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International Space Station Program

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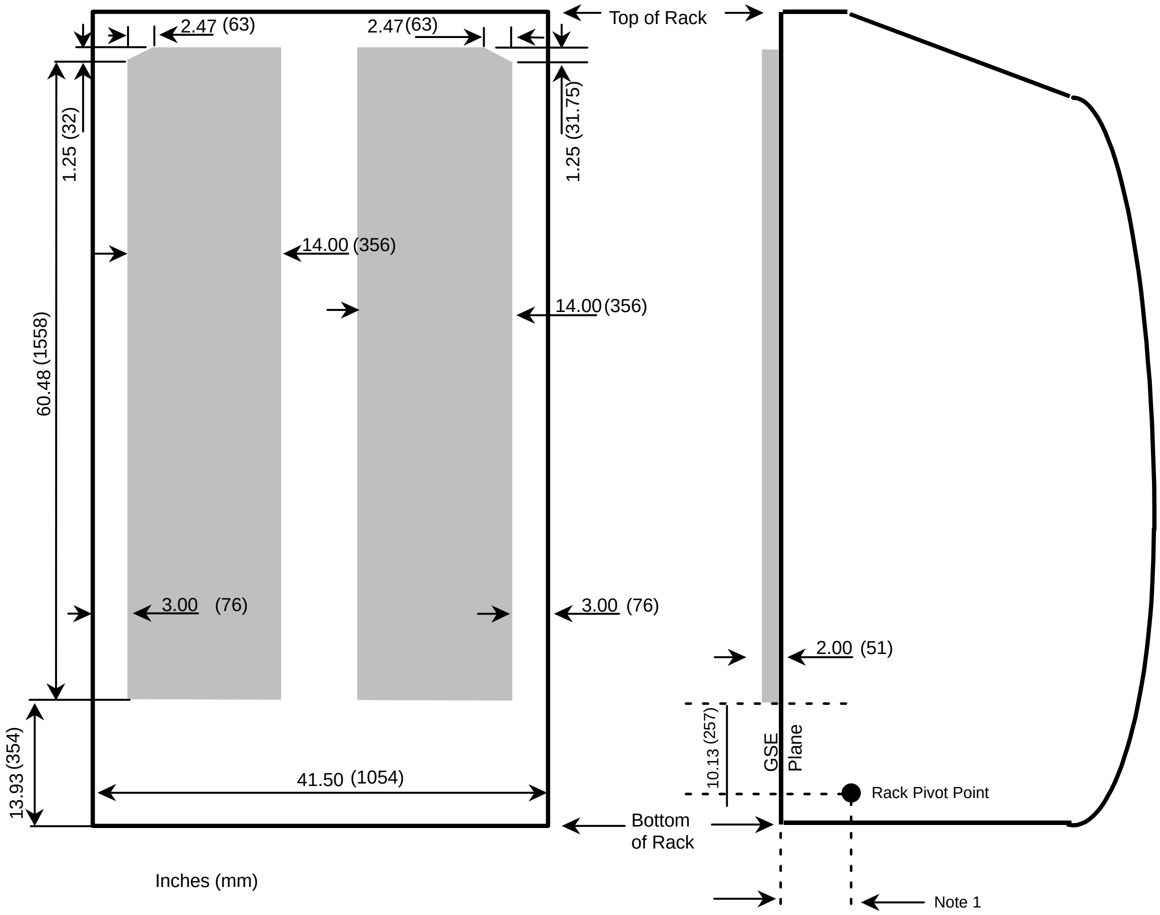


Note:
1. The dimension for a Boeing ISPR is 3.50 (89). The dimension for a NASDA ISPR is 2.47 (63).

FIGURE 3.1.1.7.5–3 ISIS FLUID LINE ENVELOPE FOR 2–INCH PROTRUSIONS

3.1.2 MICROGRAVITY

Microgravity requirements are defined to limit the disturbing effects of Integrated Racks and non–rack payloads on the microgravity environment of other payloads during microgravity mode periods. Non–rack payloads will be given a one quarter rack microgravity disturbance allocation. These requirements are separated into the quasi–steady category for frequencies below 0.01 Hz, the vibratory category for frequencies between 0.01 Hz and 300 Hz, and the transient category. For integrated racks, the interface points are the locations on the ISS structure where rack attachment brackets or isolation systems connect to the ISS. These requirements will apply to all NASA developed payloads and to any IP developed payloads that will be located in the USL. IRN 0003

3.1.2.1 QUASI-STEADY REQUIREMENTS

For frequencies below 0.01 Hz, Integrated racks and non–rack payloads shall limit unbalanced transitional average impulse to generate less than 10 lb–s (44.8 N–s) within any 10 to 500 second period, along any ISS coordinate system vector. IRN 0003

3.1.2.2 VIBRATORY REQUIREMENTS

Between 0.01 and 300 Hz, Integrated Rack payloads without ARIS and inactive ARIS racks shall limit vibration so that the limits of Figure 3.1.2.2–1 are not exceeded using the force method, or the limits of Table 3.1.2.2–2 are not exceeded using the acceleration method. Non–Rack payloads shall limit vibration so that one–fourth of the limits of Figure 3.1.2.2–1 are not exceeded using the force method, or one–fourth the limits of Table 3.1.2.2–2 are not exceeded using the acceleration method. IRN 0003

