Section 19
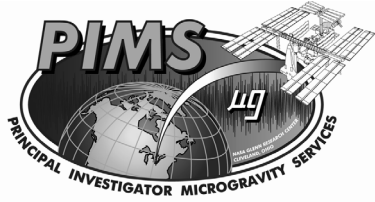# ISS Microgravity Requirements
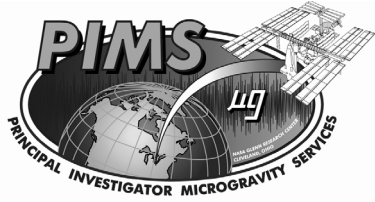
Brad Humphreys

ZIN Technologies

216-977-0360

March 6th, 2003

- **Boeing JSC – Microgravity Team**
  - **Material previously presented by:**
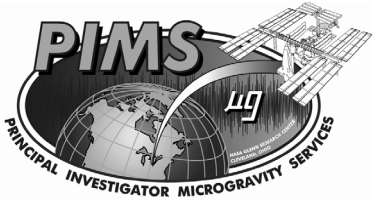
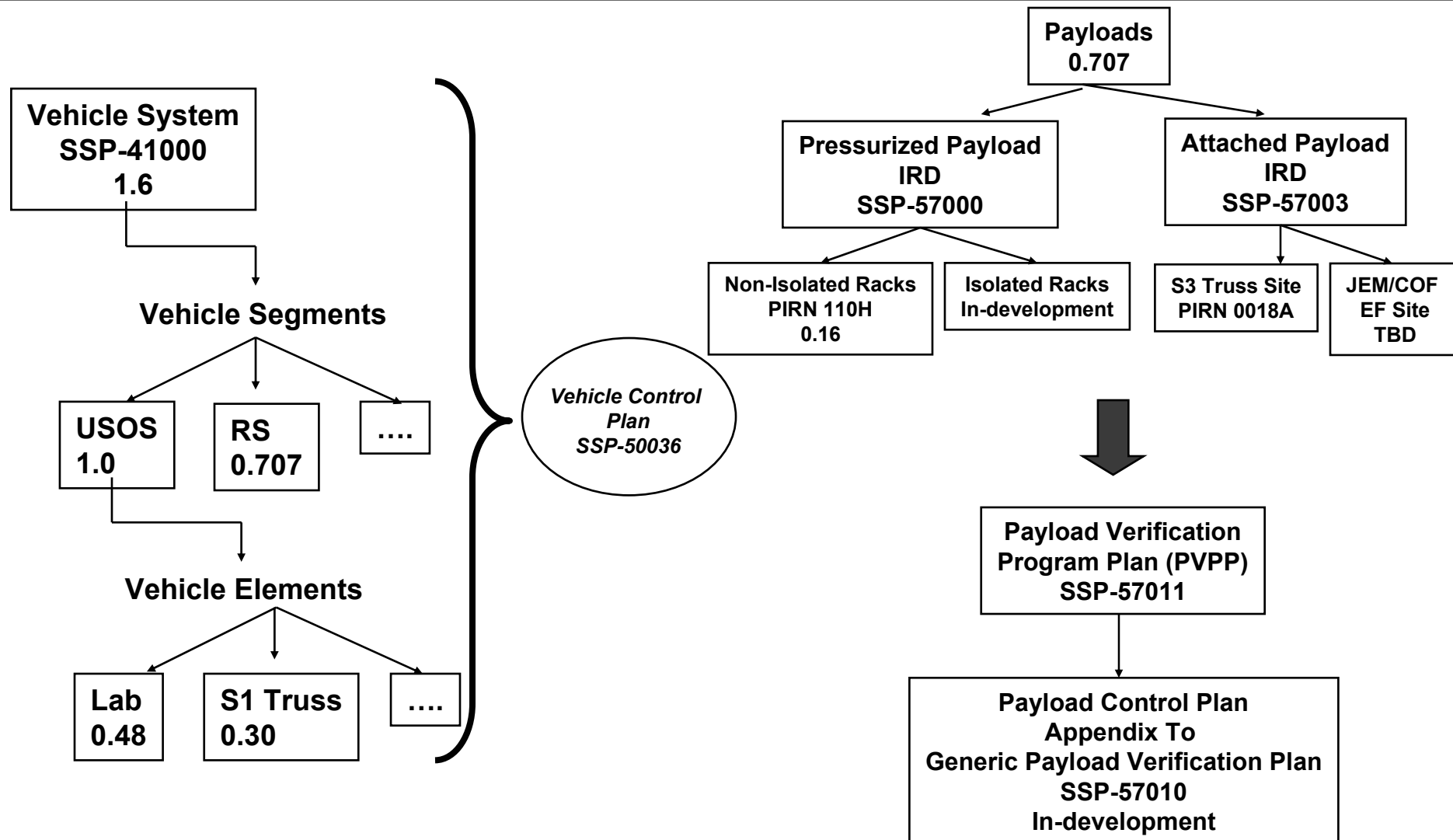 **Steve Del Basso**, The Boeing Company

