IRN NO: 57000–0002	**ISS PAYLOAD OFFICE IRN/PIRN/EXCEPTION FORM**	(Page 1 of 104) DATE PREPARED: 12–10–02
Doc. No., Rev. & Title: SSP 57000 Revision E Pressurized Payloads Interface Requirements Document		PIRN NO: 57000–NA–0214C, 57000–NA–0217A, 57000–NA–0220A, 57000–NA–0224, 57000–NA–0225A, 57000–NA–0207, 57000–NA–0212D, 57000–NA–0223D, 57000–NA–0226A, 57000–NA–0230A, 57000–NA–0240G, 57000–NA–0246A
(P)IRN TITLE: **Incorporate PTR Approved PIRNS into SSP 57000 – Rev. E to Support Stage 7A.1 and UF–1 COFR**		
ORIGINATOR: Name: Mike Horkachuck Agency: NASA Phone: (281) 226–4229 Fax:	PIRN Type: *Check One* ❑ Standard PIRN ❑ Exception	*For Payload Office Use Only* ❑ Exceedance ❑ Deviation ❑ Waiver
UTILIZATION CHANGE ENGINEER.: Name: Tom Gallagher Agency: Boeing/TBE Phone: (281) 226–4074	SSCN/CR: SSCN 005244B	RELATED PIRN NO.: N/A
Agency Tracking No.:	SYSTEM/ELEMENT AFFECTED:	
REASON FOR CHANGE: (INCLUDE APPLICABLE ICAP NUMBER) SSCD #005244R1		
PARAGRAPHS, FIGURES, TABLES AFFECTED (For PIRN use only)		
<u>Page</u> <u>Paragraph(s)</u> <u>Figure(s)</u> <u>Table(s)</u> See Continuation sheet		

AFFECTED INTERFACING PARTIES

SIGNATURE & ORGANIZATION	DATE	SIGNATURE & ORGANIZATION	DATE	SIGNATURE & ORGANIZATION	DATE
(A)					
(B)					
(C)					
(D)					
(E)					

Note: See referenced SSCD for approved signatures.

THE INFORMATION CONTAINED IN THE "'PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT IS "INTERFACE REQUIREMENT" DATA, WHICH IS CONTROLLED BY THE EXPORT ADMINISTRATION REGULATIONS (EAR) (15 CFR PARAT 730 et.seq.) AND CLASSIFIED AS EAR99 UNDER THE EAR. RE-EXPORT OR RE-TRANSMISSION OF SUCH DATA IN VIOLATION OF THE EAR OR OTHER EXPORT CONTROL LAWS AND REGULATIONS IS PROHIBITED.

IRN NO: 57000–0002	**ISS PAYLOAD OFFICE IRN/PIRN/EXCEPTION FORM CONTINUED**	PAGE NO. 2 of 104 DATE PREPARED: 12–10–02
Doc. No., Rev. & Title: SSP 57000 Revision E Pressurized Payloads Interface Requirements Document		PIRN/EXCEPTION NO:

(P)IRN TITLE: **Incorporate PTR Approved PIRNS into SSP 57000 – Rev. E to Support Stage 7A.1 and UF–1 COFR**

PAGES, PARAGRAPHS, FIGURES, TABLES AFFECTED (For PIRN use only)

Page	Paragraph(s)	Figure(s)	Table(s)	*R	*A	*D
	Cover			X		
iv	Rev. & History			X		
xxvi–b	List of Changes				X	
xxvi–c	List of Changes				X	
xxvii	Table of Contents			X		
xxviii	Table of Contents			X		
xxviii–a	Table of Contents			X		
xxxiv	Table of Contents			X		
xxxviii	Table of Contents			X		
xxxix	Table of Contents			X		
xl	Table of Contents			X		
xl–a	Table of Contents				X	
xlvi	Table of Contents			X		
lii	Tables			X		
liii	Tables			X		
liv	Figures			X		
2–1	2.1			X		
2–2	2.1			X		
2–2a	2.1			X		
3–10	3.1.1.4			X		
3–12	3.1.1.4.1			X		
3–23f	3.1.2.6				X	
3–23g	3.1.2.6.1, 3.1.2.6.2				X	
3–23h			3.1.2.6–1, 3.1.2.6–2		X	
3–29	3.2.2.1			X		
3–30	3.2.2.1			X		
3–30a		3.2.2.3–1 (No change in figure; pagination change only)		X		
3–31	3.2.2.4			X		
3–31a		3.2.2.4–1		X		
3–83	3.5.1.10			X		
3–85	3.5.1.17					X
3–88	3.7.1.1, 3.7.1.4			X		
3–89	3.7.2.1, 3.7.2.4, 3.7.3.1			X		
3–90	3.7.3.1, 3.7.3.4, 3.7.4.1			X		
3–91	3.7.4.4			X		
3–91a	3.8.1.2 (No change in paragraph, pagination change only)			X		
3–134	3.12.6.4.1			X		
3–134			3.12.6.4.1–1		X	
3–134a		3.12.6.4.1–1			X	
4–5	4.3.1.1.4			X		
4–6	4.3.1.1.4.1			X		
4–6a	4.3.1.1.6.2 (No change in paragraph, pagination change only)			X		
4–8	4.3.1.1.7.5			X		

14

IRN NO: 57000–0002	**ISS PAYLOAD OFFICE IRN/PIRN/EXCEPTION FORM CONTINUED**	PAGE NO. 3 of 104 DATE PREPARED: 12–10–02
Doc. No., Rev. & Title: SSP 57000 Revision E Pressurized Payloads Interface Requirements Document		PIRN/EXCEPTION NO:

(P)IRN TITLE:
Incorporate PTR Approved PIRNS into SSP 57000 – Rev. E to Support Stage 7A.1 and UF–1 COFR

PAGES, PARAGRAPHS, FIGURES, TABLES AFFECTED (For PIRN use only)

Page	Paragraph(s)	Figure(s)	Table(s)	*R	*A	*D
4–9	4.3.1.1.7.5			X		
4–9a–e	(Pagination Change only)			X		
4–9f	4.3.1.2.6, 4.3.1.2.6.1					
	4.3.1.2.6.2				X	
4–9g	4.3.1.2.6.2				X	
4–12	4.3.2.2.1			X		
4–13	4.3.2.2.1			X		
4–14	4.3.2.2.4			X		
4–14a	(Pagination Change Only)			X		
4–17	4.3.2.2.7.1, 4.3.2.2.7.2			X		
4–64	4.3.5.1.17					X
4–70	4.3.7, 4.3.7.1.1,					
	4.3.7.1.2			X		
4–71	4.3.7.1.4, 4.3.7.2,					
	4.3.7.2.1, 4.3.7.2.2			X		
4–72	4.3.7.2.4, 4.3.7.3					
	4.3.7.3.1, 4.3.7.3.2			X		
4–73	4.3.7.3.4, 4.3.7.4					
	4.3.7.4.1, 4.3.7.4.2			X		
4–74	4.3.7.4.4, 4.3.7.6			X		
4–74a	(Pagination Change Only)			X		
4–100	4.3.12.6.4.1			X		
4–101	4.3.12.7			X		
A–1	Appendix A			X		
A–3	Appendix A			X		
C–1 thru C–36	Appendix C (All)			X		
E–3			E–2	X		

(14)

Pressurized Payloads Interface Requirements Document

International Space Station Program

November 1, 2000

Revision E

Incorporates IRN 0001
Incorporates IRN 0004
Incorporates IRN 0003
Incorporates IRN 0005
Incorporates IRN 0002

Type 1 – APPROVED BY NASA

NASDA 宇宙開発事業団

esa european space agency

National Aeronautics and Space Administration
International Space Station Program
Johnson Space Center
Houston, Texas
Contract No. NAS9–02099 (DR PA06)

REV.	DESCRIPTION	PUB. DATE
D	Revision D (Reference per SSCD 002533, EFF. 08/02/99). Revision D incorporates the following PIRNs: 57000–NA–0132D, 57000–NA–0139B, 57000–NA–0140A, 57000–NA–141, 57000–NA–0143A, 57000–NA–0146A, 57000–NA–0147A, 57000–NA–149, 57000–NA–0150C, 57000–NA–0152A, 57000–NA–0153, 57000–NA–154, 57000–NA–0155, 57000–NA–0156A, 57000–NA–0157A, 57000–NA–0158, 57000–NA–0159, 57000–NA–0160, 57000–NA–0162A, 57000–NA–0163A, 57000–NA–164B, 57000–NA–0165A, 57000–NA–0166B, 57000–NA–0167, 57000–NA–0168B, 57000–NA–0170, 57000–NA–0174A, 57000–NA–0177A	11–16–99
E	Revision E (Reference per SSCD 003132, Rev. F, EFF. 02–21–01). Revision E incorporates the following PIRNs: 57000–NA–0151H, 57000–NA–0161C, 57000–NA–0179, 57000–NA–0180, 57000–NA–0181C, 57000–NA–0182, 57000–NA–0183A, 57000–NA–0184A, 57000–NA–0185A, 57000–NA–0189, 57000–NA–0190B, 57000–NA–0191A, 57000–NA–0192, 57000–NA–0193B, 57000–NA–0194, 57000–NA–0195E, 57000–NA–0196, 57000–NA–0202, 57000–ES–0001A, 57000–ND–0003C	4–18–01
–	IRN 0001 incorporates the following: SSCD 003970 incorporates PIRN 57000–NA–0205A SSCD 004176 incorporates PIRNS 57000–NA–0198A, 57000–NA–0203, 57000–NA–0208, 57000–NA–0222, 57000–NA–0235A	11–20–01
–	IRN 0004 per SSCD 005833, EFF. 11/06/01	02–26–02
–	IRN 0003 per SSCD 003664 R1, EFF. 06/07/02	08–29–02
–	IRN 0005 per SSCD 005717, EFF. 07/29/02	11–25–02
–	IRN 0002 per SSCD 005244, EFF. 05/31/02 Revision E IRN 0002 is the first release on the IPIC Contract.	07–30–03

ERU: /s/ M. Hehn 07–30–03

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
005244	22–NOV–02	57000–NA–0214B	3.12.6.4.1, 4.3.12.6.4.1 IRN 0002
			TABLE(S)
			3.12.6.4.1–1
			FIGURE(S)
			3.12.6.4.1–1
			PARAGRAPH(S)
		57000–NA–0217A	3.5.1.10, 3.5.1.17, 4.3.5.1.17
			TABLE(S)
			E–2
			PARAGRAPH(S)
		57000–NA–0220A	3.7.1.1, 3.7.2.1, 3.7.3.1, 3.7.4.1, 4.3.7.1.1, 4.3.7.2.1, 4.3.7.3.1, 4.3.7.4.1
		57000–NA–0224	4.3.2.2.7.1, 4.3.2.2.7.2,
		57000–NA–0225A	3.2.2.4, 4.3.2.2.4
			FIGURE(S)
			3.2.2.4–1
			PARAGRAPH(S)
		57000–NA–0207	3.7.1.4, 3.7.2.4, 3.7.3.4, 3.7.4.4, 4.3.7, 4.3.7.1, 4.3.7.1.2, 4.3.7.1.4, 4.3.7.1.5, 4.3.7.2, 4.3.7.2.2, 4.3.7.2.4, 4.3.7.2.5, 4.3.7.3, 4.3.7.3.2, 4.3.7.3.4, 4.3.7.3.5, 4.3.7.4, 4.3.7.4.2, 4.3.7.4.4, 4.3.7.4.5, 4.3.7.6, Appendix A
		57000–NA–0212D	2.2, 3.1.2.6, 3.1.2.6.1, 3.1.2.6.2, 4.3.1.2.6, 4.3.1.2.6.1, 4.3.1.2.6.2 Appendix A
			TABLE(S)
			3.1.2.6–1, 3.1.2.6–2
			PARAGRAPH(S)
		57000–NA–0223D	3.1.1.4, 4.3.1.1.4
		57000–NA–0226A	4.3.1.1.7.5
		57000–NA–0230A	3.1.1.4.1, 4.3.1.1.4.1,