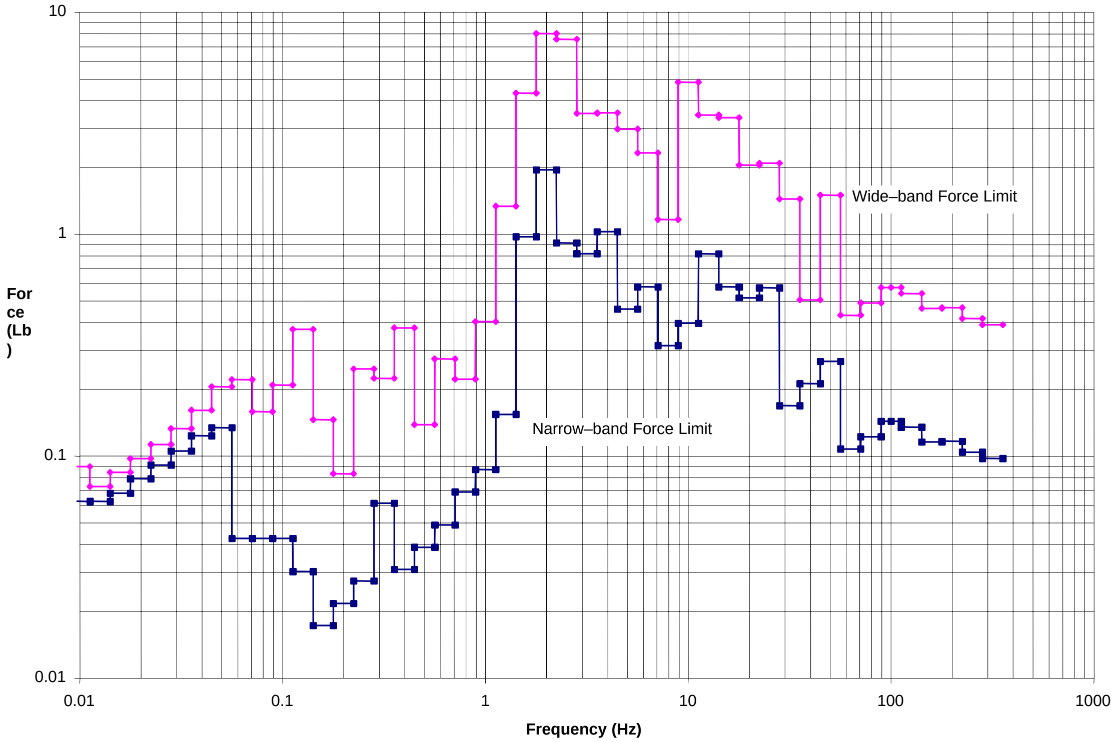
PAYLOAD INTERFACE FORCE METHOD
The total force will be calculated as the RMS average of the forces at all interface points for inactive (latched) ARIS payload configurations, or the RSS of the forces at all interface points for non–ARIS payloads and Non–Rack payloads. The force at each interface point will be calculated to be the root–summed squared (RSS) in all axis, within each third octave band, during the worst case 100 second interval.

The forces within each 1/3 octave band will be classified as either wide–band or narrow–band. Forces will be classified as wide–band if the peak–to–average ratio is less than or equal to five, otherwise they will be classified as narrow–band. The peak to average ratio will be determined by dividing the peak power spectrum magnitude of the one–third octave band by the average magnitude within the band for the axis in which the peak occurs. The forces so classified will then be compared to the appropriate limit (wide or narrow band) in Figure 3.1.2.2–1.

OR

ADJACENT ARIS PAYLOAD ACCELERATION METHOD
The modeled payload induced acceleration at an immediately adjacent ARIS rack interface described by an ISS Program Office supplied model is to be used. The interfaces are to consist of the isolation plate, "Z" panel, and "light rails", at which the RMS accelerations within any one–third octave band, over any 100 second period, are not to exceed the limits shown in Figure 3.1.2.2–2. Application of this technique requires that the payload developer use the ISS Program Office provided interface model in conjunction with payload FEM and/or SEA models to calculate the ARIS interface accelerations resulting from the worst case combination of payload disturbance sources.

IRN 0003



Note: Non–Rack Payloads are limited to one–fourth of this allocation.

FIGURE 3.1.2.2–1 ALLOWABLE ONE–THIRD OCTAVE INTERFACE FORCES FOR INTEGRATED RACKS AND NON–RACK PAYLOADS, 0.5% DAMPING FACTOR