REQUIREMENTS

- **Flow-down**

- **Vehicle**

- **Payloads**

Microgravity Requirement Architecture

Payloads
0.707

Vehicle System
SSP-41000
1.6

Pressurized Payload
IRD
SSP-57000

Attached Payload
IRD
SSP-57003

Vehicle Segments

Non-Isolated Racks
PIRN 110H
0.16

Isolated Racks
In-development

S3 Truss Site
PIRN 0018A

JEM/COF
EF Site
TBD

USOS
1.0

RS
0.707

....

Vehicle Control
Plan
SSP-50036

Vehicle Elements

Lab
0.48

S1 Truss
0.30

....

Payload Verification
Program Plan (PVPP)
SSP-57011

Payload Control Plan
Appendix To
Generic Payload Verification Plan
SSP-57010
In-development

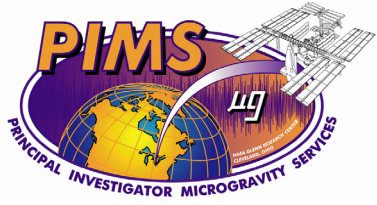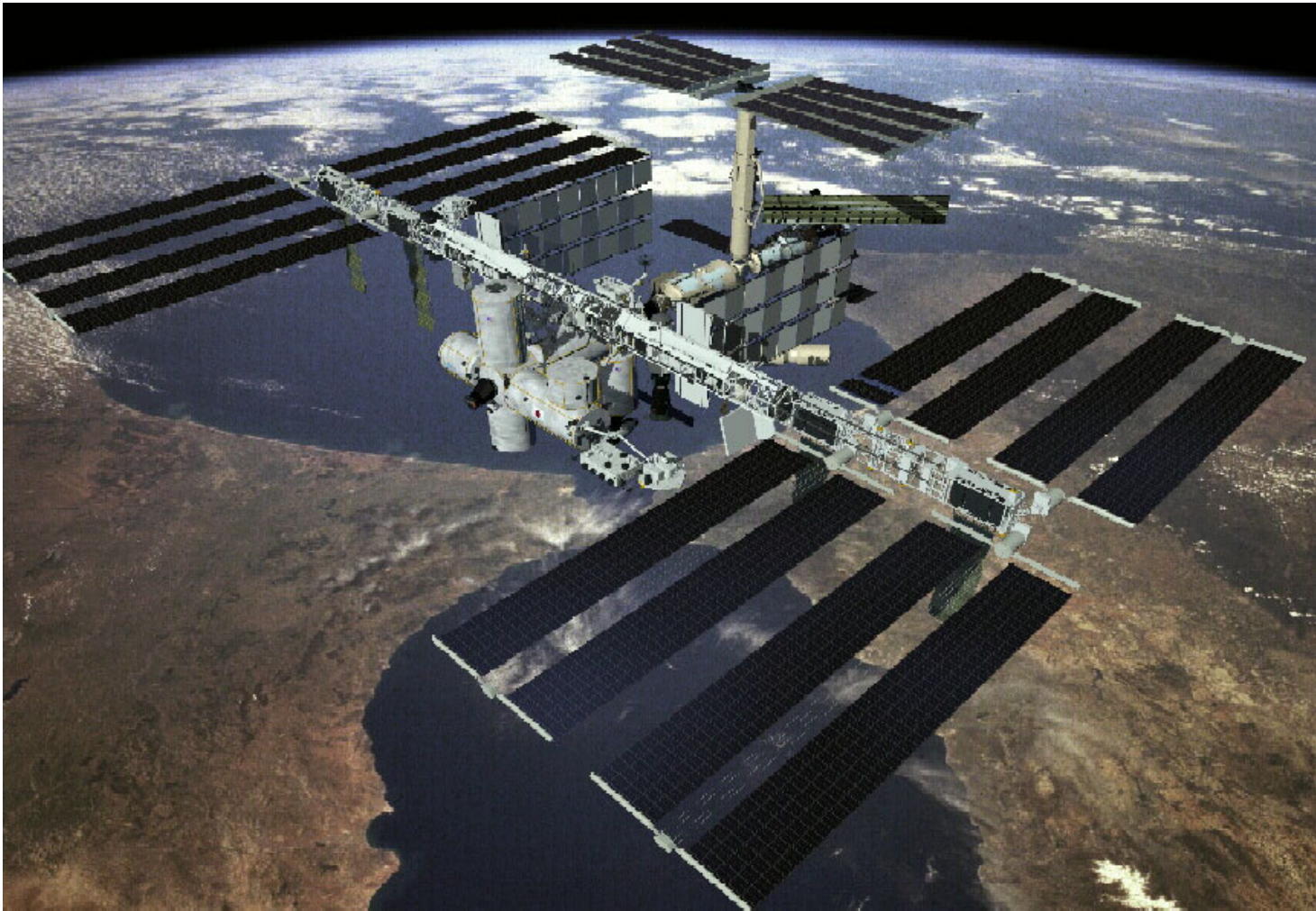At Assembly Complete the Space Station shall provide the following microgravity