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
		57000–NA–0240G	4.3.12.7, Appendix C–Table of Contents, C.1, C.2, C.3, C.3.1, C.3.2, C.3.5.1, C.3.5.3, C.3.5.4.1, C.3.5.4.2, C.3.5.4.2.1, C.3.5.4.2, C.3.5.4.2.1, C.3.5.4.2.2, C.3.5.4.2.3, C.3.5.5, C.3.5.6, C.3.5.7, C.3.5.9, C.3.5.10.2, C.3.5.11, C.3.6
			FIGURE(S)
			C.1–1, C.3.5.3–1, C.3.5.3–2, C.3.5.3–3, C.3.5.4.2.1–1, C.3.5.4.2.1–1, C.3.5.6–1, C.3.5.7–1, C.3.5.8–1, C.3.5.9–1,
			PARAGRAPH(S)
		57000–NA–0246A	3.2.2.1, 4.3.2.2.1,

IRN 0002

TABLE OF CONTENTS

PARAGRAPH		PAGE	
1.0	INTRODUCTION	1 – 1	
1.1	PURPOSE	1 – 1	
1.2	SCOPE	1 – 1	
1.3	USE	1 – 1	
1.4	EXCEPTIONS	1 – 1	
1.5	CONTROL AND MAINTENANCE	1 – 3	
2.0	DOCUMENTATION	2 – 1	
2.1	APPLICABLE DOCUMENTS	2 – 1	
2.2	REFERENCE DOCUMENTS	2 – 4	IRN 0002
3.0	PAYLOAD INTERFACE REQUIREMENTS AND GUIDANCE	3 – 1	
3.1	STRUCTURAL/MECHANICAL, AND MICROGRAVITY AND STOWAGE INTERFACE REQUIREMENTS	3 – 1	
3.1.1	STRUCTURAL/MECHANICAL	3 – 1	
3.1.1.1	GSE INTERFACES	3 – 1	
3.1.1.2	MPLM INTERFACES	3 – 1	
3.1.1.2.1	MPLM LATE/EARLY ACCESS REQUIREMENTS	3 – 2	
3.1.1.2.1.1	MPLM LATE ACCESS ENVELOPE (KSC)	3 – 2	
3.1.1.2.1.2	MPLM EARLY ACCESS ENVELOPES (KSC AND DFRC)	3 – 6	
3.1.1.3	LOADS REQUIREMENTS	3 – 7	
3.1.1.4	RACK REQUIREMENTS	3 – 9	
3.1.1.4.1	LAB WINDOW RACK LOCATION REQUIREMENTS	3 – 10	
3.1.1.5	SAFETY CRITICAL STRUCTURES REQUIREMENTS	3 – 12	
3.1.1.6	CONNECTOR AND UMBILICAL PHYSICAL MATE	3 – 12	
3.1.1.6.1	CONNECTOR PHYSICAL MATE	3 – 12	
3.1.1.6.2	UMBILICAL PHYSICAL MATE	3 – 14	
3.1.1.7	ON–ORBIT PAYLOAD PROTRUSIONS	3 – 14	
3.1.1.7.1	ON–ORBIT PERMANENT PROTRUSIONS	3 – 15	
3.1.1.7.2	ON–ORBIT SEMI–PERMANENT PROTRUSIONS	3 – 15	
3.1.1.7.3	ON–ORBIT TEMPORARY PROTRUSIONS	3 – 17	
3.1.1.7.4	ON–ORBIT MOMENTARY PROTRUSIONS	3 – 18	
3.1.1.7.5	ON–ORBIT PROTRUSIONS FOR KEEP ALIVE PAYLOADS	3 – 19	
3.1.2	MICROGRAVITY	3 – 22	
3.1.2.1	QUASI-STEADY REQUIREMENTS	3 – 23	IRN 0003
3.1.2.2	VIBRATORY REQUIREMENTS	3 – 23	
3.1.2.3	TRANSIENT REQUIREMENTS	3 – 23d	IRN 0003
3.1.2.4	MICROGRAVITY ENVIRONMENT	3 – 23e	
3.1.2.5	ARIS RACK VIBRATORY REQUIREMENET	3 – 23e	
3.1.2.6	ANGULAR MOMENTUM LIMITS	3 – 23f	IRN 0002
3.1.2.6.1	LIMIT DISTURBANCE INDUCED ISS ATTITUDE RATE	3 – 23g	

TABLE OF CONTENTS (Continued)

PARAGRAPH		PAGE
3.1.2.6.2	LIMIT DISTURBANCE INDUCED CMG MOMENTUM USAGE	3 – 23g
3.1.3	STOWAGE	3 – 23h
3.2	ELECTRICAL INTERFACE REQUIREMENTS	3 – 23h
3.2.1	ELECTRICAL POWER CHARACTERISTICS	3 – 23f
3.2.1.1	STEADY-STATE VOLTAGE CHARACTERISTICS	3 – 24
3.2.1.1.1	INTERFACE B	3 – 24
3.2.1.1.2	INTERFACE C	3 – 24
3.2.1.2	RIPPLE VOLTAGE CHARACTERISTICS	3 – 25
3.2.1.2.1	RIPPLE VOLTAGE AND NOISE	3 – 25
3.2.1.2.2	RIPPLE VOLTAGE SPECTRUM	3 – 25
3.2.1.3	TRANSIENT VOLTAGES	3 – 26
3.2.1.3.1	INTERFACE B	3 – 26
3.2.1.3.2	INTERFACE C	3 – 26
3.2.1.3.3	FAULT CLEARING AND PROTECTION	3 – 26
3.2.1.3.4	NON-NORMAL VOLTAGE RANGE	3 – 29
3.2.1.4	DELETE	3 – 29
3.2.2	ELECTRICAL POWER INTERFACE	3 – 29
3.2.2.1	UIP AND UOP CONNECTORS AND PIN ASSIGNMENTS	3 – 29
3.2.2.2	POWER BUS ISOLATION	3 – 29
3.2.2.3	COMPATIBILITY WITH SOFT START/STOP RPC	3 – 30
3.2.2.4	SURGE CURRENT	3 – 31
3.2.2.5	REVERSE ENERGY/CURRENT	3 – 33
3.2.2.6	CIRCUIT PROTECTION DEVICES	3 – 33
3.2.2.6.1	ISS EPS CIRCUIT PROTECTION CHARACTERISTICS	3 – 33
3.2.2.6.1.1	REMOTE POWER CONTROLLERS (RPCS)	3 – 33
3.2.2.6.2	EPCE RPC INTERFACE REQUIREMENTS	3 – 34
3.2.2.6.2.1	RPC TRIP COORDINATION	3 – 34
3.2.2.6.2.1.1	PAYLOAD TRIP RATINGS	3 – 34
3.2.2.6.2.1.2	DELETED	3 – 34
3.2.2.7	EPCE COMPLEX LOAD IMPEDANCES	3 – 34
3.2.2.7.1	INTERFACE B	3 – 34
3.2.2.7.2	INTERFACE C	3 – 38
3.2.2.8	LARGE SIGNAL STABILITY	3 – 38
3.2.2.9	DELETED	3 – 38
3.2.2.10	ELECTRICAL LOAD-STAND ALONE STABILITY	3 – 38
3.2.2.11	ELECTRICAL LOAD INDUCTANCE	3 – 38
3.2.2.12	MAXIMUM LOAD STEP SIZE	3 – 40a
3.2.3	ELECTRICAL POWER CONSUMER CONSTRAINTS	3 – 41
3.2.3.1	WIRE DERATING	3 – 41

IRN 0002

TABLE OF CONTENTS (Continued)

PARAGRAPH		PAGE
3.2.3.2	EXCLUSIVE POWER FEEDS	3 – 41
3.2.3.3	LOSS OF POWER	3 – 42
3.2.4	ELECTROMAGNETIC COMPATIBILITY	3 – 42

TABLE OF CONTENTS (Continued)

PARAGRAPH		PAGE	
3.7.1.4	NITROGEN LEAKAGE	3 – 88	
3.7.1.5	NITROGEN PHYSICAL INTERFACE	3 – 88	
3.7.2	ARGON INTERFACE REQUIREMENTS	3 – 89	IRN 0002
3.7.2.1	ARGON INTERFACE CONTROL	3 – 89	
3.7.2.2	ARGON INTERFACE MDP	3 – 89	
3.7.2.3	ARGON INTERFACE TEMPERATURE	3 – 89	
3.7.2.4	ARGON LEAKAGE	3 – 89	
3.7.2.5	ARGON PHYSICAL INTERFACE	3 – 89	
3.7.3	CARBON DIOXIDE INTERFACE REQUIREMENTS	3 – 89	
3.7.3.1	CARBON DIOXIDE INTERFACE CONTROL	3 – 89	
3.7.3.2	CARBON DIOXIDE INTERFACE MDP	3 – 90	IRN 0002
3.7.3.3	CARBON DIOXIDE INTERFACE TEMPERATURE	3 – 90	
3.7.3.4	CARBON DIOXIDE LEAKAGE	3 – 90	
3.7.3.5	CARBON DIOXIDE PHYSICAL INTERFACE	3 – 90	
3.7.4	HELIUM INTERFACE REQUIREMENTS	3 – 90	
3.7.4.1	HELIUM INTERFACE CONTROL	3 – 90	
3.7.4.2	HELIUM INTERFACE MDP	3 – 90	
3.7.4.3	HELIUM INTERFACE TEMPERATURE	3 – 91	IRN 0002
3.7.4.4	HELIUM LEAKAGE	3 – 91	
3.7.4.5	HELIUM PHYSICAL INTERFACE	3 – 91	
3.7.5	PRESSURIZED GAS SYSTEMS	3 – 91	
3.7.6	MANUAL VALVES	3 – 91	
3.8	PAYLOAD SUPPORT SERVICES INTERFACES REQUIREMENTS	3 – 91	
3.8.1	POTABLE WATER	3 – 91	
3.8.1.1	POTABLE WATER INTERFACE CONNECTION	3 – 91	
3.8.1.2	POTABLE WATER INTERFACE PRESSURE	3 – 91a	IRN 0002
3.8.1.3	POTABLE WATER USE	3 – 92	
3.8.2	FLUID SYSTEM SERVICER	3 – 92	
3.9	ENVIRONMENT INTERFACE REQUIREMENTS	3 – 92	
3.9.1	ATMOSPHERE REQUIREMENTS	3 – 92	
3.9.1.1	PRESSURE	3 – 92	
3.9.1.2	TEMPERATURE	3 – 92	
3.9.1.3	HUMIDITY	3 – 92	
3.9.2	INTEGRATED RACK USE OF CABIN ATMOSPHERE	3 – 93	
3.9.2.1	ACTIVE AIR EXCHANGE	3 – 93	
3.9.2.2	OXYGEN CONSUMPTION	3 – 93	
3.9.2.3	CHEMICAL RELEASES	3 – 93	
3.9.3	RADIATION REQUIREMENTS	3 – 94	

TABLE OF CONTENTS (Continued)