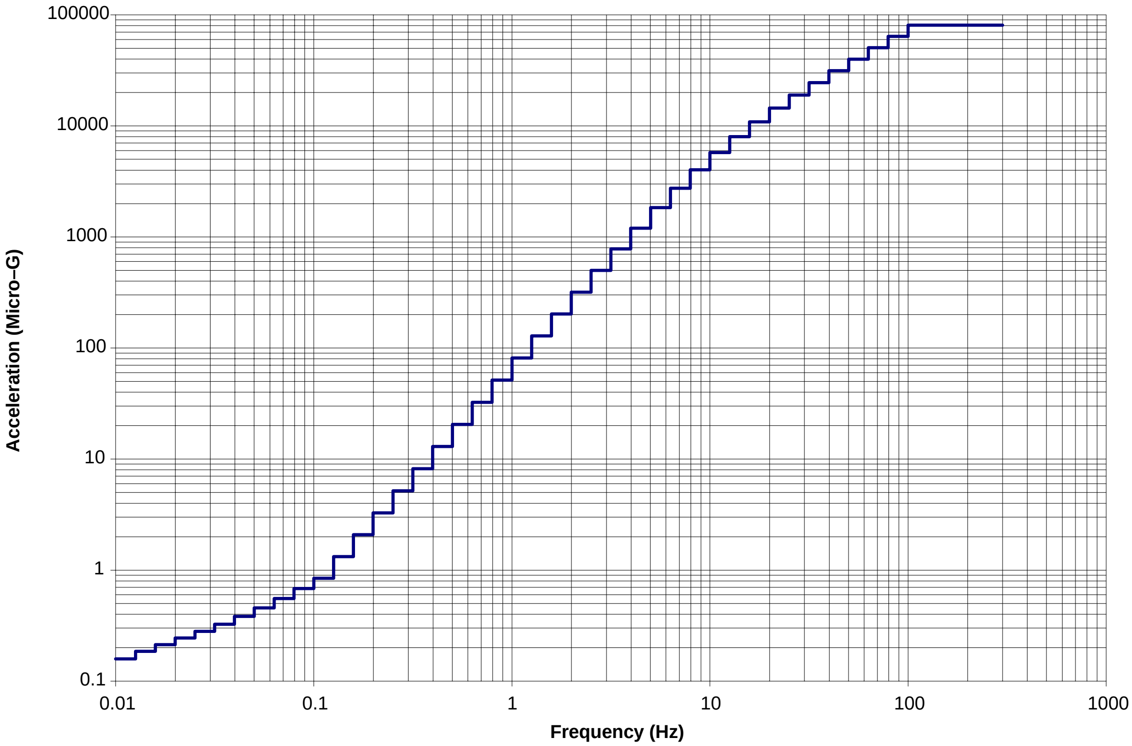
IRN 0003

TABLE 3.1.2.2–1 ALLOWABLE INTEGRATED RACK NARROW–BAND ENVELOPE AND WIDEBAND INTERFACE FORCE VALUES FOR ISPRS, 0.5% DAMPING FACTOR

Freq (Hz)	NB lb f	WB Lb f	Freq (Hz)	NB lb f	WB Lb f	Freq (Hz)	NB lb f	WB Lb f
0.008913	0.06261	0.089635	0.3548	0.061482	0.224779	11.22	0.817148	3.451307
0.01122	0.06261	0.089635	0.3548	0.030924	0.378806	14.13	0.817148	3.451307
0.01122	0.06261	0.073218	0.4467	0.030924	0.378806	14.13	0.579786	3.358266
0.01413	0.06261	0.073218	0.4467	0.038934	0.138909	17.78	0.579786	3.358266
0.01413	0.068172	0.084667	0.5623	0.038934	0.138909	17.78	0.516921	2.048448
0.01778	0.068172	0.084667	0.5623	0.04901	0.274588	22.39	0.516921	2.048448
0.01778	0.079202	0.097495	0.7079	0.04901	0.274588	22.39	0.57451	2.091627
0.02239	0.079202	0.097495	0.7079	0.06922	0.222568	28.18	0.57451	2.091627
0.02239	0.091377	0.112968	0.8913	0.06922	0.222568	28.18	0.168996	1.443748
0.02818	0.091377	0.112968	0.8913	0.087153	0.404688	35.48	0.168996	1.443748
0.02818	0.105641	0.133067	1.122	0.087153	0.404688	35.48	0.212776	0.50643
0.03548	0.105641	0.133067	1.122	0.154561	1.337042	44.67	0.212776	0.50643
0.03548	0.123739	0.161094	1.413	0.154561	1.337042	44.67	0.267886	1.498072
0.04467	0.123739	0.161094	1.413	0.976353	4.322593	56.23	0.267886	1.498072
0.04467	0.134457	0.205508	1.778	0.976353	4.322593	56.231	0.10793	0.431721
0.05623	0.134457	0.205508	1.778	1.953413	8.01995	70.79	0.10793	0.431721
0.05623	0.042699	0.22137	2.239	1.953413	8.01995	70.791	0.122491	0.489965
0.07079	0.042699	0.22137	2.239	0.915835	7.567684	89.13	0.122491	0.489965
0.07079	0.042699	0.158917	2.818	0.915835	7.567684	89.131	0.143827	0.575309
0.08913	0.042699	0.158917	2.818	0.818034	3.504552	100	0.143827	0.575309
0.08913	0.042699	0.2093	3.548	0.818034	3.504552	112.2	0.143827	0.575309
0.1122	0.042699	0.2093	3.548	1.029953	3.531682	112.2	0.135367	0.541469
0.1122	0.030213	0.373089	4.467	1.029953	3.531682	141.3	0.135367	0.541469
0.1413	0.030213	0.373089	4.467	0.460611	2.979207	141.3	0.115819	0.463274
0.1413	0.017289	0.146008	5.623	0.460611	2.979207	177.8	0.115819	0.463274
0.1778	0.017289	0.146008	5.623	0.579824	2.330438	177.8	0.116941	0.467763
0.1778	0.021755	0.083429	7.079	0.579824	2.330438	223.9	0.116941	0.467763
0.2239	0.021755	0.083429	7.079	0.315606	1.16448	223.9	0.104363	0.417452
0.2239	0.027396	0.24715	8.913	0.315606	1.16448	281.8	0.104363	0.417452
0.2818	0.027396	0.24715	8.913	0.39737	4.848007	281.8	0.097688	0.390751
0.2818	0.061482	0.224779	11.22	0.39737	4.848007	354.8	0.097688	0.390751

Note: Non–rack payloads are limited to one–fourth of these values

IRN 0003



Note: Non–Rack Payloads are limited to one–fourth of this limit.

