 81.1 | 8.1 |
| **499.9** | 250 | 0.600 | -10.000 | 0.060 | **65.13** | **4.604** | 299.9 | 8.9924E+04 | 310.6 | 31.1 |
| 523.5 | 250 | 0.600 | -10.000 | 0.052 | 61.75 | 0.239 | 14.8 | 2.1779E+02 | 311.0 | 31.1 |
| 577.1 | 250 | 0.600 | -10.000 | 0.037 | 55.14 | 0.000 | 0.0 | 0.0000E+00 | 311.0 | 31.1 |
| 697.2 | 250 | 0.600 | -10.000 | 0.020 | 44.27 | 0.000 | 0.0 | 0.0000E+00 | 311.0 | 31.1 |
| 716.1 | 250 | 0.600 | -10.000 | 0.018 | 42.91 | 0.000 | 0.0 | 0.0000E+00 | 311.0 | 31.1 |
| 755.3 | 250 | 0.600 | -10.000 | 0.015 | 40.34 | 0.160 | 6.5 | 4.1658E+01 | 311.1 | 31.1 |
| 756.4 | 250 | 0.600 | -10.000 | 0.015 | 40.27 | 0.000 | 0.0 | 0.0000E+00 | 311.1 | 31.1 |
| 867.1 | 250 | 0.600 | -10.000 | 0.010 | 34.37 | 0.000 | 0.0 | 0.0000E+00 | 311.1 | 31.1 |
| 962.6 | 250 | 0.600 | -10.000 | 0.007 | 30.44 | 0.000 | 0.0 | 0.0000E+00 | 311.1 | 31.1 |
| 968.9 | 250 | 0.600 | -10.000 | 0.007 | 30.21 | 0.056 | 1.7 | 2.8621E+00 | 311.1 | 31.1 |
| 1230.1 | 250 | 0.600 | -10.000 | 0.003 | 22.90 | 0.618 | 14.2 | 2.0026E+02 | 311.4 | 31.1 |
| 1616.9 | 250 | 0.600 | -10.000 | 0.001 | 16.67 | 0.000 | 0.0 | 0.0000E+00 | 311.4 | 31.1 |
| 1735.8 | 250 | 0.600 | -10.000 | 0.001 | 15.35 | 0.000 | 0.0 | 0.0000E+00 | 311.4 | 31.1 |
| 1795.1 | 250 | 0.600 | -10.000 | 0.001 | 14.77 | 0.000 | 0.0 | 0.0000E+00 | 311.4 | 31.1 |
| 1970.7 | 250 | 0.600 | -10.000 | 0.001 | 13.25 | 0.000 | 0.0 | 0.0000E+00 | 311.4 | 31.1 |
| | | | | | EFFWSUM | 7.1 | | RLF (RSS) = | 311.4 | |
| | | | | | EFFWRATIO | 0.71 | | MASS = | 10 | |
| | | | | | | | | RLF = | 31.1 | |
| | | | | | Delta Wt.= | 2.904 | | | | |
| | | | | | 3xGrms= | 44.639 | | RLF'= | **33.7** | |