PARAGRAPH		PAGE
3.12.6	RESTRAINTS AND MOBILITY AIDS	3 – 132
3.12.6.1	STOWAGE DRAWER CONTENTS RESTRAINTS	3 – 132
3.12.6.2	STOWAGE AND EQUIPMENT DRAWERS/TRAYS	3 – 134
3.12.6.3	CAPTIVE PARTS	3 – 134
3.12.6.4	HANDLE AND GRASP AREA DESIGN REQUIREMENTS	3 – 134
3.12.6.4.1	HANDLES AND RESTRAINTS	3 – 134
3.12.6.4.2	DELETED	3–134a IRN 0002
3.12.6.4.3	HANDLE LOCATION/FRONT ACCESS	3–134a
3.12.6.4.4	HANDLE DIMENSIONS	3–134a
3.12.6.4.5	NON-FIXED HANDLES DESIGN REQUIREMENTS	3 – 136
3.12.7	IDENTIFICATION LABELING	3 – 136
3.12.7.1	DELETED	3 – 136
3.12.7.2	DELETED	3 – 136
3.12.7.3	DELETED	3 – 136
3.12.7.4	DELETED	3 – 136
3.12.7.5	DELETED	3 – 136
3.12.7.6	DELETED	3 – 136
3.12.8	COLOR	3 – 136
3.12.9	CREW SAFETY	3 – 137
3.12.9.1	ELECTRICAL HAZARDS	3 – 137
3.12.9.1.1	MISMATCHED	3 – 137
3.12.9.1.2	DELETED	3 – 138
3.12.9.1.3	DELETED	3 – 138
3.12.9.1.4	OVERLOAD PROTECTION	3 – 138
3.12.9.1.4.1	DEVICE ACCESSIBILITY	3 – 138
3.12.9.1.4.2	EXTRACTOR –TYPE FUSE HOLDER	3 – 138
3.12.9.1.4.3	OVERLOAD PROTECTION LOCATION	3 – 138
3.12.9.1.4.4	OVERLOAD PROTECTION IDENTIFICATION	3 – 138
3.12.9.1.4.5	AUTOMATIC RESTART PROTECTION	3 – 138
3.12.9.1.5	DELETED	3 – 139
3.12.9.1.5.1	DELETED	3 – 139
3.12.9.2	SHARP EDGES AND CORNERS PROTECTION	3 – 139
3.12.9.3	HOLES	3 – 139
3.12.9.4	LATCHES	3 – 139
3.12.9.5	SCREWS AND BOLTS	3 – 139
3.12.9.6	SECURING PINS	3 – 139
3.12.9.7	LEVERS, CRANKS, HOOKS, AND CONTROLS	3 – 139
3.12.9.8	BURRS	3 – 139
3.12.9.9	LOCKING WIRES	3 – 140

TABLE OF CONTENTS (Continued)

PARAGRAPH		PAGE
3.12.9.10	AUDIO DEVICES (DISPLAYS)	3 – 140
3.12.9.11	DELETED	3 – 140
3.12.9.12	EGRESS	3 – 140
3.12.10	PAYLOAD IN-FLIGHT MAINTENANCE	3 – 140
3.12.11	DELETED	3 – 140
4.0	VERIFICATION	4 – 1
4.1	RESPONSIBILITIES	4 – 1
4.2	VERIFICATION METHODS	4 – 1
4.3	INTERFACE VERIFICATION METHODS	4 – 2
4.3.1	STRUCTURAL/MECHANICAL AND MICROGRAVITY AND STOWAGE INTERFACE REQUIREMENTS	4 – 2
4.3.1.1	STRUCTURAL/MECHANICAL	4 – 2
4.3.1.1.1	GSE INTERFACES	4 – 2
4.3.1.1.2	MPLM INTERFACES	4 – 2
4.3.1.1.2.1	MPLM LATE / EARLY ACCESS REQUIREMENTS	4 – 3
4.3.1.1.2.1.1	MPLM LATE ACCESS ENVELOPE (KSC)	4 – 3
4.3.1.1.2.1.2	MPLM EARLY ACCESS ENVELOPES (KSC AND DFRC)	4 – 3
4.3.1.1.3	LOADS REQUIREMENTS	4 – 4
4.3.1.1.4	RACK REQUIREMENTS	4 – 4
4.3.1.1.4.1	LAB WINDOW RACK LOCATION REQUIREMENTS	4 – 6 IRN 0002
4.3.1.1.5	SAFETY CRITICAL STRUCTURES REQUIREMENTS	4 – 6
4.3.1.1.6	CONNECTOR AND UMBILICAL PHYSICAL MATE	4 – 6
4.3.1.1.6.1	CONNECTOR PHYSICAL MATE	4 – 6
4.3.1.1.6.2	UMBILICAL PHYSICAL MATE	4 – 6a IRN 0002
4.3.1.1.7	ON ORBIT PAYLOAD PROTRUSIONS	4 – 7
4.3.1.1.7.1	ON–ORBIT PERMANENT PROTRUSIONS	4 – 7
4.3.1.1.7.2	ON–ORBIT SEMI–PERMANENT PROTRUSIONS	4 – 7
4.3.1.1.7.3	ON–ORBIT TEMPORARY PROTRUSIONS	4 – 8
4.3.1.1.7.4	ON–ORBIT MOMENTARY PROTRUSIONS	4 – 8
4.3.1.1.7.5	ON–ORBIT PROTRUSIONS FOR KEEP ALIVE PAYLOADS	4 – 8
4.3.1.2	MICROGRAVITY	4 – 9
4.3.1.2.1	QUASI-STEADY REQUIREMENTS	4 – 9
4.3.1.2.2	MECHANICAL VIBRATION	4 – 9
4.3.1.2.3	TRANSIENT REQUIREMENTS	4 – 9d IRN 0002
4.3.1.2.4	MICROGRAVITY ENVIRONMENT	4 – 9d
4.3.1.2.5	ARIS ON–BOARD TO OFF–BOARD VIBRATORY REQUIREMENT	4 – 9d
4.3.1.2.6	ANGULAR MOMENETUM LIMITS	4 – 9f
4.3.1.2.6.1	LIMIT INDUCED ISS ATTITUDE RATE	4 – 9f
4.3.1.2.6.2	LIMIT DISTURBANCE INDUCED CMG MOMENT USAGE	4 – 9f

TABLE OF CONTENTS (Continued)

PARAGRAPH		PAGE	
4.3.1.3	STOWAGE	4 – 9g	IRN 0002
4.3.2	ELECTRICAL INTERFACE REQUIREMENTS	4 – 9g	
4.3.2.1	ELECTRICAL POWER CHARACTERISTICS	4 – 10	
4.3.2.1.1	STEADY-STATE VOLTAGE CHARACTERISTICS	4 – 10	
4.3.2.1.1.1	INTERFACE B	4 – 10	
4.3.2.1.1.2	INTERFACE C	4 – 10	
4.3.2.1.2	RIPPLE VOLTAGE CHARACTERISTICS	4 – 10	
4.3.2.1.2.1	RIPPLE VOLTAGE AND NOISE	4 – 11	
4.3.2.1.2.2	RIPPLE VOLTAGE SPECTRUM	4 – 11	
4.3.2.1.3	TRANSIENT VOLTAGES	4 – 11	
4.3.2.1.3.1	INTERFACE B	4 – 11	
4.3.2.1.3.2	INTERFACE C	4 – 11	
4.3.2.1.3.3	FAULT CLEARING AND PROTECTION	4 – 12	
4.3.2.1.3.4	NON-NORMAL VOLTAGE RANGE	4 – 12	
4.3.2.1.4	DELETE	4 – 12	
4.3.2.2	ELECTRICAL POWER INTERFACE	4 – 12	
4.3.2.2.1	UIP AND UOP CONNECTORS AND PIN ASSIGNMENTS	4 – 12	
4.3.2.2.2	POWER BUS ISOLATION	4 – 13	
4.3.2.2.3	COMPATIBILITY WITH SOFT START/STOP RPC	4 – 14	IRN 0002
4.3.2.2.4	SURGE CURRENT	4 – 14	
4.3.2.2.5	REVERSE CURRENT	4 – 14	
4.3.2.2.6	CIRCUIT PROTECTION DEVICES	4 – 15	
4.3.2.2.6.1	ISS EPS CIRCUIT PROTECTION CHARACTERISTICS	4 – 15	
4.3.2.2.6.1.1	REMOTE POWER CONTROLLERS (RPCS)	4 – 15	
4.3.2.2.6.2	EPCE RPC INTERFACE REQUIREMENTS	4 – 16	
4.3.2.2.6.2.1	RPC TRIP COORDINATION	4 – 16	
4.3.2.2.6.2.1.1	PAYLOAD TRIP RATINGS	4 – 16	
4.3.2.2.6.2.1.2	DELETED	4 – 16	
4.3.2.2.7	EPCE COMPLEX LOAD IMPEDANCES	4 – 16	
4.3.2.2.7.1	INTERFACE B	4 – 17	
4.3.2.2.7.2	INTERFACE C	4 – 17	
4.3.2.2.8	LARGE SIGNAL STABILITY	4 – 18	
4.3.2.2.9	MAXIMUM RIPPLE VOLTAGE EMISSIONS	4 – 21	
4.3.2.2.10	ELECTRICAL LOAD-STAND ALONE STABILITY	4 – 21	
4.3.2.2.11	ELECTRICAL LOAD INDUCTANCE	4 – 21	
4.3.2.2.12	MAXIMUM LOAD STEP SIZE	4 – 21	
4.3.2.3	ELECTRICAL POWER CONSUMER CONSTRAINTS	4 – 21	
4.3.2.3.1	WIRE DERATING	4 – 22	
4.3.2.3.2	EXCLUSIVE POWER FEEDS	4 – 22	

TABLE OF CONTENTS (Continued)

PARAGRAPH		PAGE
4.3.2.3.3	LOSS OF POWER	4 – 22
4.3.2.4	ELECTROMAGNETIC COMPATIBILITY	4 – 23
4.3.2.4.1	ELECTRICAL GROUNDING	4 – 24

TABLE OF CONTENTS (Continued)

PARAGRAPH		PAGE	
4.3.7.2.4	ARGON LEAKAGE	4 – 72	IRN 0002
4.3.7.2.5	ARGON PHYSICAL INTERFACE	4 – 72	IRN 0005
4.3.7.3	CARBON DIOXIDE INTERFACE VERIFICATION REQUIREMENTS	4 – 72	
4.3.7.3.1	CARBON DIOXIDE INTERFACE CONTROL	4 – 72	
4.3.7.3.2	CARBON DIOXIDE INTERFACE PRESSURE	4 – 72	
4.3.7.3.3	CARBON DIOXIDE INTERFACE TEMPERATURE	4 – 72	
4.3.7.3.4	CARBON DIOXIDE LEAKAGE	4 – 73	IRN 0002
4.3.7.3.5	CARBON DIOXIDE PHYSICAL INTERFACE	4 – 72	IRN 0005
4.3.7.4	HELIUM INTERFACE VERIFICATION REQUIREMENTS	4 – 73	
4.3.7.4.1	HELIUM INTERFACE CONTROL	4 – 73	
4.3.7.4.2	HELIUM INTERFACE MDP	4 – 73	
4.3.7.4.3	HELIUM INTERFACE TEMPERATURE	4 – 73	
4.3.7.4.4	HELIUM LEAKAGE	4 – 74	IRN 0002
4.3.7.4.5	HELIUM INTERFACE CONNECTION	4 – 73	
4.3.7.5	PRESSURIZED GAS SYSTEMS	4 – 74	
4.3.7.6	MANUAL VALVES	4 – 74	
4.3.8	PAYLOAD SUPPORT SERVICES INTERFACES VERIFICATION REQUIREMENTS	4 – 74	
4.3.8.1	POTABLE WATER	4 – 74	
4.3.8.1.1	POTABLE WATER INTERFACE CONNECTION	4 – 74	
4.3.8.1.2	POTABLE WATER INTERFACE PRESSURE	4 – 74a	IRN 0002
4.3.8.1.3	POTABLE WATER USE	4 – 74a	
4.3.8.2	FLUID SYSTEM SERVICER	4 – 75	
4.3.9	ENVIRONMENT INTERFACE VERIFICATION REQUIREMENTS	4 – 75	
4.3.9.1	ATMOSPHERE REQUIREMENTS	4 – 75	
4.3.9.1.1	PRESSURE	4 – 75	
4.3.9.1.2	TEMPERATURE	4 – 75	
4.3.9.1.3	HUMIDITY	4 – 75	
4.3.9.2	INTEGRATED RACK USE OF CABIN ATMOSPHERE	4 – 76	
4.3.9.2.1	ACTIVE AIR EXCHANGE	4 – 76	
4.3.9.2.2	OXYGEN CONSUMPTION	4 – 76	
4.3.9.2.3	CHEMICAL RELEASES	4 – 76	
4.3.9.3	IONIZING RADIATION REQUIREMENTS	4 – 76	
4.3.9.3.1	INTEGRATED RACK CONTAINED OR GENERATED IONIZING RADIATION	4 – 76	
4.3.9.3.2	IONIZING RADIATION DOSE	4 – 76	
4.3.9.3.3	SINGLE EVENT EFFECT (SEE) IONIZING RADIATION DOSE	4 – 77	
4.3.9.3.4	LAB WINDOW RACK LOCATION RADIATION REQUIREMENTS	4 – 77	
4.3.9.3.4.1	WINDOW RACK INFRARED RADIATION REQUIREMENTS	4 – 77	