FIGURE 3.1.2.2–2 NON–ARIS TO ARIS ACCELERATION LIMIT ALTERNATIVE TO FORCE LIMITS

IRN 0003

TABLE 3.1.2.2–2 NON–ARIS INTEGRATED RACK TO ARIS ACCELERATION LIMIT ALTERNATIVE TO FORCE LIMITS

Freq	Accel Limit (ug)	Freq	Accel Limit (ug)	Freq	Accel Limit (ug)
0.0089	0.159	0.226	5.18	5.74	2746
0.0112	0.159	0.285	5.18	7.23	2746
0.0112	0.185	0.285	8.19	7.23	4026
0.0141	0.185	0.359	8.19	9.11	4026
0.0141	0.213	0.359	12.97	9.11	5758
0.0178	0.213	0.452	12.97	11.48	5758
0.0178	0.244	0.452	20.53	11.48	8021
0.0224	0.244	0.570	20.53	14.47	8021
0.0224	0.281	0.570	32.49	14.47	10898
0.0283	0.281	0.718	32.49	18.23	10898
0.0283	0.325	0.718	51.42	18.23	14495
0.0356	0.325	0.904	51.42	22.96	14495
0.0356	0.383	0.904	81.33	22.96	18956
0.0449	0.383	1.139	81.33	28.93	18956
0.0449	0.458	1.139	128.51	28.93	24483
0.0565	0.458	1.435	128.51	36.45	24483
0.0565	0.556	1.435	202.73	36.45	31346
0.0712	0.556	1.808	202.73	45.93	31346
0.0712	0.682	1.808	318.99	45.93	39894
0.0897	0.682	2.278	318.99	57.87	39894
0.0897	0.843	2.278	499.90	57.87	50578
0.1130	0.843	2.871	499.90	72.91	50578
0.1130	1.322	2.871	778.69	72.91	63958
0.1424	1.322	3.617	778.69	91.86	63958
0.1424	2.079	3.617	1202.18	91.86	80751
0.1794	2.079	4.557	1202.18	100.00	80751
0.1794	3.280	4.557	1832.55	300.00	80751
0.2260	3.280	5.741	1832.55		

Note: Non–rack payloads are limited to one–fourth of these values

3.1.2.3 TRANSIENT REQUIREMENTS

IRN 0003

A. Integrated racks shall limit force applied to the ISS over any ten second period to an impulse of no greater than 10 lb–s (44.5 N–s). Non–rack payloads shall limit force applied to the ISS over any ten second period to an impulse of no greater than 2.5 lb–s (11.1 N–s).

B. Integrated racks and non–rack payloads shall limit their peak force applied to the ISS to less than 1000 lb (4448 N) for any duration.

NOTE: Meeting the transient requirements of both A and B does not obviate the need to also meet the 100 second vibration requirement of 3.1.2.2 for vibration included in and following the transient disturbance.

3.1.2.4 MICROGRAVITY ENVIRONMENT

The microgravity environment is documented in section 3.9, Environments.

3.1.2.5 ARIS RACK VIBRATORY REQUIREMENT

IRN 0003

ARIS Rack vibration induced by payloads shall not exceed the on–board to off–board vibration force limit of Figure 3.1.2.5–1 during microgravity periods, considering ARIS suspended rack structural dynamics and control system interaction, while ARIS is actively isolating.