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# RANDOM LOAD FACTORS

## Hi-Pac DTV Comparison (Electronics box with a base flange)

### Y-Axis Input

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


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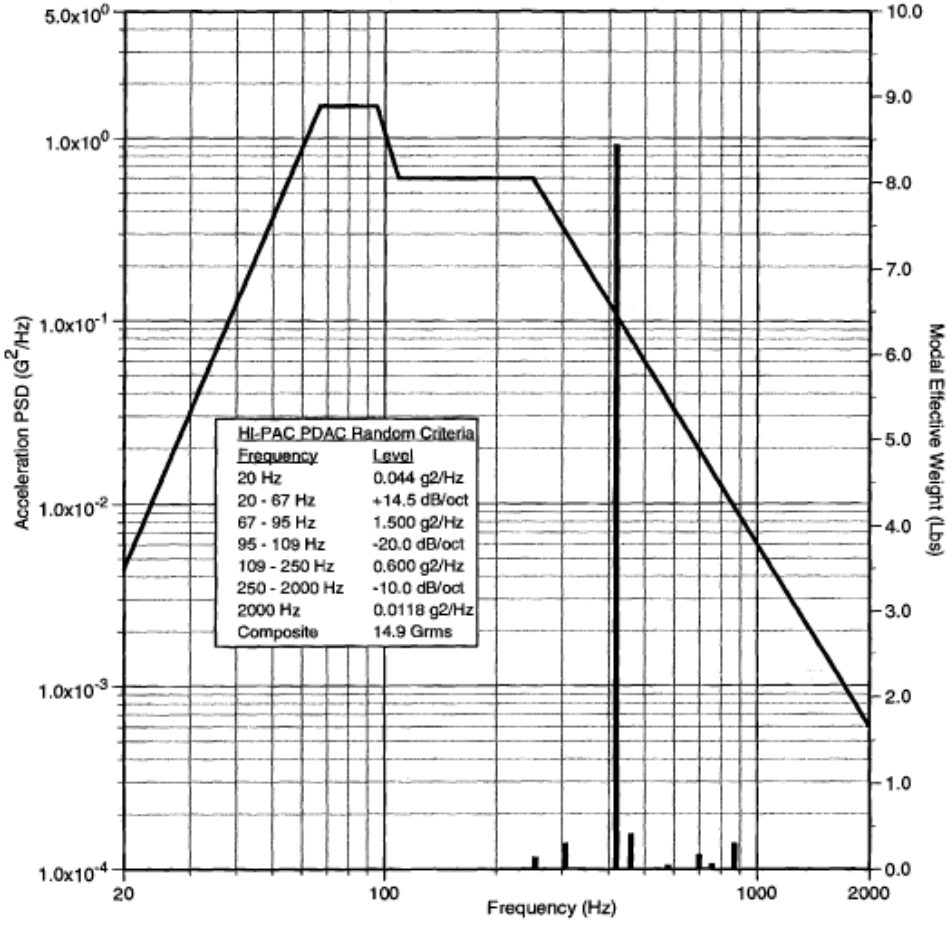
# RANDOM LOAD FACTORS

## Hi-Pac DTV Comparison (Electronics box with a base flange)

### Z-Axis Input




Input at the interface with HESS (Ref. PDAC CEI Spec/410SPC0327 Table 3-5)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| F01 = | 20 | PSD01 = | 0.004 | n1 = | 14.5 | Grms1= | 4.17 | 14.88 | |
| F02 = | 67 | PSD02 = | 1.500 | n2 = | 0 | Grms2= | 6.48 | | |
| F03 = | 95 | PSD03 = | 1.500 | n3 = | -20 | Grms3= | 3.69 | | |
| F04 = | 109 | PSD04 = | 0.600 | n4 = | 0 | Grms4= | 9.20 | | |
| F05 = | 250 | PSD05 = | 0.600 | n5 = | -10 | Grms5= | 7.99 | | |
| F06 = | 2000 | PSD06 = | 0.001 | n6 = | 0 | | | | |
| | | | | | | Grms= | 14.88 | | |
| Q = | 10 | | | | | | | | |

Analysis results from USML-2 HI-PAC DTV PDAC Module Model (Run 4/27/95 on CSA '94)