TABLES

TABLE		PAGE
3.1.1.3–1	CREW-INDUCED LOADS	3 – 8
3.1.1.3–2	RANDOM VIBRATION CRITERIA FOR ISPR POST-MOUNTED EQUIPMENT WEIGHING 100 POUNDS OR LESS IN THE MPLM	3 – 8
3.1.1.3–3	RANDOM VIBRATION CRITERIA FOR ISPR POST-MOUNTED EQUIPMENT WEIGHING MORE THAN 100 POUNDS IN THE MPLM	3 – 9
3.1.1.3–4	PAYLOAD ISPR MOUNTED EQUIPMENT LOAD FACTORS (EQUIPMENT FREQUENCY 35 HZ)	3 – 9
3.1.1.6.1–1	MODULE CONNECTORS	3 – 13
3.1.2.2–1	ALLOWABLE INTEGRATED RACK NARROW–BAND ENVELOPE AND WIDEBAND INTERFACE FORCE VALUES FOR ISPRS, 0.5% DAMPING FACTOR	3 – 23b IRN 0003
3.1.2.2–2	NON–ARIS INTEGRATED RACK TO ARIS ACCELERATION LIMIT ALTERNATIVE TO FORCE LIMITS	3 – 23d
3.1.2.5–1	ALLOWABLE ON–BOARD FORCE VALUES FOR ARIS INTEGRATED PAYLOADS TO MEET OFF–BOARD LIMITS	3 – 23f
3.1.2.6–1	MAXIMUM ANGULAR MOMENTUM IMPULSE	3 – 23h IRN 0002
3.1.2.6–2	CMG MOMENTUM USAGE CALCULATION	3 – 23h
3.2.2.5–1	MAXIMUM REVERSE ENERGY/CURRENT FROM DOWNSTREAM LOADS	3 – 33
3.2.5.2–1	RACK MAINTENANCE SWITCH (RACK POWER SWITCH) LABEL	3 – 45
3.2.5.4–1	LET-GO CURRENT PROFILE THRESHOLD VERSUS FREQUENCY	3 – 46
3.3.5.2.1.4–1	REMOTE TERMINAL HARDWIRED ADDRESS CODING FOR STANDARD PAYLOAD BUS	3 – 59
3.3.5.2.3–1	MIL–STD–1553B NETWORK CHARACTERISTICS	3 – 61
3.3.6.1.6–1	LINK SEGMENT CABLE CHARACTERISTICS	3 – 63
3.3.8.1–1	RACK CONNECTOR PART NUMBERS	3 – 67
3.3.10.1–1	BI-LEVEL DATA CHARACTERISTICS (SWITCH CONTACT)	3 – 70
3.3.10.2.1–1	ELECTRICAL CHARACTERISTICS ENVELOPE OF ANALOG SIGNALS	3 – 71
3.3.10.2.2–1	ELECTRICAL CHARACTERISTICS OF THE BIT INTERFACE	3 – 71
3.3.10.2.3–1	SMOKE INDICATOR INTERFACE CHARACTERISTICS	3 – 72
3.4.1.1–1	NTSC VIDEO PERFORMANCE CHARACTERISTICS (OPTICAL VIDEO ONLY) (TBR #3)	3 – 73
3.4.1.2–1	NTSC FIBER OPTIC VIDEO SIGNAL CHARACTERISTICS	3 – 74
3.4.1.2.4–1	PFM NTSC VIDEO OPTICAL FIBER CHARACTERISTICS	3 – 75
3.4.1.3.2–1	JEM VIDEO AND SYNC SIGNAL STANDARD	3 – 78
3.5.1.13–1	MPLM CABIN AIR HEAT ABSORPTION	3 – 84
3.9.3.4–1	SOLAR RADIATION	3 – 94
3.9.4–1	ENVIRONMENTAL CONDITIONS	3 – 96

TABLES (Continued)

TABLE		PAGE
3.9.4–2	ASSEMBLY COMPLETE QUASI–STEADY STATE MICROGRAVITY ENVIRONMENT	3 – 97
3.12.3.3.1–1	CONTINUOUS NOISE LIMITS	3 – 116
3.12.3.3.2–1	INTERMITTENT NOISE LIMITS	3 – 117
3.12.3.4–1	SURFACE INTERIOR COLORS AND PAINTS	3 – 119
3.12.3.4–2	PAYLOAD REQUIRED ILLUMINATION LEVELS	3 – 119
3.12.6.4.1–1	HAND SIZE DIMENSIONS	3 – 134 IRN 0003

FIGURES (Continued)

FIGURE		PAGE
3.3.5.2.1.4–1	REMOTE TERMINAL HARDWIRED ADDRESS CODING (EXAMPLE)	3 – 60
3.3.8.1–1	DATA/POWER CABLE DESIGN	3 – 67
3.4.1.3.2–1	INTERFACE POINT FOR JEM ELECTRICAL VIDEO	3 – 77
3.4.1.3.3–1	VIDEO/SYNC SIGNAL INTERFACE CIRCUIT	3 – 79
3.9.1.3–1	ISS TEMPERATURE/HUMIDITY ENVELOPE	3 – 93
3.9.4–1	OPERATING LIMITS OF THE ISS ATMOSPHERIC TOTAL PRESSURE, AND NITROGEN AND OXYGEN PARTIAL PRESSURES	3 – 98
3.9.4–2	DELETED	3 – 99
3.9.4–3	DELETED	3 – 99
3.9.4–4	DELETED	3 – 100
3.10.3.2–1	MANUAL FIRE SUPPRESSION HARDWARE ENVELOPE	3 – 104
3.10.3.2–2	CLOSED VOLUME PFE NOZZLE	3 – 105
3.12.1–1	ARM, HAND, AND THUMB/FINGER STRENGTH (5TH PERCENTILE MALE DATA)	3 – 108
3.12.1–2	LEG STRENGTH AT VARIOUS KNEE AND THIGH ANGLES (5TH PERCENTILE MALE DATA)	3 – 109
3.12.1–3	TORQUE STRENGTH	3 – 109
3.12.1–4	MAXIMAL STATIC PUSH FORCES	3 – 110
3.12.1–5	MALE GRIP STRENGTH AS A FUNCTION OF THE SEPARATION BETWEEN GRIP ELEMENTS	3 – 111
3.12.2.2–1	MINIMUM SIZES FOR ACCESS OPENINGS FOR FINGERS	3 – 111
3.12.3.3–1	INTERMITTENT NOISE LIMIT REQUIREMENTS	3 – 114
3.12.3.3.2–1	INTERMITTENT NOISE LIMITS	3 – 118
3.12.4.4.2–1	DELETED	3 – 124
3.12.4.4.2–2	MINIMAL CLEARANCE FOR TOOL–OPERATED FASTENERS	3 – 125
3.12.5.1–1	CONTROL SPACING REQUIREMENTS FOR UNGLOVED OPERATION	3 – 128
3.12.5.2.3–1	ROTARY SWITCH GUARD	3 – 130
3.12.5.3–1	VALVE HANDLE - CENTRAL PIVOT TYPE	3 – 131
3.12.5.3–2	VALVE HANDLE – LEVER TYPE	3 – 132
3.12.5.4–1	TOGGLE SWITCHES	3 – 133
3.12.6.4.1–1		3–134a IRN 0002
3.12.6.4.4–1	MINIMUM IVA HANDLE DIMENSIONS FOR IVA APPLICATIONS	3 – 135
4.3.2.2.8–1	STABILITY TEST SETUP, TRANSIENT RESPONSES	4 – 19
4.3.2.2.8–2	ISS LINE IMPEDANCE SIMULATION NETWORK (LISN)	4 – 20
4.3.12.3.3.1–1	TEST-CORRELATED MODEL PROCESS	4 – 88

2.0 DOCUMENTATION

The following documents include specifications, models, standards, guidelines, handbooks, and other special publications. Specific date and revision number of documents under control of the Space Station Control Board can be found in SSP 50257, Program Control Document Index or SSP 50258, Prime Control Document Index. IRN 0005

The documents in this paragraph form a part of this specification to the extent specified herein. In the event of a conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

2.1 APPLICABLE DOCUMENTS

IRN 0005

DOCUMENT NO.	TITLE	
CCSDS 301.0–B–2	CCSDS Time Code Format	
CCSDS 701.0-B-2	Advanced Orbiting Systems, Network and Data Links: Architectural Specification, Blue Book	
220G07455	Upper Structure Assembly	IRN 0004
220G07470	MSFC Base Assembly	
220G07475	SSPF Base Assembly	
220G07500	Rack Shipping Containers	
683-50243-4	Rack, Equipment, U.S. Standard–Assy	IRN 0005
683–10007	Fire Detection Assembly	
683–17103	Fluid System Servicer (FSS) Interface Definition Drawings	
D684–10056–01	International Space Station Program, Prime Contractor Software Standards and Procedures Specification	
EIA–RS–170	Electrical Performance Standards for Television Studio Facilities	
EIA/TIA 250	Electrical Performance for Television Relay Facility	
FED–STD–595	Federal Standard Colors Used in Government Procurement	
ISO/IEC 8802-3	Carrier Sense Multiple Access With Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications	
JSC 26557	International Space Station On–Orbit Assembly, Modeling, and Mass Properties Databook	IRN 0002
JSC 27199	End Item Specification for the International Space Station Portable Utility Light	

DOCUMENT NO.	TITLE	
JSC 27260	Decal Process Document and Catalog	
JSC 27337	Project Technical Requirements for the PCS	IRN 0005
MA2–95–048	Thermal Limits for Intravehicular Activity	
MA2–97–093	Crew Mating/Demating of Powered Connectors	
MIL–HDBK–1553	Digital Time Division Command/Response Multiplex Data Bus Handbook	
MIL–STD–462	EMI Characteristics, Measurement of	IRN 0005
MIL–STD–1553B	Digital Time Division Command/Response Multiplex Data Bus	
MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) Document	
		IRN 0005
MSFC–SPEC–250	Protective Finishes for Space Vehicle Structures and Associated Flight Equipment, General Specification for Document	
MSFC–STD–275	Marking of Electrical Ground Support Equipment, Front Panels, and Rack Title Plates	
		IRN 0005
NTC Report No. 7	Video Facility Testing Technical Performance Objectives (NTC)	
NSTS/ISS 13830	Payload Safety Review and Data Submittal Requirements For Payloads Using the Space Shuttle and International Space Station	
NSTS 1700.7 ISS Addendum	Safety Policy and Requirements for Payloads Using the International Space Station	
NSTS/ISS 18798	Interpretations of NSTS/ISS Payload Safety Requirements	
SDD32100397	Decal, Fire Hole	IRN 0005
SED33108703	Desk Top Plate Assy, Inflight Computere	
SED39126010	Assembly, DC Power Supply PGSC 486	
SEG33107631	Bracket Assy, Multi–Use	
SN–C–0005	NSTS Contamination Control Requirements Manual	
SSP 30219	Space Station Reference Coordinate Systems	IRN 0002
SSP 30233	Space Station Requirements for Material and Processes	
SSP 30237	Space Station Requirements for Electromagnetic Emission and Susceptibility Requirements	

DOCUMENT NO.	TITLE
SSP 30238	Space Station Electromagnetic Techniques
SSP 30240	Space Station Grounding Requirements
SSP 30242	Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility

D. Equipment mounted directly to the rack will have a modal frequency goal of 35 Hz for launch and landing, based on rigidly mounting the component at the component to rack interface.