IRN 0003

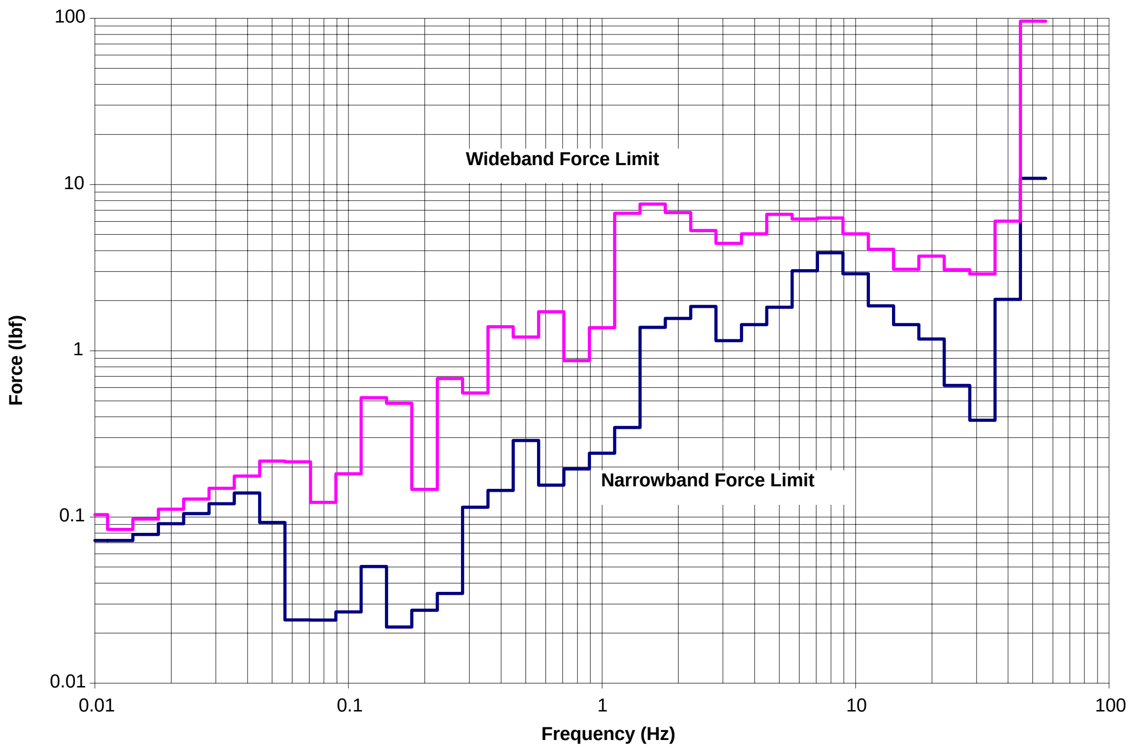


FIGURE 3.1.2.5–1 ALLOWABLE ON–BOARD FORCE VALUES FOR ARIS INTEGRATED PAYLOADS TO MEET OFF–BOARD LIMITS

IRN 0003

TABLE 3.1.2.5–1 ALLOWABLE ON–BOARD FORCE VALUES FOR ARIS INTEGRATED PAYLOADS TO MEET OFF–BOARD LIMITS

Freq. (Hz.)	NBP Limit (lbf)	WB Limit (lbf)	Freq. (Hz.)	NBP Limit (lbf)	WB Limit (lbf)	Freq. (Hz.)	NBP Limit (lbf)	WB Limit (lbf)
0.0089	0.0722	0.1033	0.1778	0.0274	0.1466	3.5480	1.4337	5.0388
0.0112	0.0722	0.1033	0.2239	0.0274	0.1466	4.4670	1.4337	5.0388
0.0112	0.0722	0.0842	0.2239	0.0346	0.6819	4.4670	1.8234	6.6213
0.0141	0.0722	0.0842	0.2818	0.0346	0.6819	5.6230	1.8234	6.6213
0.0141	0.0785	0.0971	0.2818	0.1147	0.5577	5.6230	3.0271	6.2002
0.0178	0.0785	0.0971	0.3548	0.1147	0.5577	7.0790	3.0271	6.2002
0.0178	0.0910	0.1113	0.3548	0.1445	1.3967	7.0790	3.8832	6.2891
0.0224	0.0910	0.1113	0.4467	0.1445	1.3967	8.9130	3.8832	6.2891
0.0224	0.1046	0.1279	0.4467	0.2881	1.2088	8.9130	2.9020	5.0388
0.0282	0.1046	0.1279	0.5623	0.2881	1.2088	11.2200	2.9020	5.0388
0.0282	0.1201	0.1488	0.5623	0.1554	1.7174	11.2200	1.8602	4.0770
0.0355	0.1201	0.1488	0.7079	0.1554	1.7174	14.1300	1.8602	4.0770
0.0355	0.1392	0.1763	0.7079	0.1945	0.8709	14.1300	1.4350	3.0919
0.0447	0.1392	0.1763	0.8913	0.1945	0.8709	17.7800	1.4350	3.0919
0.0447	0.0926	0.2167	0.8913	0.2416	1.3743	17.7800	1.1754	3.7060
0.0562	0.0926	0.2167	1.1220	0.2416	1.3743	22.3900	1.1754	3.7060
0.0562	0.0240	0.2147	1.1220	0.3449	6.7131	22.3900	0.6179	3.0764
0.0708	0.0240	0.2147	1.4130	0.3449	6.7131	28.1800	0.6179	3.0764
0.0708	0.0240	0.1225	1.4130	1.3847	7.6318	28.1800	0.3821	2.9013
0.0891	0.0240	0.1225	1.7780	1.3847	7.6318	35.4800	0.3821	2.9013
0.0891	0.0269	0.1820	1.7780	1.5667	6.7883	35.4800	2.0342	6.0143
0.1122	0.0269	0.1820	2.2390	1.5667	6.7883	44.6700	2.0342	6.0143
0.1122	0.0502	0.5226	2.2390	1.8464	5.2891	44.6700	10.9057	96.2593
0.1413	0.0502	0.5226	2.8180	1.8464	5.2891	56.2300	10.9057	96.2593
0.1413	0.0218	0.4830	2.8180	1.1511	4.4228			
0.1778	0.0218	0.4830	3.5480	1.1511	4.4228			

3.1.3 STOWAGE

Stowage interface information is provided in SSP 50467, ISS Stowage Accommodations Handbook: Pressurized Volume.

3.2 ELECTRICAL INTERFACE REQUIREMENTS

3.2.1 ELECTRICAL POWER CHARACTERISTICS

Electrical power characteristics are specified in this section for two interfaces, Interfaces B and C, as depicted in Figure 3.2.1–1, Electrical Power System Interface Locations. Integrated racks, payload associated hardware and payload hardware connected to Utility Outlet Panels (UOPs) in the USL, JEM, and CAM or the Standard Utility Panels (SUP) in the APM are required to be compatible with the prescribed characteristics of the Electrical Power System (EPS). For purposes of this specification, compatibility is defined as operating without producing an unsafe condition or one that could result in damage to ISS equipment or payload hardware.

4.3.1.2 MICROGRAVITY

NVR IRN 0003

Hardware which will remain on–orbit after UF–3 should be verified to the subsequent requirements prior to launch.