| FREQUENCY | F0 | PSD0 | SLOPE | PSD | RLF(I) | EFFW | Force | RLF(SQ) | RLF(RSS) | RLF(EI FW) |
|---|---|---|---|---|---|---|---|---|---|---|
| 200.4 | 109 | 0.600 | 0.000 | 0.600 | 130.36 | 0.000 | 0.0 | 0.0000E+00 | 0.0 | 0.0 |
| 254.1 | 250 | 0.600 | -10.000 | 0.569 | 142.92 | 0.150 | 21.4 | 4.5961E+02 | 21.4 | 2.1 |
| 305.2 | 250 | 0.600 | -10.000 | 0.309 | 115.50 | 0.311 | 35.9 | 1.2903E+03 | 41.8 | 4.2 |
| 305.4 | 250 | 0.600 | -10.000 | 0.309 | 115.42 | 0.000 | 0.0 | 0.0000E+00 | 41.8 | 4.2 |
| 392.2 | 250 | 0.600 | -10.000 | 0.134 | 86.34 | 0.000 | 0.0 | 0.0000E+00 | 41.8 | 4.2 |
| **418.1** | 250 | 0.600 | -10.000 | 0.109 | **80.16** | **8.441** | 676.6 | 4.5779E+05 | 677.9 | 67.8 |
| 448.1 | 250 | 0.600 | -10.000 | 0.086 | 73.95 | 0.000 | 0.0 | 0.0000E+00 | 677.9 | 67.8 |
| 458.5 | 250 | 0.600 | -10.000 | 0.080 | 72.01 | 0.416 | 30.0 | 8.9739E+02 | 678.6 | 67.9 |
| 463.9 | 250 | 0.600 | -10.000 | 0.077 | 71.04 | 0.000 | 0.0 | 0.0000E+00 | 678.6 | 67.9 |
| 499.9 | 250 | 0.600 | -10.000 | 0.060 | 65.13 | 0.000 | 0.0 | 0.0000E+00 | 678.6 | 67.9 |
| 523.5 | 250 | 0.600 | -10.000 | 0.053 | 61.75 | 0.000 | 0.0 | 0.0000E+00 | 678.6 | 67.9 |
| 577.1 | 250 | 0.600 | -10.000 | 0.037 | 55.14 | 0.053 | 2.9 | 8.5398E+00 | 678.6 | 67.9 |
| 697.2 | 250 | 0.600 | -10.000 | 0.020 | 44.27 | 0.177 | 7.8 | 6.1394E+01 | 678.6 | 67.9 |
| 716.1 | 250 | 0.600 | -10.000 | 0.018 | 42.91 | 0.000 | 0.0 | 0.0000E+00 | 678.6 | 67.9 |
| 755.3 | 250 | 0.600 | -10.000 | 0.015 | 40.34 | 0.000 | 0.0 | 0.0000E+00 | 678.6 | 67.9 |
| 756.4 | 250 | 0.600 | -10.000 | 0.015 | 40.27 | 0.070 | 2.8 | 7.9461E+00 | 678.6 | 67.9 |
| 867.1 | 250 | 0.600 | -10.000 | 0.010 | 34.37 | 0.311 | 10.7 | 1.1423E+02 | 678.7 | 67.9 |
| 962.6 | 250 | 0.600 | -10.000 | 0.007 | 30.44 | 0.000 | 0.0 | 0.0000E+00 | 678.7 | 67.9 |
| 968.9 | 250 | 0.600 | -10.000 | 0.007 | 30.21 | 0.000 | 0.0 | 0.0000E+00 | 678.7 | 67.9 |
| 1230.1 | 250 | 0.600 | -10.000 | 0.003 | 22.90 | 0.000 | 0.0 | 0.0000E+00 | 678.7 | 67.9 |
| 1616.9 | 250 | 0.600 | -10.000 | 0.001 | 16.67 | 0.000 | 0.0 | 0.0000E+00 | 678.7 | 67.9 |
| 1735.8 | 250 | 0.600 | -10.000 | 0.001 | 15.35 | 0.000 | 0.0 | 0.0000E+00 | 678.7 | 67.9 |
| 1795.1 | 250 | 0.600 | -10.000 | 0.001 | 14.77 | 0.024 | 0.4 | 1.2558E-01 | 678.7 | 67.9 |
| 1970.7 | 250 | 0.600 | -10.000 | 0.001 | 13.25 | 0.001 | 0.0 | 1.7553E-04 | 678.7 | 67.9 |
| | | | | | EFFWSUM | 10.0 | | RLF (RSS) = | 678.7 | |
| | | | | | EFFWRATIO | 1.00 | | MASS = | 10 | |
| | | | | | | | | RLF = | 67.9 | |
| | | | | | Delta Wt.= | 0.046 | | | | |
| | | | | | 3xGrms= | 44.639 | | RLF= | **67.9** | |



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# RANDOM LOAD FACTORS

## Hi-Pac DTV Comparison (Electronics box with a base flange)

### Z-Axis Input

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 | 2 | Miles Equation | -12.2 | 42.7 | -131.8 | 139.1 |
| | | Eff. Wt./RSS | -10.4 | 36.2 | -111.6 | 117.7 |
| | | Random Response | 13.6 | 46.2 | 141.5 | 149.4 |
| | 4 | Miles Equation | 0.0 | 11.2 | -137.5 | 137.9 |
| | | Eff. Wt./RSS | 0.0 | 9.5 | -116.4 | 116.8 |
| | | Random Response | 0.0 | 11.5 | 143.8 | 144.2 |
| | 6 | Miles Equation | 12.2 | 42.7 | -131.8 | 139.1 |
| | | Eff. Wt./RSS | 10.4 | 36.2 | -111.6 | 117.7 |
| | | Random Response | 13.6 | 46.2 | 141.5 | 149.4 |
| | 44 | Miles Equation | -12.2 | -42.7 | -131.8 | 139.1 |
| | | Eff. Wt./RSS | -10.4 | -36.2 | -111.6 | 117.7 |
| | | Random Response | 13.6 | 46.2 | 141.5 | 149.4 |
| | 46 | Miles Equation | 0.0 | -11.2 | -137.5 | 137.9 |
| | | Eff. Wt./RSS | 0.0 | -9.5 | -116.4 | 116.8 |
| | | Random Response | 0.0 | 11.5 | 143.8 | 144.2 |
| | 48 | Miles Equation | 12.2 | -42.7 | -131.8 | 139.1 |
| | | 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


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