E. Integrated racks shall comply with the keepout zone for rack pivot mechanism as defined in SSP 41017 Part 1, paragraph 3.2.1.1.2.

F. Integrated racks that will be installed in the U.S. Lab Nadir Window location shall accommodate the modified ISPR static envelope defined by Figure 3.1.1.4–1 of the Pressurized Payload Hardware ICD, SSP 57001.

G. Deleted

H. Deleted.

I. Integrated racks shall be capable of rotating a minimum of 80 degrees about the pivot point for on-orbit installation, removal, and maintenance functions.

J. Deleted

K. Integrated racks and rack equipment that have PFE access ports shall maintain positive margins of safety when exposed to the PFE discharge rate given in Figure 3.1.1.4–1.

L. Integrated racks requiring rotation shall use the rack and crew restraints identified in SSP 30257:004 (for example, the 14 inch fixed length tether and the 71 inch adjustable length tether) to secure the rack in these rotated positions for payload operations and maintenance.

M. Integrated racks shall not have a pressure relief device on the front of the rack.

N. Integrated racks that are designed to rotate shall be free to rotate fully as specified in 3.1.1.4.I while connected to rack utilities (e.g. power, data, video, and fluid lines) from the pressurized element. Note: This requirement does not apply to the following racks: Racks utilizing ARIS or PaRIS, MELFI, WORF, EXPRESS, HRF Rack 1, HRF Rack 2, CR (Centrifuge Rotor) and LSG. IRN 0002

3.1.1.4.1 LAB WINDOW RACK LOCATION REQUIREMENTS

When the lab window scratch pane is removed, radiation shielding as specified in 3.9.3.4 is required.

A. When the lab window scratch pane is removed, a protective cover shall be provided that prevents contact with the lab window surface.

B. Integrated racks at the lab window location shall accommodate a keep–out zone as specified in SSP 57001, Figure 3.1.1.4–1. This requirement shall only be valid when the WORF is not installed. IRN 0002

C. Integrated racks at the lab window location, that are open on the back (window) side of the rack, shall provide a barrier from the Lab pressure wall to the integrated rack to isolate the rack volume from the stand–offs and area behind the racks.

D. Payloads that are hand–held, regardless of whether the WORF rack is installed or not, shall incorporate bumper rings coated with the material DB2352 from the Plasti–Coat Corporation to prevent damage to any window panes in the USL nadir window. Payloads that are designed to be secured to the WORF payload shelf prior to retraction of the Bump Shield will be exempted from this requirement. IRN 0002

3.1.1.5 SAFETY CRITICAL STRUCTURES REQUIREMENTS

A. Integrated racks shall be designed in accordance with the requirements specified in SSP 52005.

B. Deleted

C. Deleted

D. Deleted

3.1.1.6 CONNECTOR AND UMBILICAL PHYSICAL MATE

3.1.1.6.1 CONNECTOR PHYSICAL MATE

Integrated rack and sub-rack equipment shall physically mate with the UIP, UOP and Fluid Services connectors intended to be used by the payload as listed in Table 3.1.1.6.1–1.

TABLE 3.1.2.5–1 ALLOWABLE ON–BOARD FORCE VALUES FOR ARIS INTEGRATED PAYLOADS TO MEET OFF–BOARD LIMITS IRN 0003

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			

3.1.2.6 ANGULAR MOMENTUM LIMITS

IRN 0002

This requirement applies only to payload disturbance forces and moments which generate pure internal angular momentum impulse greater than 100 ft–lb–sec (135 N–m–sec) or a maximum impulse greater than 1.1 lb–s (5.2 N–s) over any continuous period of 9 minutes.

The following general requirements apply to the determination of applicability as stated above and to the evaluation of the ability of payloads to meet the limits of 3.1.2.6.1 and 3.1.2.6.2:

A. It is not necessary to consider transient or cyclic angular momentum changes that exceed limits over shorter intervals than the specified continuous duration if the cumulative angular momentum impulse limit is not exceeded by the end of the specified continuous duration.

B. The beginning and end times of continuous periods may be arranged in any order, as long as all periods of operation are covered in one or more continuous period. This permits start–ups followed by stopping actions within any 9 minute window to be considered as cancelled angular impulse.

C. Shorter duration angular momentum impulse sources are covered by the microgravity transient and vibratory force limits, assuming standard ISPR attachment point separation distances. IRN 0002

D. Payloads are not required to report angular momentum changes or forces resulting from the use of standard ISS resources such as the Vacuum Resource System or Waste Gas System.

E. If the disturbance source produces translational forces, the disturbance torque due to the disturbance force will be calculated using the moment arm from the point of application of the force to the ISS Assembly Complete configuration center of mass. The location of the Assembly Complete configuration center of mass is specified in JSC 26557, the ISS On–Orbit Assembly, Modeling and Mass Properties Databook.

F. If the disturbance source produces forces and moments, the disturbance moment due to the disturbance force will be added to the induced pure moments.

G. The locations of pure moments do not need to be reported.

3.1.2.6.1 LIMIT DISTURBANCE INDUCED ISS ATTITUDE RATE

When the on–orbit Space Station is in the microgravity mode, any nontransitory disturbance induced on the on–orbit Space Station by an individual disturbance source of a payload shall have an angular momentum impulse of less than the per axis values shown in Table 3.1.2.6–1 during any continuous nine minute period. Over no interval of time of 10 seconds or less shall a payload angular momentum impulse exceed 250 ft–lb–s (340 N–m–s), and over no interval of time of 2 minutes or less shall a payload angular momentum impulse exceed 2900 ft–lb–s (3930 N–m–s). Angular momentum impulse due to gyroscopic moments (the cross–produce of ISS orbital rate with payload angular momentum) may be excluded from these limits if the payload gyroscopic moment does not exceed 6–ft–lb (8.14 N–m).

3.1.2.6.2 LIMIT DISTURBANCE INDUCED CMG MOMENTUM USAGE

When the on–orbit Space Station is in the microgravity mode, any disturbance induced on the on–orbit Space Station by an individual disturbance source of a payload shall have an angular momentum impulse that produces an estimated Control Moment Gyroscope (CMG) momentum magnitude less than 10,000 ft–lb–sec (13,577 N–m–sec) during any continuous 110 minute period when evaluated per expression in Table 3.1.2.6–2. Angular momentum impulse due to gyroscopic moments (the cross–product of ISS orbital rate with payload angular momentum) may be excluded from these limits if the payload gyroscopic moment does not exceed 6 ft–lb (8.14 N–m).

IRN 0002

TABLE 3.1.2.6–1 MAXIMUM ANGULAR MOMENTUM IMPULSE

Axis	Hx	Hy	Hz
ft–lb–sec	930	1277	2876
N–m–sec	1261	1732	3900
Note: (1) Where Hx, Hy, and Hz are the x, y, and z components of the disturbance angular momentum relative to the coordinate system specified in SSP 30219, Figure 4.0–3.			

TABLE 3.1.2.6–2 CMG MOMENTUM USAGE CALCULATION

Estimated CMG Momentum Usage	
ft–lb–sec	SQRT((1.25*Hx+1069)**2 + (1.25*Hy+6885)**2 + (1.25*Hz+779)**2) <10,000
N–m–sec	SQRT((1.25*Hx+1449)**2 + (1.25*Hy+9334)**2 + (1.25*Hz+1056)**2) <13,577
Notes: (1) Where Hx, Hy, and Hz are the x, y, and z components of the disturbance angular momentum impulse using the coordinate system specified in SSP 30219, Figure 4.0–3. (2) Where 1069, 6885, and 779 ft–lb–sec (and 1449, 9334, and 1056 N–m–sec) are the x, y, and z components, respectively, of the CMG angular momentum allocation for environmental disturbances.	

3.1.3 STOWAGE

Stowage interface information is provided in SSP 50467, Cargo Stowage Technical Manual: Pressurized Volume. IRN 0004

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.

3.2.1.3.4 NON-NORMAL VOLTAGE RANGE

The Integrated rack connected to Interface B and EPCE connected to Interface C shall not produce an unsafe condition or one that could result in damage to ISS equipment or payload hardware with the following non-normal voltage characteristics:

A. Maximum overvoltage of +165 Vdc for 10 sec.

B. Undervoltage conditions of +102 Vdc for an indefinite period of time.

3.2.1.4 DELETE

3.2.2 ELECTRICAL POWER INTERFACE

3.2.2.1 UIP, UOP AND SUP CONNECTORS AND PIN ASSIGNMENTS IRN 0002

A. Integrated rack connectors P1 and P2 mating requirements to the UIP connectors J1 and J2 are specified in Table 3.1.1.6.1–1, A and B. IRN 0002

B. Integrated rack connectors P1 and P2 shall meet the pin out interfaces of the UIP connectors J1 and J2 as specified in SSP 57001, paragraph 3.2.1.1.

C. Integrated rack connectors P1 and P2 shall meet the requirements of SSQ 21635 or equivalent.

D. EPCE connectors P3 and P4 mating requirements to the UOP connectors J3 and J4 are specified in Table 3.1.1.6.1–1, X, Y, and Z. IRN 0002

E. EPCE connectors P3 and P4 shall meet the pin out interfaces of the UOP connectors J3 and J4 as specified in SSP 57001, paragraph 3.2.1.2.

F. EPCE connectors P3 and P4 to UOP shall meet the requirements of SSQ 21635 or equivalent. IRN 0002

G. EPCE connectors P1, P2 and P3 mating requirements to the SUP connectors J1, J2 and J3 are specified in Table 3.1.1.6.1–1, AA, AB and AC. IRN 0002

H. EPCE connectors P1, P2 and P3 shall meet the pin out interfaces of the SUP connectors J1, J2 and J3 as specified in SSP 57001, paragraph 3.2.1.3.

I. EPCE connectors P1, P2 and P3 to SUP shall meet the requirements of SSQ 21635 or equivalent.

Note: As shown in Table 3.2.1.3–1 of SSP 57001, connector J4 is for ESA use only and connectors J5, J6, J7, J8 and J9 are not available for payload use. IRN 0002

3.2.2.2 POWER BUS ISOLATION

A. Integrated rack locations requiring power from two independent ISS power buses shall provide a minimum of 1-megohm isolation in parallel with not more than 0.03 microfarads of mutual capacitance within internal and external rack EPCE at all times such that no single failure shall cause the independent power buses to be electrically tied. (Mutual capacitance is defined as line-to-line capacitance, exclusive of the EMI input filter.)

B. Integrated rack internal and external EPCE shall not use diodes to electrically tie together independent ISS power bus high side or return lines. These requirements apply to both supply and return lines.

ISS provides the capability to support simultaneous use of Main (J1) and Auxiliary (J2) power at each ISPR location (except MPLM). Constrained element level payload operations may occur from individual payload racks which automatically switch to or require simultaneous use of auxiliary power. ISS is required to reserve the maximum auxiliary power needed on that channelized Bus (even when not in use) to prevent Bus overload. For this reason, auxiliary power feeds will nominally be powered off by the module RPC. Specific constraints on the use of auxiliary power will be defined in the payload unique ICD.

3.2.2.3 COMPATIBILITY WITH SOFT START/STOP RPC

An integrated rack connected to Interface B or EPCE connected to Interface C shall initialize with the soft start/stop performance characteristics when power is applied, sustained, and removed by control of remote power control switches. The soft start/stop function, active only when the Remote Power Controller (RPC) is commanded on or off, is limited to 100 amps/ms, or less, by the RPC output. The response of the soft start/stop function is linear for resistive loads for 1 to 10 ms for U.S. LAB feeds, 1.5 to 5 ms for JEM 50 amp main feeds, 1.5 to 5 ms for JEM 25 amp main feeds, 0.1 to 5 ms for JEM 10 amp auxiliary feeds, and 0.1 to 50 ms for APM feeds between 10% and 90% of rated current level. IRN 0001 IRN 0001

Note: Soft start/stop characteristics of U.S. standard RPCMs are shown in Figure 3.2.2.3–1.