acceleration performance for at least 50 percent of the internal payload locations (excluding nadir window payload location) for 180 days per year in continuous time intervals of at least 30 days:
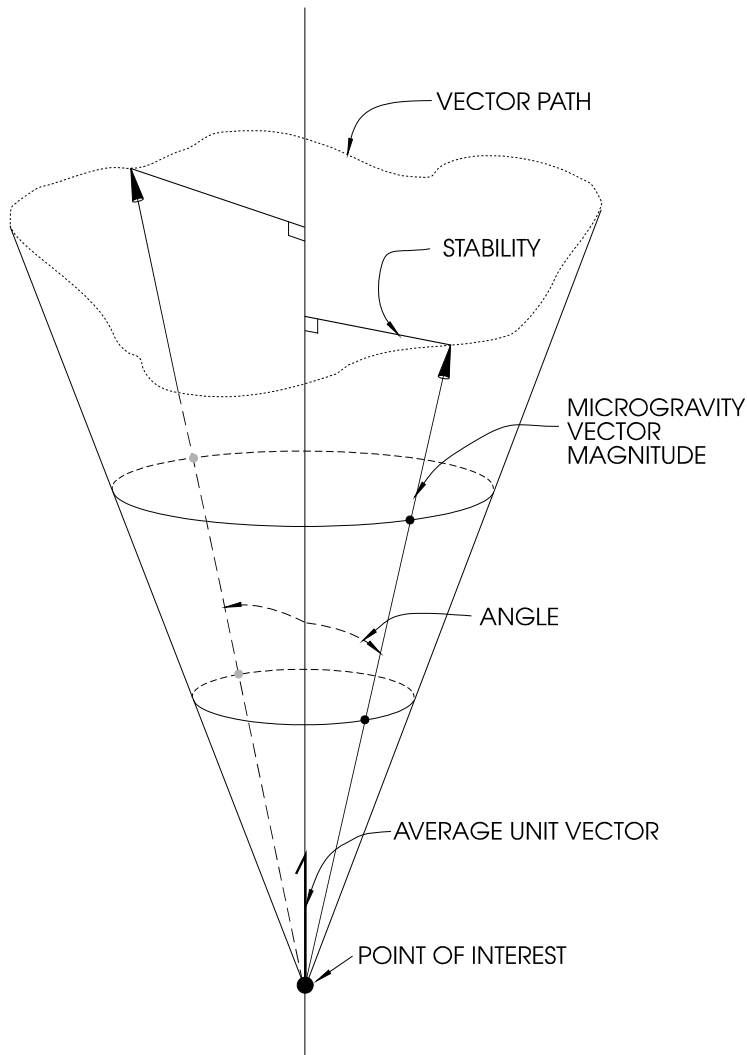
Duration

- **Periods: >/= 30 days**

- **Yearly Total: >/= 180 days / year**

Location - at ISPR center

Magnitude - 1.0 µg (0 </= f </= 0.01 Hz.)

Stability - 0.2 µg perpendicular component to orbital average QS acceleration vector

VECTOR PATH

STABILITY

MICROGRAVITY
VECTOR
MAGNITUDE

ANGLE

AVERAGE UNIT VECTOR

POINT OF INTEREST
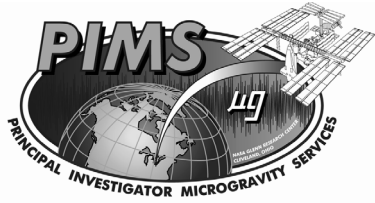
Duration - same as quasi-steady

Location - at module/ISPR interface

Does not include effects of crew activity. Requirements on design not crew members.