4.3.1.2.1 QUASI-STEADY REQUIREMENTS

Forces produced by a payload below 0.01 Hz shall be verified by analysis against 3.1.2.1. This analysis shall be considered successful when it is shown that no impulse is exerted by the payload to the ISS, either directly or through the ISS vent/exhaust systems, greater than 10 lb–s (44 N–s) over any 10 to 500 second interval. IRN 0003

4.3.1.2.2 MECHANICAL VIBRATION

Verification of non–isolated rack mechanical vibration against 3.1.2.2 shall be accomplished by Finite Element Modeling (FEM), Statistical Energy Analysis (SEA), test or simplified analysis as discussed in the following paragraphs. SEA may be performed where sufficient modal density is present as defined by the SEA parameter limitations explanation included with the SEA model. FEM analysis may be performed to either the ISS side of the rack attachment brackets interface using a force limit requirement of Table 3.1.2.2–1 or to an assumed adjacent ARIS rack interface using the interface acceleration limit requirement of Table 3.1.2.2–2. In applying these methods, the following are to be observed:

1. Payload FEM models must use a damping factor of 0.5% unless alternative damping values are shown appropriate by test. Damping coefficient test data must be obtained using force levels no greater than the maximum disturbance force allowable to meet microgravity requirements and at the approximate location for the payload disturbance. High strain producing test methods are to be avoided since such test may increase damping, leading to misleading results.

2. The one–third octave force limits include allowance for payload frequency deviation as large as 10% from predicted or measured values. Payloads with disturbance frequency variation and uncertainty which exceeds 10% shall use worst–case assumptions for frequency disturbance close to one–third octave boundaries.

3. If multiple disturbance sources that are not phase synchronized are modeled, then the effect of each source operating independently is to be added in RSS fashion. If the disturbance sources are phase synchronized then the sum of the vibration contributions for each disturber in phase must be added at each resultant point in each axis prior to obtaining the RSS.

IRN 0003

4. To ensure capture of modal peak responses in finite element frequency domain verification procedures, the transfer function and/or response analysis should explicitly include the modal frequencies of the finite element model. These should be supplemented with additional frequencies to adequately capture off–peak responses. It is required that the supplemental frequency density be sufficient to include at least one additional frequency within the half–power bandwidth of the modes. A constant logarithmic frequency spacing in which the delta frequency factor (deltafreq=deltafreqfac*lastfreq) is less than the half–power bandwidth (halfpowbw=2*c/ccrit) provides such a condition.

5. For the frequency range above 50 Hz, either SEA or FEM may be used. SEA models shall use a loss factor coefficient of 0.5% unless alternative values are justified by payload test FEM models are to be used to the highest frequency verified by test. FEM models may also be used beyond the range verifiable by test to envelope possible rack response as an alternative to SEA. The RSS of each one–third octave band plus one fourth of the RSS of each adjacent band as obtained by rack models applied to measured rack disturbances may be used to envelope FEM force response in the extended frequency range. Test data analysis may be used to adjust the damping coefficient used in either FEM or SEA models or to adjust the coupling coefficients and loss factor used for SEA models.

6. Disturbance forces must be applied to transfer functions from Force Spectral Density (FSD) form for each one–third octave. The RSS value for each incremental division of FSD(f) contribution of multiple sources, wide–band and narrow–band, are to be added to yield a total FSD(f) for each frequency subdivision before Frms is calculated. Values are given either as wide–band (an RMS value and a frequency range) or as narrow–band (an rms value and a discrete frequency). Wide–band RMS one–third octave data are to be converted to FSD(f) per the following equation:

$$FSD(f) = \frac{Frms^2}{\Delta fto}$$

   Where Frms is the Data base rms force value and Δfto is the bandwidth of the one–third octave band. Narrow–band data base values are to be converted to FSD(f) by the same expression adding the data base rms value only in the single frequency subdivision spanning the data base frequency. The FSD(f) contribution for multiple sources, wideband and narrowband, are to be added to yield a total FSD(f) for each frequency subdivision before Frms is calculated.

The method used for combining results to obtain peak rms for each one–third octave is dependent upon the verification method used. Method A will be used for payloads employing the interface force method and Method B will be used for payloads employing integrated payload and ISS models.

IRN 0003

PAYLOAD INTERFACE FORCE METHOD
Verification of the vibratory requirements shall be analysis or test. Acceptable methods for performing vibration test are contained in SSP 57010, Appendix E (Microgravity Control Plan).

The following sequence is to be used to verify integrated non–ARIS rack or latched ARIS rack compliance with Section 3.1.2.2.1:

1. Obtain disturbance forces in Force Spectral Density (FSD) for each one–third octave.

2. Calculate rms force magnitude within each one–third octave at each payload attachment interface as the RSS of X, Y and Z components (rms force) in each one–third octave band. This is to be calculated by combining N frequency subdivisions of each one–third octave per the following equation:

$$\mathrm{Frms} = \left(\sum_{N} H(f)^2 \cdot \mathrm{FSD}(f) \right)^{\frac{1}{2}}$$

   Where H(f) is the transfer function in lb/lb obtained by the FEM model for each frequency subdivision and FSD(f), is the Force Spectral Density forcing function for each frequency subdivision. The appropriate analytical model shall include the effects of the integrated payload rack and its attachment using a Payload Project Office provided interface model.

3. Find the combined force from all payload attachment interfaces at the RSS of all interface point forces (the results of A above) summed over each one–third octave bands.

4. Compare the combined force with the force limits in Figure 3.1.2.2–1. The wide–band limit may be used if the peak/average ratio is less than 5, otherwise the narrow–band peak limit must be used.