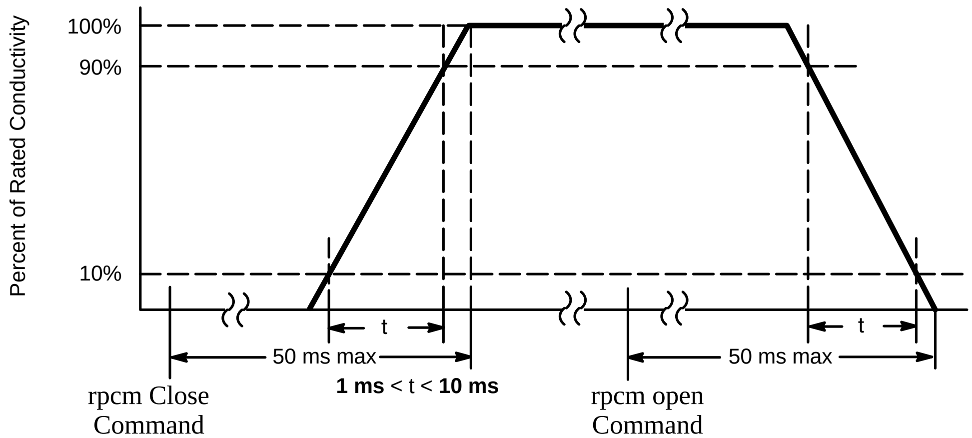
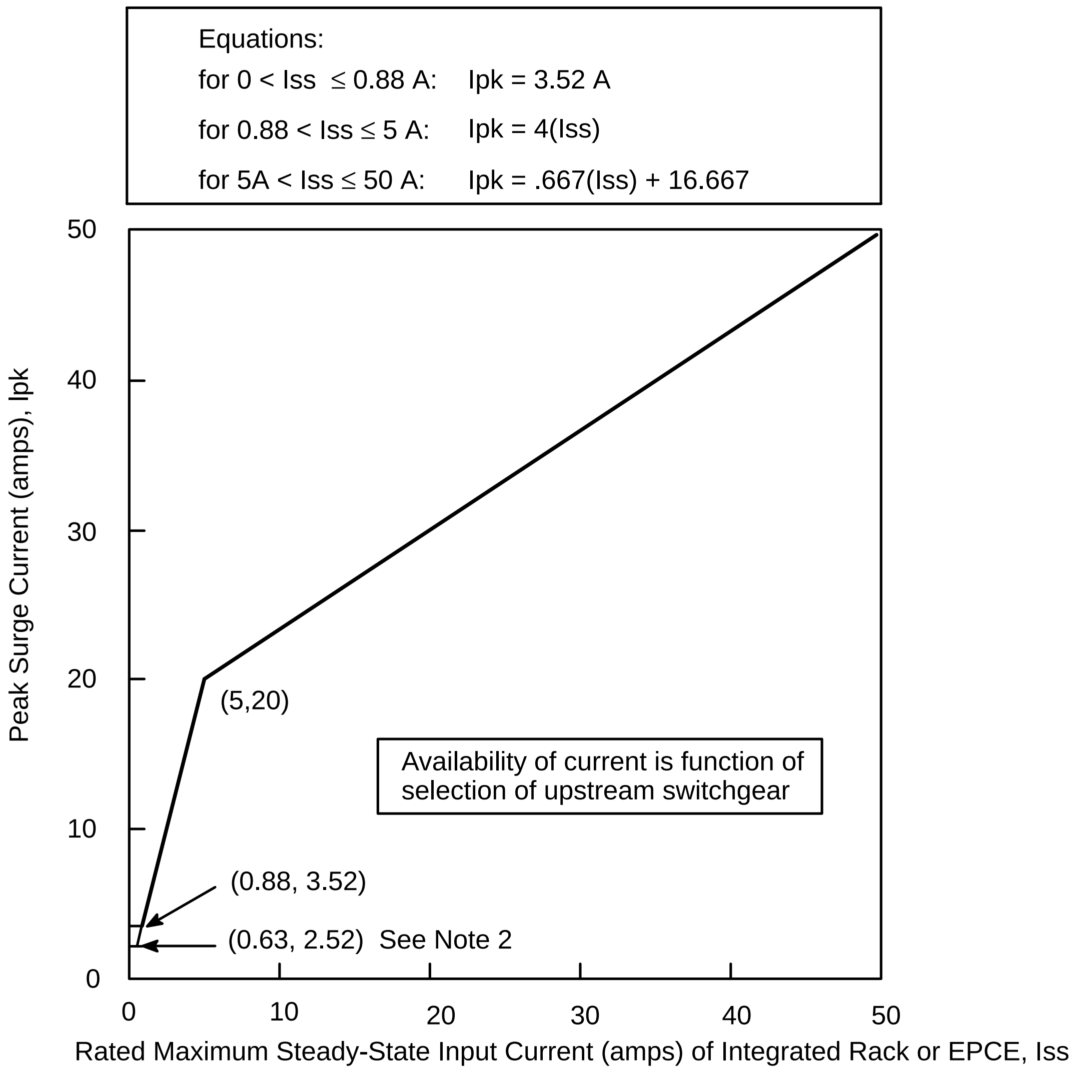


FIGURE 3.2.2.3–1 U.S. RPCM SOFT START/STOP CHARACTERISTICS

3.2.2.4 SURGE CURRENT

The surge current at the power input to the integrated rack connected to Interface B or EPCE connected to Interface C shall not exceed the surge current values defined in Figures 3.2.2.4–1 and 3.2.2.4–2 when powered from a voltage source with characteristics specified in paragraphs 3.2.1 and 3.2.2.3, with the exception that the source impedance is considered to be 0.1 ohm. The duration of the surge current shall not exceed 10 ms. The duration of surge current is measured as the duration in which the current exceeds the maximum steady state input current derived from the payload maximum continuous power defined in the unique hardware ICD in accordance with Table 3.2.7–1 of SSP 57001. These requirements apply to all operating modes and changes including power-up and power-down. IRN 0002 IRN 0002



IRN 0002

NOTES:

1. For transients less than 100 microseconds, refer to SSP 30237.
2. NASA Space Station equipment accommodated in JEM will have a maximum allowable peak surge current of 2.52 amps for equipment having a steady-state input no greater than 0.63 amps.

FIGURE 3.2.2.4–1 PEAK SURGE CURRENT AMPLITUDE VERSUS RATED STEADY-STATE INPUT CURRENT IRN 0002

Integrated racks requiring active cooling in the MPLM shall withstand the active thermal control loop maximum design pressure of 210 psia (1448 kPa). The maximum design pressure is derived from an Orbiter Freon loop/Payload Heat Exchanger failure condition, the MPLM coolant will be a mixture of water and Freon 21.

3.5.1.8 FAIL SAFE DESIGN

The integrated racks shall assess the payload equipment and rack internal water loop piping to ensure that it is fail safe in the case of loss of cooling under all modes of operation.

3.5.1.9 LEAKAGE

A. The integrated rack shall not exceed the maximum rack leakage rate of water of 14×10^{-3} scc/ hr (liquid) per each thermal loop at the MDP of 121 psia (834 kPa).

B. Integrated Refrigerator and Freezer racks that operate in the MPLM shall not exceed the maximum leakage rate of water of 9×10^{-3} scc/ hr (liquid) for 72 hours when exposed to 100% Freon–21 in the water lines at the MDP of 210 psia (1,448 kPa).

3.5.1.10 QUICK-DISCONNECT AIR INCLUSION

Payload Quick Disconnects shall not exceed the maximum air inclusion of .30 cubic centimeters (cc) maximum per couple/uncouple cycle. IRN 0002

3.5.1.11 RACK FRONT SURFACE TEMPERATURE

The integrated rack shall be designed such that the average front surface temperature is less than 37° C (98.6° F) and partial limit not to exceed 49° C (120° F). **(TBR #4)**

3.5.1.12 CABIN AIR HEAT LEAK

The sensible heat leak to the cabin air from the integrated rack either alone or together with the other ISPRs simultaneously active will not exceed the limits specified in paragraph 3.5.1.8 of the Pressurized Payload Hardware Interface Control Document, SSP 57001. These limits represent the total cabin air heat load capability when the cabin temperature is at 18° C (65° F). The numbers in this Table are the total cabin heat load allocation for all the ISPR’s on a module basis.

3.5.1.16 PAYLOAD COOLANT QUANTITY

Integrated racks shall contain no more than the maximum allowable coolant quantity of water, referenced at 61° C (141.8° F), as specified in paragraph 3.5.1.6 of the Pressurized Payload Hardware Interface Control Document SSP 57001.

3.5.1.17 DELETED

IRN 0002

3.6 VACUUM SYSTEM REQUIREMENTS

3.6.1 VACUUM EXHAUST SYSTEM (VES)/WASTE GAS SYSTEM (WGS) REQUIREMENTS

3.6.1.1 VES/WGS PHYSICAL INTERFACE

Integrated rack connectors for the VES/WGS mating requirements to the UIP connectors are specified in paragraph 3.1.1.6.1, Q.

3.6.1.2 INPUT PRESSURE LIMIT

A. Integrated racks shall limit their vented exhaust gas to a pressure of 276 kPa (40 psia) or less at the rack to Station interface.

B. Integrated rack volumes connected to the VES/WGS shall be designed to a maximum design pressure of at least 276 kPa (40 psia) with safety factors in accordance with SSP 52005 paragraph 5.1.3.

C. The integrated rack shall be two failure tolerant to protect against failure conditions which would exceed VES/WGS max design pressure of 40 psia.

3.6.1.3 INPUT TEMPERATURE LIMIT

The initial temperature range of exhaust gases shall be between 16° C (60° F) to 45° C (113° F).

3.6.1.4 INPUT DEWPOINT LIMIT

The initial dewpoint of exhaust gases shall be limited to 16° C (60° F) or less.

3.7 PRESSURIZED GASES INTERFACE REQUIREMENTS

3.7.1 NITROGEN INTERFACE REQUIREMENTS

3.7.1.1 NITROGEN INTERFACE CONTROL

A. The integrated rack shall provide a valve, located within the integrated rack envelope, to turn on and off the flow of nitrogen to the integrated rack. IRN 0002

B. The integrated rack shall provide a means to control the flow of nitrogen to not exceed 5.43 kg/hr (12 lbm/hr) when connected to the nitrogen interface operating pressure range of 517 to 827 kPa (75 to 120 psia).

3.7.1.2 NITROGEN INTERFACE MDP

The MDP of the integrated rack nitrogen system shall be 1,379 kPa (200 psia).

3.7.1.3 NITROGEN INTERFACE TEMPERATURE

The integrated rack nitrogen system shall be designed for a nitrogen supply temperature range of 15.6°C to 45°C (60°F to 113°F).

3.7.1.4 NITROGEN LEAKAGE

The integrated rack shall have a nitrogen leakage rate no greater than 10^{-3} scc/sec at MDP. Leakage is considered to be loss to the cabin atmosphere associated with quick disconnects, fittings, seals, valves, and permeation through materials from, and including, the standoff UIP connection to the nitrogen on/off flow control point in the integrated rack. All nitrogen flowing past the on/off flow control point is considered usage. The integrated rack allocation for nitrogen will comprise leakage and usage. IRN 0002

3.7.1.5 NITROGEN PHYSICAL INTERFACE

Integrated rack connectors for the nitrogen system mating requirements to the UIP connectors are specified in paragraph 3.1.1.6.1, P.