Combined Vibratory - per figure (0.01 </= f </=300.0 Hz.)

- **100 second root mean square average**

- **Per one-third octave band**

Individual Transient

- **1000 μg peak per axis**

- **10 μg*s integrated over any 10 s interval per axis**

ISPR Layout

STAGE: AC

JEM ELM-PS

CAM

RACKS UP

Name	To Location
EXPR8/87	LAB1P4
CRYO	CAM1A3
HHR#2/TBD	CAM1A4

RACKS DOWN

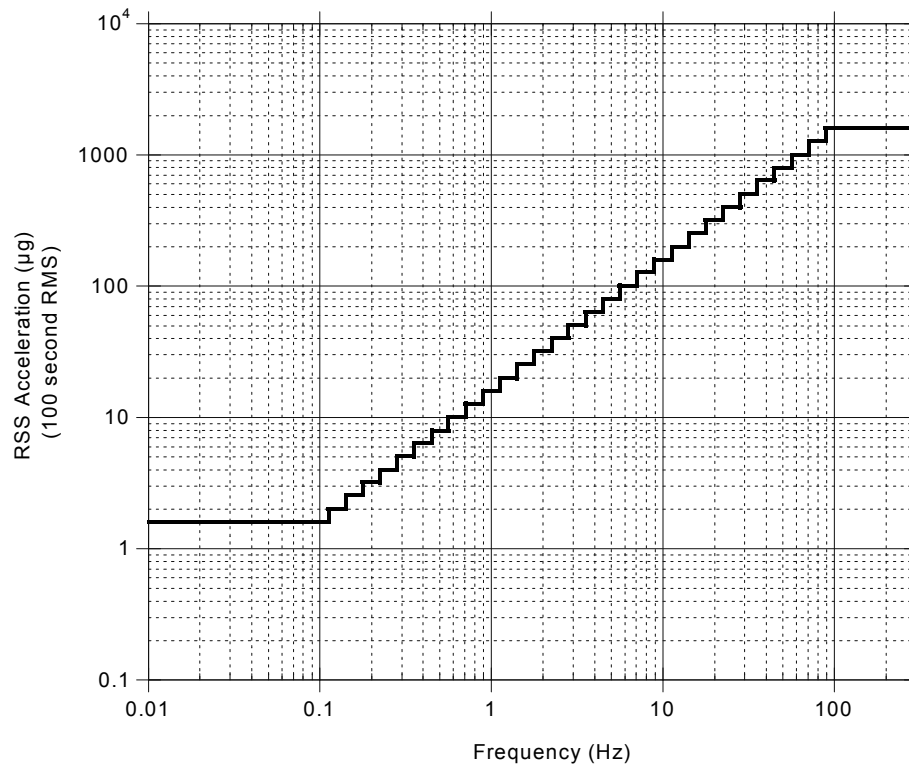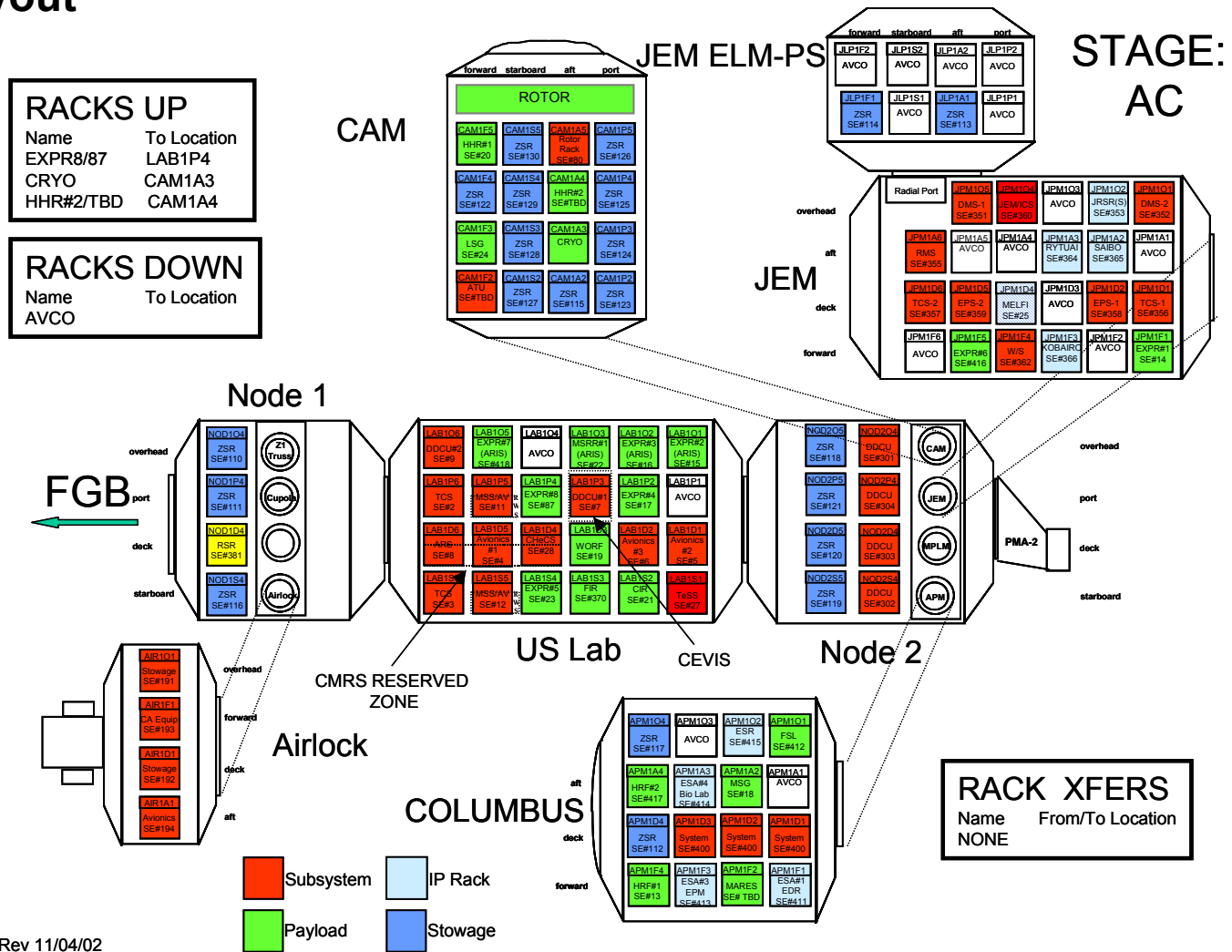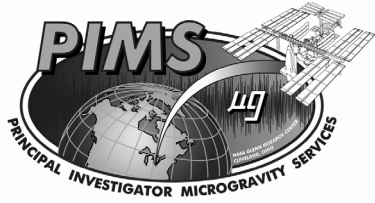| Name	To Location
AVCO	