Verification is successful when the analysis or test results show that the interface forces are less than the limits specified in 3.1.2.2.

ADJACENT ARIS PAYLOAD ACCELERATION METHOD
Verification by this technique requires that the payload developer determine the ARIS interface accelerations resulting from the worst case combination of payload disturbance sources. This method is applicable for all pressurized payloads, including ARIS integrated racks, non–ARIS integrated racks and non–rack payloads. Application of this method required integration of an ISS Payload Office provided interface model with payload developer FEM and/or SEA models. Verification of ARIS accelerations is to be performed by the following steps:

IRN 0003

1. Obtain disturbance forces in Force Spectral Density (FSD) for each on–third octave.

2. Calculate rms acceleration magnitude within each one–third octave at each payload attachment interface as the RSS of X, Y and Z components (rms acceleration) in each one–third octave band. This is to be performed using unit forces applied in the X, Y and Z direction separately. The X, Y and Z components for each direction as a transfer function are to be calculated for all frequencies of interest. The FSD is to be applied to each transfer function yielding force magnitude is to be calculated for each 1/3rd octave by combining N frequency subdivisions of each one–third octave per the following equation:

$$\mathrm{Arms} = \left(\sum_{N} H(f)^2 \cdot FSD(f) \right)^{\frac{1}{2}}$$

   Where H(f) is the transfer function in ug/lb obtained by the FEM model for each frequency subdivision and FSD(f), is the Force Spectral Density forcing function for each frequency subdivision.

3. Find the combined acceleration from all payload attachment interfaces as the RSS of all interface point accelerations (the results of A above) summed over each one–third octave bands.

If the source direction is unknown then the largest response envelope resulting from applying the

$$\mathrm{Asum} = \left[\frac{\sum_{Np} \sum_{(X,Y,Z)} \sum_{Ns} \mathrm{Amag}^2}{Np} \right]^{0.5}$$

magnitude in each axis is to be determined. Verification will be considered successful if the RMS Average of accelerations at the ARIS interface points from all sources, at all interface points, and all axis does not exceed the limits defined in Table 3.1.2.2–2. The following equation describes this summation process:

Where:
Amag is the X, Y or Z magnitude of model output acceleration at each interface point
Ns is the number of sources
Np is the number of ARIS interface points
Asum is the RMS acceleration to be compared with Table 3.1.2.2–2 for each one–third octave.

4.3.1.2.3 TRANSIENT REQUIREMENTS

Verification of the maximum transient impulse limit is to be performed by Method A. Verification of maximum force limit is to be performed by Method B. IRN 0003

A. Verification of maximum transient impulse shall be by analysis or test. Acceptable test methods are defined in SSP 57010, Appendix E. Verification shall be considered successful when the impulse delivery by an integrated rack or non–rack payload over any 10 second period is shown to be less than 10 lb s (44 N s) and when the sum of the impulse and vibration resulting from the impulse do not exceed the vibratory limits of 3.1.2.2 over any 100 second period. FEM time domain analysis is an acceptable verification method for this requirement as defined in 4.3.1.2.2. Acceleration or force response test data is acceptable if interface impedance considerations are included, including adjustment for possible modal frequency shift and interface structural amplification or attenuation.

B. The maximum force at the integrated rack or non–rack payload interface, as determined by either analysis or test, shall be less than 1000 lb (4448 N) in any direction. Rigid body analysis may be used if it can be shown that the rigid payload force to a rigid interface will not exceed 500 lb (2224 N). Otherwise, FEM payload analysis using a Payload Project Office supplied ISS model must be used to shown that the flexible interface force will not exceed 1000 lb (4448 N).

4.3.1.2.4 MICROGRAVITY ENVIRONMENT

NVR

4.3.1.2.5 ARIS ON–BOARD TO OFF–BOARD VIBRATORY REQUIREMENT

The general verification requirements of 4.3.1.2.2 are applicable. Rigid Body assumptions may be made if disturbance frequencies are below the first rack mode. Under baseline ARIS control parameters are used for ISS Stage 5A, the on–board to off–board limits of 3.1.2.5.1–3 are most restrictive at low frequencies and the sensor saturation limits are most restrictive at high frequencies. Allowing for the middle frequency range which may affect either requirement, the on–board to off–board analysis may be limited to the low frequency range below 15 and the sensor saturation verification range may be limited to frequencies above 2 Hz. Consequently, based upon assumed payload use of the standard ARIS control parameters, verification may be simplified to meting the following processes:

<u>Rigid Body Analysis Method</u>
Assuming that the first free–free ARIS mode is greater than 17 Hz, rigid body analysis is sufficient using payload mass properties and know disturbance forces. Effective ARIS interface force shall be calculated by the following method:

IRN 0003

1. Obtain frequency domain representations of all input forces by direction and one–third octave. This is to include both narrow–band sources and wide–band sources and the 100 second rms frequency domain representation of transients.

2. Obtain the effective forces due to moments by dividing each moment by the characteristic distance for the moment direction. The characteristics distances are 3 ft (0.91 m) for moments about the rack X and Y axis, and 1.50 ft (0.46 m) for moments about the rack Z axis.

3. The forces and effective forces are to be summed by RSS in the frequency domain of force and effective force by axis.

4. The results are to be summed by RSS of the contribution along each axis in the frequency domain.

5. Compare the results against the allowable limits of Table 3.1.2.5–1. The wide–band limit may be used if the peak/average ratio is less than 5, otherwise the narrow–band peak limit must be used.