3.7.2 ARGON INTERFACE REQUIREMENTS

3.7.2.1 ARGON INTERFACE CONTROL

A. The integrated rack shall provide a valve, located within the integrated rack envelope, to turn on and off the flow of argon to the integrated rack. IRN 0002

B. The integrated rack shall provide a means to control the flow of argon to not exceed 2.14 kg/hr (4.71 lbm/hr) when connected to the argon interface operating pressure range of 517 to 786 kPa (75 to 114 psia).

3.7.2.2 ARGON INTERFACE MDP

The MDP of the integrated rack argon system shall be 1,379 kPa (200 psia).

3.7.2.3 ARGON INTERFACE TEMPERATURE

The integrated rack argon system shall accept an argon supply temperature range of 13°C to 45°C (55.4°F to 113°F).

3.7.2.4 ARGON LEAKAGE

The integrated rack shall have an argon leakage rate no greater than 10^{-3} scc/sec at MDP. Leakage is considered to be loss to the cabin atmosphere associated with quick disconnects, fittings, seals, valves, and permeation through materials from, and including, the standoff UIP connection to the argon on/off flow control point in the integrated rack. All argon flowing past the on/off flow control point is considered usage. The integrated rack allocation for argon will comprise leakage and usage. IRN 0002

3.7.2.5 ARGON PHYSICAL INTERFACE

Integrated rack connectors for the argon system mating requirements to the UIP connectors are specified in paragraph 3.1.1.6.1, S.

3.7.3 CARBON DIOXIDE INTERFACE REQUIREMENTS

3.7.3.1 CARBON DIOXIDE INTERFACE CONTROL

A. The integrated rack shall provide a valve, located within the integrated rack envelope, to turn on and off the flow of carbon dioxide to the integrated rack. IRN 0002

B. The integrated rack shall provide a means to control the flow of carbon dioxide to not exceed 0.59 kg/hr (1.30 lbm/hr) when connected to the carbon dioxide interface operating pressure range of 517 to 786 kPa (75 to 114 psia). IRN 0002

3.7.3.2 CARBON DIOXIDE INTERFACE MDP

The MDP of the integrated rack carbon dioxide system shall be 1,379 kPa (200 psia).

3.7.3.3 CARBON DIOXIDE INTERFACE TEMPERATURE

The integrated rack carbon dioxide system shall accept a carbon dioxide supply temperature range of 13°C to 45°C (55.4°F to 113°F).

3.7.3.4 CARBON DIOXIDE LEAKAGE

The integrated rack shall have a carbon dioxide leakage rate no greater than 10^{-3} scc/sec at MDP. Leakage is considered to be loss to the cabin atmosphere associated with quick disconnects, fittings, seals, valves, and permeation through materials from, and including, the standoff UIP connection to the carbon dioxide on/off flow control point in the integrated rack. All carbon dioxide flowing past the on/off flow control point is considered usage. The integrated rack allocation for carbon dioxide will comprise leakage and usage. IRN 0002

3.7.3.5 CARBON DIOXIDE PHYSICAL INTERFACE

Integrated rack connectors for the carbon dioxide system mating requirements to the UIP connectors are specified in paragraph 3.1.1.6.1, U.

3.7.4 HELIUM INTERFACE REQUIREMENTS

3.7.4.1 HELIUM INTERFACE CONTROL

A. The integrated rack shall provide a valve, located within the integrated rack envelope, to turn on and off the flow of helium to the integrated rack. IRN 0002

B. The integrated rack shall provide a means to control the flow of helium to not exceed 0.21 kg/hr (0.47 lbm/hr) when connected to the helium interface operating pressure range of 517 to 786 kPa (75 to 114 psia).

3.7.4.2 HELIUM INTERFACE MDP

The MDP of the integrated rack helium system shall be 1,379 kPa (200 psia).

3.7.4.3 HELIUM INTERFACE TEMPERATURE

The integrated rack helium system shall accept a helium temperature range of 13°C to 45°C (55.4°F to 113°F).

3.7.4.4 HELIUM LEAKAGE

The integrated rack shall have a helium leakage rate no greater than 10^{-3} scc/sec at MDP. Leakage is considered to be loss to the cabin atmosphere associated with quick disconnects, fittings, seals, valves, and permeation through materials from, and including, the standoff UIP connection to the helium on/off flow control point in the integrated rack. All helium flowing past the on/off flow control point is considered usage. The integrated rack allocation for helium will comprise leakage and usage. IRN 0002

3.7.4.5 HELIUM PHYSICAL INTERFACE

Integrated rack connectors for the helium system mating requirements to the UIP connectors are specified in paragraph 3.1.1.6.1, T.

3.7.5 PRESSURIZED GAS SYSTEMS

Pressurized gas systems with a total expanded gas volume exceeding 400 liters at Standard Conditions shall limit the gas flow after a single failure to less than 240 SLPM after 400 liters at Standard Conditions has been released to the cabin air.

3.7.6 MANUAL VALVES

If a manual valve is employed for control of a pressurized gas, the valve shall be accessible as specified in paragraph 3.12.5.3 without rack rotation.

3.8 PAYLOAD SUPPORT SERVICES INTERFACES REQUIREMENTS

3.8.1 POTABLE WATER

3.8.1.1 POTABLE WATER INTERFACE CONNECTION

Integrated rack connectors for the potable water system mating requirements are specified in paragraph 3.1.1.6.1, V.

Payload-provided containers used to convey water from the Space Shuttle Orbiter prior to the deployment of the ISS potable water processor, the ISS galley, and the ISS fuel-cell water tank on-orbit will be compatible with the Orbiter water interfaces.

3.8.1.2 POTABLE WATER INTERFACE PRESSURE

The payload-provided container, and all tubing, hoses and connectors used to connect to the ISS potable water interface shall not visibly leak when exposed to the ISS potable water interface pressure of 103.4 to 206.8 kPa gauge pressure (15 to 30 psig).

3.12.6.2 STOWAGE AND EQUIPMENT DRAWERS/TRAYS

A. All latches, handles, and operating mechanisms shall be designed to be latched/unlatched and opened/closed with one hand by the 95th percentile American male to the 5th percentile female.

B. The design of latches shall be such that their status (locked/unlocked) can be determined through visual inspection.

3.12.6.3 CAPTIVE PARTS

Payloads and payload equipment shall be designed in such a manner to ensure that all unrestrained parts (e.g., locking pins, knobs, handles, lens covers, access plates, or similar devices) that may be temporarily removed on orbit will be tethered or otherwise held captive.

3.12.6.4 HANDLE AND GRASP AREA DESIGN REQUIREMENTS

3.12.6.4.1 HANDLES AND RESTRAINTS

All removable or portable items that are larger than 1 ft^3 shall be provided with handles or other suitable means of grasping, tethering, carrying and restraining. Hand size dimensions are provided in Table 3.12.6.4.1–1. Figure 3.12.6.4.1–1 shows where the measurements are taken for hand size dimensions. IRN 0002

TABLE 3.12.6.4.1–1 HAND SIZE DIMENSIONS

	5^{TH} Percentile Female Inches (mm)	95^{TH} Percentile Male Inches (mm)
Length (420)	6.2 (158)	8.1 (206)
Breadth (411)	2.7 (69)	3.8 (96)
Circumference (416)	6.5 (166)	9.2 (234)

IRN 0002

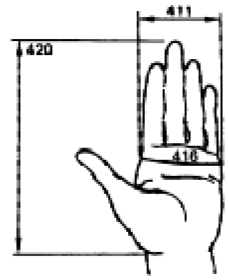


FIGURE 3.12.6.4.1–1

Number	Measurement
420	Hand Length
411	Hand Breadth
416	Hand Circumference

3.12.6.4.2 DELETED

3.12.6.4.3 HANDLE LOCATION/FRONT ACCESS

Handles and grasp areas shall be placed on the accessible surface of a payload item consistent with the removal direction.

3.12.6.4.4 HANDLE DIMENSIONS

IVA handles for movable or portable units shall be designed in accordance with the minimum applicable dimensions in Figure 3.12.6.4.4–1.

successful when the analysis shows that 3.5 kPa (0.5 psi) delta pressure is not exceeded. Verification may be by inspection of integrated rack design drawings for NASA provided 683–50243–4 ISPRs with intact and unblocked pressure relief valves).

C. An analysis shall be conducted using the guidelines provided in SSP 52005 appendix C.1.2.2. The verification shall be considered successful when the analysis shows that integrated rack meets the frequency requirement specified.

D. Information – no verification necessary.

E. Verification shall be by inspection of the umbilical routing drawing to ensure that the keepout zone is provided. The verification shall be considered successful when the inspection shows that the envelope is provided or analysis shows that the umbilicals can be moved out of the envelope without exceeding any umbilical bend radii requirements.

F. An analysis shall be conducted to determine the clearance dimensions of the window hardware with the integrated rack hardware. The verification shall be considered successful when the analysis indicates a positive clearance.

G. Deleted.

H. Deleted.

I. An analysis shall be conducted using integrated rack and module data to evaluate the maximum rotation angle. The verification shall be considered successful when the rotation angle is calculated to be at least 80 degrees.

J. Deleted

K. An analysis shall be conducted which determines the maximum delta pressure from within to outside the integrated rack during PFE discharge and shows that the integrated rack maintains positive margins of safety (delta pressure limited to 3.5 kPa (0.5 psi) and rack equipment maintains positive margins of safety. Verification shall be considered successful when the analysis shows that the structures maintain positive margins.

L. Verification of rack positional and crew restraints at rotation angles shall be by analysis. The analysis shall show the use of restraints to maintain the rack in the position required for payload operations and maintenance. Verification shall be considered successful when the analysis shows that the ISS provided hardware can secure the rack in the required rotation positions.

M. The rack rotation shall be verified by analysis. The analysis shall be performed using lower–level component qualification data. The verification shall be considered successful when the pressured volume racks that are designed to rotate, are shown able to rotate as specified. IRN 0002

4.3.1.1.4.1 LAB WINDOW RACK LOCATION REQUIREMENTS

A. Verification that a protective cover is provided that prevents contact with the lab window surface shall be by analysis. An analysis shall be performed to determine whether or not the rack provided protective cover can withstand loads as specified in 3.1.1.3.D, cabinets and any other exposed equipment. Verification shall be considered successful when the analysis shows the cover can withstand the loads specified in 3.1.1.3.D, cabinets and any other exposed equipment.

B. Verification that integrated racks at the lab window location provide a keep–out zone as specified in SSP 57001, Figure 3.1.1.4–1 shall be by inspection. An inspection shall determine whether or not the integrated rack provides keep–out zones as specified in SSP 57001, Figure 3.1.1.4–1. Verification shall be considered successful when the inspection shows the integrated rack provides a keep–out zone as specified in SSP 57001, Figure 3.1.1.4–1. Once the WORF is installed verification shall no longer be required. IRN 0002

C. Verification that the integrated rack at the lab window location provide a barrier between the Lab pressure wall and the integrated rack shall be by analysis. An analysis shall determine whether or not a barrier is provided by the integrated rack that would prevent airflow and debris from leaving/entering the integrated rack. Verification shall be considered successful when the analysis shows a barrier is provided that would prevent airflow and debris from entering/leaving the rack between the back of the rack and the pressure wall.

D. Verification shall be by inspection. An inspection of the as built drawings will be made to determine that the cameras are equipped with bumper rings per 3.1.1.4.1.D. Verification shall be considered successful when inspection shows that no damage is insued when the camera impacts the scratch pane. IRN 0002

4.3.1.1.5 SAFETY CRITICAL STRUCTURES REQUIREMENTS

A. Verification shall be in accordance with the requirements specified in SSP 52005.

B. Deleted

C. Deleted

D. Deleted

4.3.1.1.6 CONNECTOR AND UMBILICAL PHYSICAL MATE

4.3.1.1.6.1 CONNECTOR PHYSICAL MATE

Verification that the integrated rack connector physically mates with the corresponding module connector shall be by demonstration. The demonstration shall use a module connector with the part number specified in Table 3.1.1.6.1–1 to verify that the connectors physically mate. The verification shall be considered successful when the demonstration shows the integrated rack connector physically mates with its corresponding module connector.