CAM

forward starboard aft port

ROTOR

CAM1F5 HHR#1 SE#20	CAM1S5 ZSR SE#130	CAM1A5 Rotor Rack SE#80	CAM1P5 ZSR SE#126
CAM1F4 ZSR SE#122	CAM1S4 ZSR SE#129	CAM1A4 HHR#2 SE#TBD	CAM1P4 ZSR SE#125
CAM1F3 LSG SE#24	CAM1S3 ZSR SE#128	CAM1A3 CRYO	CAM1P3 ZSR SE#124
CAM1F2 ATU SE#TBD	CAM1S2 ZSR SE#127	CAM1A2 ZSR SE#115	CAM1P2 ZSR SE#123

JEM ELM-PS

forward starboard aft port

| JLP1F2 AVCO | JLP1S2 AVCO | JLP1A2 AVCO | JLP1P2 AVCO |
| JLP1F1 ZSR SE#114 | JLP1S1 AVCO | JLP1A1 ZSR SE#113 | JLP1P1 AVCO |

JEM

Radial Port

overhead

| | JPM1O5 DMS-1 SE#351 | JPM1O4 JEM/ICS SE#360 | JPM1O3 AVCO | JPM1O2 JRSR(S) SE#353 | JPM1O1 DMS-2 SE#352 |
| JPM1A6 RMS SE#355 | JPM1A5 AVCO | JPM1A4 AVCO | JPM1A3 RYTUA1 SE#364 | JPM1A2 SAIBO SE#365 | JPM1A1 AVCO |

aft

| JPM1D6 TCS-2 SE#357 | JPM1D5 EPS-2 SE#359 | JPM1D4 MELFI SE#25 | JPM1D3 AVCO | JPM1D2 EPS-1 SE#358 | JPM1D1 TCS-1 SE#356 |

deck

| JPM1F6 AVCO | JPM1F5 EXPR#6 SE#416 | JPM1F4 W/S SE#362 | JPM1F3 KOBAIRO SE#366 | JPM1F2 AVCO | JPM1F1 EXPR#1 SE#14 |

forward

Node 1

overhead

| NOD1O4 ZSR SE#110 |
| NOD1O2 ZSR SE#111 |
| NOD1O4 RSR SE#381 |
| NOD1S4 ZSR SE#116 |

FGB port

Z1 Truss

Cupola

Airlock

deck

starboard

US Lab

LAB1O6 DDCU#2 SE#9	LAB1O5 EXPR#7 (ARIS) SE#118	LAB1O4 AVCO	LAB1O3 MSRR#1 (ARIS) SE#22	LAB1O2 EXPR#3 (ARIS) SE#416	LAB1O1 EXPR#2 (ARIS) SE#15
LAB1P6 TCS SE#2	LAB1P5 MSS/AVI SE#11	LAB1P4 EXPR#8 SE#87	LAB1P3 DDCU#1 SE#7	LAB1P2 EXPR#4 SE#17	LAB1P1 AVCO
LAB1D6 ARIS SE#8	LAB1D5 Avionics #1 SE#4	LAB1D4 CHeCS SE#28	LAB1D3 WORF SE#19	LAB1D2 Avionics #3 SE#6	LAB1D1 Avionics #2 SE#5
LAB1S6 TCS SE#3	LAB1S5 MSS/AVI SE#12	LAB1S4 EXPR#5 SE#23	LAB1S3 FIR SE#370	LAB1S2 CIR SE#21	LAB1S1 TeSS SE#27

CMRS RESERVED ZONE

CEVIS

Node 2

overhead

NOD2O5 ZSR SE#118	NOD2O4 DDCU SE#301
NOD2P5 ZSR SE#121	NOD2P4 DDCU SE#304
NOD2D5 ZSR SE#120	NOD2D4 DDCU SE#303
NOD2S5 ZSR SE#119	NOD2S4 DDCU SE#302

CAM

JEM

MPLM

APM

PMA-2

port

deck

starboard

Airlock

| AIR1O1 Stowage SE#191 |
| AIR1F1 CA Equip SE#193 |
| AIR1D1 Stowage SE#192 |
| AIR1A1 Avionics SE#194 |

overhead

forward

deck

aft

COLUMBUS

APM1O4 ZSR SE#117	APM1O3 AVCO	APM1O2 ESR SE#415	APM1O1 FSL SE#412
APM1A4 HRF#2 SE#417	APM1A3 ESA#4 Bio Lab SE#414	APM1A2 MSG SE#18	APM1A1 AVCO
APM1D4 ZSR SE#112	APM1D3 System SE#400	APM1D2 System SE#400	APM1D1 System SE#400
APM1F4 HRF#1 SE#13	APM1F3 ESA#3 EPM SE#413	APM1F2 MARES SE# TBD	APM1F1 ESA#1 EDR SE#411

aft

deck

forward

RACK XFERS

Name	From/To Location
NONE	

Legend:
- Subsystem (red)
- IP Rack (light blue)
- Payload (green)
- Stowage (blue)
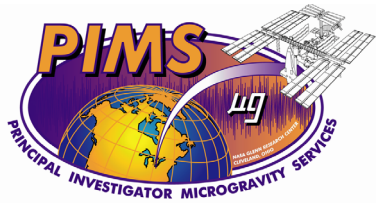
SSP 57000 3.1.2.1 Quasi-Steady Requirements: For frequencies below 0.01 Hz, Integrated racks and non-rack payloads shall limit unbalanced translational average impulse to generate less than 10 lb-s (44.8 N-s) within any 10 to 500 second period, along any ISS coordinate system vector.

SSP 57000 3.1.2.2 Vibratory Requirements: Between 0.01 and 300 Hz, Integrated Rack payloads without ARIS, inactive ARIS payloads and Non-Rack payloads shall limit vibration so that the force limits are not exceeded using the force method, or the acceleration limits are not exceeded using the acceleration method.

SSP 57000 3.1.2.3 Transient Requirements:

- Integrated racks and non-rack payloads 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).