<u>FEM Analysis Method</u>
If the ARIS payload has modes below 17 Hz under operational free–free conditions then FEM analysis will be required. FEM analysis shall be performed using the following method:

1. Obtain frequency domain representations of all input forces by direction and one–third octave. This is to include narrow–band sources, wide–band sources and the 100 second rms frequency domain representation of transients. If RMS input vs frequency data is used, this is to be converted to Frequency Spectral Density (FSD) by guideline 6 of 4.3.1.2.2.

2. Determine the acceleration response at each ARIS actuator interface point and at the center of the umbilical panel.

3. The accelerations are to be summed for each one–third octave as the RSS of all frequencies within each one–third octave by the following equation:

$$\text{Arms} = \left[\sum_{(x,y,z)} \sum_{N} A(d,n)^2 \right]^{\frac{1}{2}}$$

Where A(d,n) is the acceleration by direction (d) and interface point (n).

4. Compare the results against the allowable limits of Table 3.1.2.5–1. The wide–band limit may be used if the peak/average ratio is less than 5. Otherwise the narrow–band peak limit must be used. IRN 0003

4.3.1.3 STOWAGE

Information only. No verification required.

4.3.2 ELECTRICAL INTERFACE REQUIREMENTS

NVR

digital communications system statistics (1553, Ethernet, and high rate system status, etc.), and video system status (camera and video recorder on/off indications, Synchronization indicators, etc.).

Integrated Rack: The ISPR and all other sub–rack equipment which operates within a rack.

Intermittent Noise Source: A significant noise source which exists for a cumulative total of less than eight hours in a 24-hour period is considered an intermittent noise source.

Line Impedance Stabilization Network: An electrical circuit, including resistance, capacitance, and inductance, used to simulate a specific electrical power bus.

Narrow–band Disturbance Force: A narrow–band disturbance force is a force which peaks within frequency range. IRN 0003

Narrow–band Peak Enveloped Force Limit: The integrated rack microgravity disturbance allocation applicable to those one–third octave bands in which the peak power spectrum disturbance force at any frequency divided by the average disturbance force is greater than or equal to five.

Non–Normal: Pertaining to performance of the Electrical Power System outside the nominal design due to ISS system equipment failure, fault clearing, or overload conditions.

Non–Rack Payload: A pressurized payload which does not utilize an ISPR and has discrete physical interfaces to ISS services (i.e. power, data, video, vacuum, etc.) IRN 0003

On–Orbit Momentary Protrusions: Payload obstructions which typically would protrude for a very short time or could be readily eliminated by the crew at any time. Momentary protrusions includes only the following: drawer/door/cover replacement or closure.

On–Orbit Permanent Protrusion: A payload hardware item which is not ever intended to be removed.

On–Orbit Protrusions for Keep Alive Payloads: A protrusion which supports and/or provides the uninterrupted resources necessary to run an experiment. On–orbit protrusions for Keep Alive Payloads includes only power/data cables and thermal hoses.

On–Orbit Semi–permanent Protrusion: A payload hardware item which is typically left in place but can be removed by the crew with hand operations or standard IVA tools.

Example: SIR and ISIS drawer handles, other equipment that does not interfere with crew restraints & mobility aids.

On–Orbit Temporary Protrusion: A payload item which is typically located in the aisle for experiment purposes only. These items should be returned to their stowed configuration when not being used.

Example: Front panel mounted equipment

Operate: Perform intended design functions given specified conditions.

Patient: A crewmember instrumented with electrical/electronic equipment.

Potential Fire Source: Any electrical, chemical, or other energy source capable of creating a fire event (e.g., electrically powered equipment).

Protrusion: A payload hardware item which extends beyond the GSE plane.

Quasi–Steady Acceleration: ISS accelerations in the frequency range below 0.01 Hz. This limit is defined to be consistent with SSP 50036 so that the maximum average acceleration contribution from no integrated rack exceeds 0.02 micro–g continuously nor exceeds 10 micro–g seconds over any period of time not protected by the continuous limit. IRN 0003

Reusable Wipes: Utility handwipes that can be impregnated or dampened with premixed evaporative detergent/biocidal solutions or with water.

Safety–Critical: Having the potential to be hazardous to the safety of hardware, software, and personnel.

Specularity: Defined as the ratio of the flux leaving a surface or medium by regular (specular) reflection to the incident flux.

Standard Conditions: Measured volumes of gases are generally recalculated to 0°C temperature and 760 mm Hg pressure, which have been arbitrarily chosen as standard conditions.

vented conditions: Condition (Temperature and Pressure) of the gas in the experiment chamber as the chamber is opened to the ISS VES/WGS.

VES/WGS: Vacuum Exhaust System and/or Waste Gas System. The USL, JEM and APM each have similar systems to vent gases to space from an experiment chamber. The System in the USL is the Vacuum Exhaust System and the Systems in the JEM and APM are the Waste Gas Systems.

Wide–Band Disturbance Force A wide–band disturbance force is a force which occurs with uniform intensity over a frequency range. IRN 0003

Wide–Band Force Limit: The integrated–rack microgravity disturbance allocation applicable to those one–third octave bands in which the peak power spectrum disturbance force at any frequency divided by the average disturbance force within the band is less than five.

Wire derating: Wire is derated based on the current flow, environment, electrical circuitry that operates within an integrated rack or within electrical power consuming equipment individual boxes.

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