- 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.
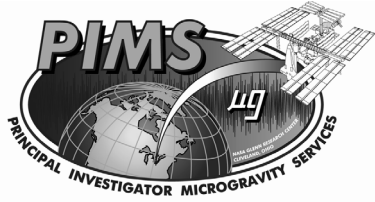
PRESSURIZED PAYLOAD REQUIREMENTS
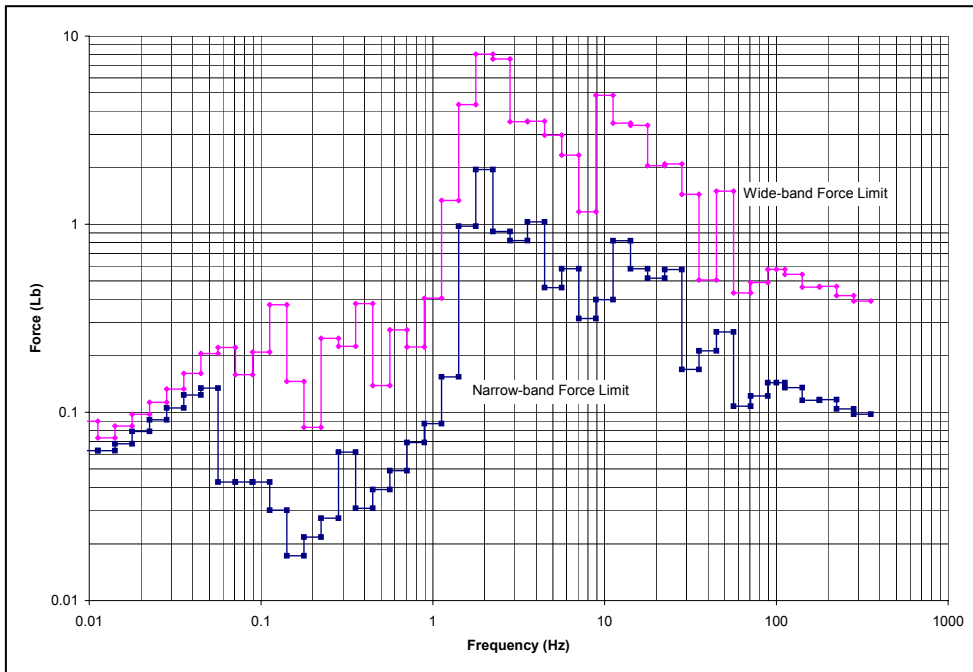
Rack Interface Force Requirement

Transfer Function Reference:

SSP-MG99-055B- *Acceleration and Force Limits for Payload Microgravity Compliance Assessment*

**Adjacent Rack Interface Acceleration Requirement**

SSP 57000 3.1.5.1 Quasi-Steady Requirements: For frequencies below 0.01 Hz, Attached Payloads shall limit unbalanced translational 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.

SSP 57000 3.1.5.2 Vibratory Requirements: Between 0.01 and 300 Hz, payloads shall limit vibration so that the acceleration limits are not exceeded using the force and moment transfer functions.
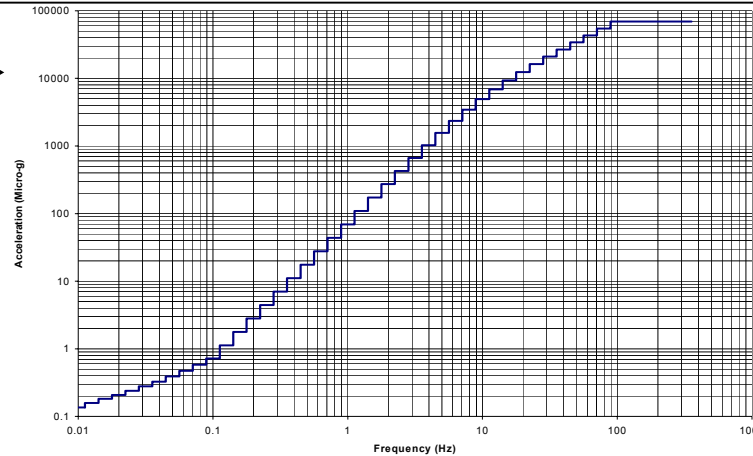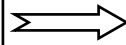
SSP 57000 3.1.5.3 Transient Requirements:

- Attached Payloads 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).

- Attached Payloads shall limit their peak force applied to the ISS to less than 1000 lb (4448 N) for any duration.
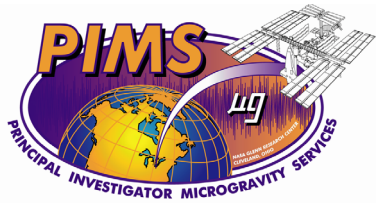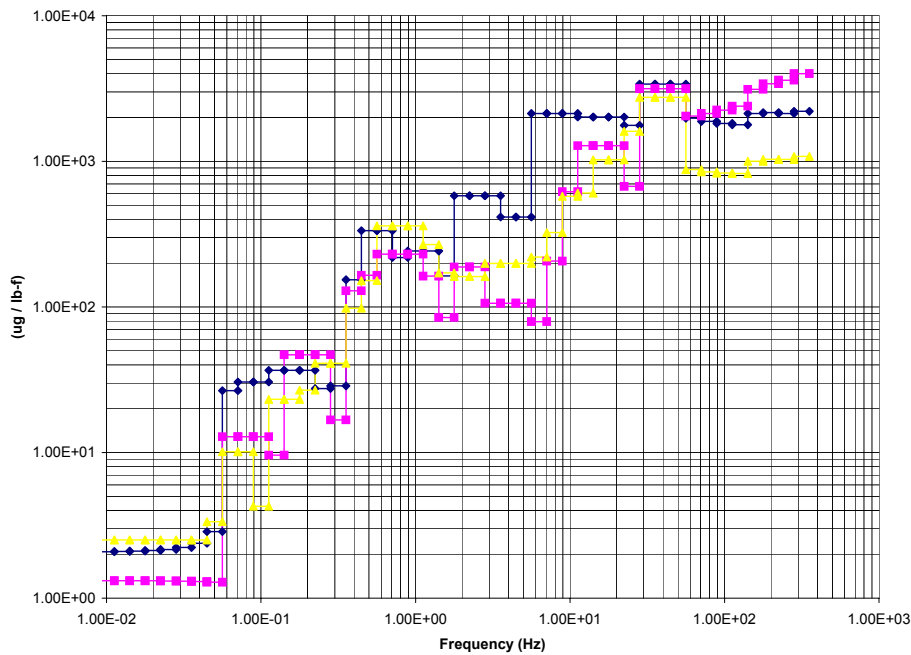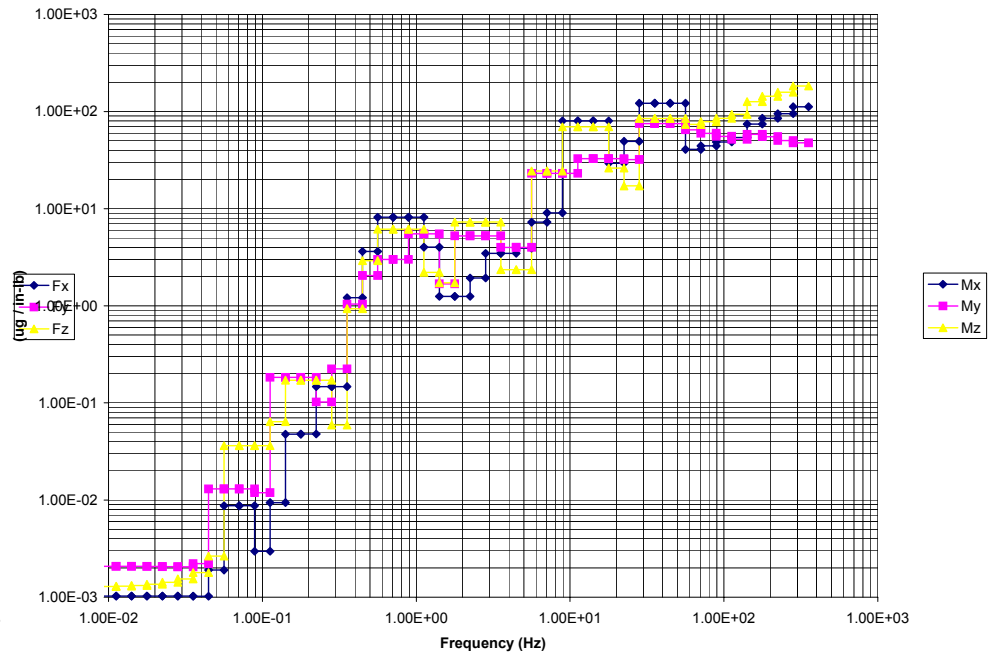
ATTACHED PAYLOAD REQUIREMENTS

Acceleration Limit ⟹

Force Transfer Functions

Moment Transfer Functions