4.3.1.1.6.2 UMBILICAL PHYSICAL MATE

A demonstration shall be conducted using the Payload Rack Checkout Unit (PRCU) or equivalent to show that the umbilicals can successfully reach their intended connector and the connectors are observed in a fully mated condition.

4.3.1.1.7.3 ON–ORBIT TEMPORARY PROTRUSIONS

A. An inspection of the integrated rack shall be conducted to determine that all on–orbit temporary protrusions remain within the envelope shown in Figure 3.1.1.7.3–1. The inspection shall be of the hardware or the as built drawings. The verification shall be considered successful when the inspection shows that all on–orbit temporary protrusions remain within the envelope shown in Figure 3.1.1.7.3–1.

B. Verification that the on–orbit temporary protrusions have been designed such that they can be eliminated or returned to their stowed configuration using hand operations and/or standard IVA tools within 10 minutes shall be performed by demonstration. The demonstration shall be performed on the hardware or a flight like equivalent. The verification shall be considered successful when the on–orbit temporary protrusions have been designed such that they can be eliminated or returned to their stowed configuration using hand operations and/or standard IVA tools within 10 minutes. To simulate on–orbit conditions, assume the ground based protrusion removal require half the time of on–orbit protrusion removal and that the tools are readily available.

4.3.1.1.7.4 ON–ORBIT MOMENTARY PROTRUSIONS

Verification of the on–orbit momentary protrusions, which includes drawer/door/cover, shall be by demonstration. The demonstration shall be performed on the hardware or a flight like equivalent. The verification shall be considered successful when the demonstration shows that the on–orbit momentary protrusion can be eliminated within the integrated rack within 30 seconds.

4.3.1.1.7.5 ON–ORBIT PROTRUSIONS FOR KEEP ALIVE PAYLOADS

A. Verification for on–orbit protrusions for keep–alive payload experiments shall be by inspection of the hardware or the as–built drawings. Verification shall be considered successful when the inspection shows that the power/data cables and thermal hoses are limited to no more than 500 square inches within the envelope shown in Figure 3.1.1.7.5–1. IRN 0002

B. The following two verification requirements are applicable only to the Habitat Holding Racks, Advanced Animal Habitat, Aquatic Habitat, Cell Culture Unit, Egg Incubator, Insect Habitat, Plant Research Unit, Incubator, and Refrigerated Centrifuge.

(1) Verification shall be by an inspection of the hardware or the as–built drawings. Verification shall be considered successful when the inspection shows that the mated low temperature fluid line connectors and associated connection hardware are limited to no more than 100 square inches within the envelope shown in Figure 3.1.1.7.5–2.

(2) Verification shall be by an inspection of the hardware or the as–built drawings. Verification shall be considered successful when the inspection shows that the air

filters and low temperature fluid lines are limited to no more than 900 square inches within the envelope shown in Figure 3.1.1.7.5–3. IRN 0002

4.3.1.2 MICROGRAVITY

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.

IRN 0003

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.

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:

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

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:

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

   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:

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

   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

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

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. IRN 0003

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:

Rigid Body Analysis Method

IRN 0003

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:

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.

FEM Analysis Method

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:

IRN 0003

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

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.

4.3.1.2.6 ANGULAR MOMENTUM LIMITS

IRN 0002

NVR

4.3.1.2.6.1 LIMIT INDUCED ISS ATTITUDE RATE

This requirement shall be verified by analysis. The analysis shall consist of a comparison of the calculated angular momentum impulse due to individual payload on–board disturbances to the per axis angular momentum allocations to verify that the allocations are not exceeded. The disturbance angular momentum impulse will normally be calculated as the integral of the disturbance torque relative to the ISS Assembly Complete center of mass over the specified period of time. For constant, continuously increasing, or continuously decreasing disturbance torques over two or more adjacent time periods, the difference in angular momentum impulse of the adjacent time periods should be used. Each integrated rack or non–rack payload source may be verified independently against the nine minute limit. Each integrated rack or non–rack payload shall be verified under worst–case combined source conditions against the two minute and ten second limits. ISS assembly complete mass properties and worst case element location/design parameters should be used when assessing compliance with this requirement. The verification shall be considered successful when analysis shows that the per axis disturbance angular momentum impulses are as specified for each axis.

4.3.1.2.6.2 LIMIT DISTURBANCE INDUCED CMG MOMENT USAGE

This requirement shall be verified by analysis utilizing analytical models of the disturbance. This analysis shall consist of calculating the angular momentum impulse for each axis due to individual payload on–board disturbances and applying them in the specified equation for estimating worst case CMG momentum usage. The disturbance angular momentum impulse will normally be calculated as the integral of the disturbance torque relative to the ISS Assembly Complete center of mass over the specified period of time. For constant, continuously increasing, or continuously decreasing disturbance torques over two or more adjacent 110 minute periods, the difference in angular momentum impulse of the adjacent 110 minute periods should be used. ISS assembly complete mass properties and worst case element location/design parameters (location and orientation producing the greatest H impulse vector with respect to the requirement of Table 3.1.2.6–2) should be used when assessing compliance with this requirement. The verification shall be considered successful when analysis shows that the estimated worst case CMG momentum usage is less than the specified amount. IRN 0002

4.3.1.3 STOWAGE

Information only. No verification required.

4.3.2 ELECTRICAL INTERFACE REQUIREMENTS

NVR

Input voltage shall be 113 Vdc and 126 Vdc with the Interface C source impedance, as specified in SSP 30482, Volume I.

Verification of compatibility with the specified Transient Voltages shall be performed by test or analysis of EPCE operation across the transient envelope as specified in Figure 3.2.1.3.2–1 of this document.

The verification shall be considered successful when the test or analysis shows the EPCE is compatible with the EPS transient voltage characteristics as specified in Figure 3.2.1.3.2–1.

4.3.2.1.3.3 FAULT CLEARING AND PROTECTION

Fault Clearing and Protection shall be verified by analysis.

The verification shall be considered successful when analysis shows the integrated rack at Interface B and EPCE at Interface C does not produce an unsafe condition or one that could result in damage to ISS equipment or payload hardware from the EPS transient voltages as specified in Figure 3.2.1.3.3–1 of this document.

4.3.2.1.3.4 NON-NORMAL VOLTAGE RANGE

The following verification requirements are applicable to paragraph 3.2.1.3.4A and B.

Verification of compatibility with Non-Normal voltage range conditions shall be performed by analysis. The analysis shall ensure the integrated rack or EPCE will not produce an unsafe condition or one that could result in damage to ISS equipment external to the integrated rack or EPCE when parameters are as specified in paragraph 3.2.1.3.4. The analysis should be performed with all converters directly downstream of Interface B or Interface C.

The verification shall be considered successful when analysis shows the integrated rack or EPCE is safe within ISS interface conditions as defined in paragraph 3.2.1.3.4.

4.3.2.1.4 DELETE

4.3.2.2 ELECTRICAL POWER INTERFACE

NVR

4.3.2.2.1 UIP, UOP AND SUP CONNECTORS AND PIN ASSIGNMENTS IRN 0002

A. NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

B. Verification of P1 and P2 appropriate pin assignment shall be by inspection. The inspection shall be an inspection of payload drawings to verify that the P1 and P2 pinouts match the corresponding J1 and J2 pinouts. The verification shall be considered successful when the inspection shows that the P1 and P2 connector pinout is appropriate.

C. Verification of the P1 and P2 connector with the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P1 and P2 connectors.

D. NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

E. Verification of P3 and P4 appropriate pin assignment shall be by inspection. The inspection shall be an inspection of payload drawings to verify that the P3 and P4 pinouts match the corresponding J3 and J4 pinouts. The verification shall be considered successful when the inspection shows that the P3 and P4 connector pinout is appropriate.

F. Verification of the P3 and P4 connectors with the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P3 and P4 connectors. IRN 0002

IRN 0002

G. NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1

H. Verification of P1, P2 and P3 pin assignment shall be by inspection. The inspection shall be an inspection of payload drawings to verify that the P1, P2 and P3 pinouts match the corresponding J1, J2 and J3 pinouts. The verification shall be considered successful when the inspection shows that the P1, P2 and P3 connector pinouts are compatible with J1, J2 and J3 pinouts.

I. Verification of the P1, P2 and P3 connectors with the requirements of SSQ 21635 shall be by inspection. The inspection shall consist of an inspection of the drawings to identify that the SSQ 21635 requirement is identified on the drawing for the P1, P2 and P3 connectors.

4.3.2.2.2 POWER BUS ISOLATION

A. Verification of Power Bus Isolation between two independent ISS Power Buses as specified, shall be performed by analysis. The verification shall be considered successful when the analysis shows the integrated rack, with a source voltage of + 126 Vdc, and its internal and external EPCE provides a minimum of 1–megohm isolation in parallel with not more than 0.03 microfarads of mutual capacitance between the two independent power buses including both the supply and return lines.

B. Verification of Power Bus Isolation without the use of diodes shall be verified by analysis. The analysis shall show the exclusion of diodes used to isolate the two independent ISS power bus high side or return lines. The verification shall be considered successful when analysis shows there are no diodes used, to electrically tie together independent ISS power bus high side or return lines, within the integrated rack and its internal and external EPCE.

4.3.2.2.3 COMPATIBILITY WITH SOFT START/STOP RPC

Compatibility with Soft Start/Stop RPC(s) shall be verified by test.

Verification of initialization with soft start/stop performance characteristics shall be performed by test when the initial supply of power is provided to the equipment connected to the RPC(s). Input power to the payload EPCE shall be delivered through a PRCU or equivalent. The EPCE connected to interface B or C shall be operated with multiple load combinations at levels ranging from 0% to 100% of the RPC rated conductivity.

The verification shall be considered successful when test shows the EPCE can initialize operation and prove compatibility with the soft start/stop RPC characteristics, representative of Figure 3.2.2.3–1, as specified in paragraph 3.2.2.3.

4.3.2.2.4 SURGE CURRENT

Surge Current shall be verified by test and analysis.

Input power to the integrated rack or EPCE should be representative of the ISS power environment.

Verification of compatibility with Surge Current limits shall be performed by test at high and low input voltage values as specified. The power source used to perform the test shall be capable of providing a range of power between 0 kW to 6 kW at 116–126 Vdc for Interface B connected equipment and 0 kW to 1.44 kW at 113–126 Vdc for Interface C connected equipment. The EPCE shall be operated under selected loading conditions that envelope operational loading. The analysis shall be performed using test data from the above test. The analysis shall indicate operability and compatibility exist based on test data and the requirements specified in paragraph 3.2.2.4. IRN 0002

The verification shall be considered successful when test and analysis shows under high and low voltage conditions the EPCE can perform all functional capabilities and prove compatibility by operating within the specified limits of paragraph 3.2.2.4. IRN 0002

4.3.2.2.5 REVERSE CURRENT

Reverse Energy/Current shall be verified by analysis.

Input power to the integrated rack or EPCE should be representative of the ISS power environment.

Verification of compatibility with Reverse Energy/Current limits shall be performed by analysis at 6 kW, 3 kW or 1.44 kW values corresponding to the integrated rack or EPCE design. The power source used to perform the analysis shall be capable of providing a range of power between 0 kW to 6 kW at 116–126 Vdc for Interface B connected equipment and 0 kW to 1.44 kW at 113–126 Vdc for Interface C connected equipment. The EPCE shall be analyzed under selected loading conditions that envelope operational loading.

The verification will be considered successful when analysis shows that the integrated rack or EPCE complies with requirements defined in Table NO TAG for the reverse energy/current into the upstream power source. Also, when the reverse energy or the reverse current requirement for all environmental conditions specified in this document when powered from a voltage source

[Note: This paragraph is continued on page 4–15, as a result of the IRN pagination, and to prevent multiple page changes. The paragraph will be merged together when the document is revised.]

4.3.2.2.7.1 INTERFACE B

The following verification requirements apply to paragraph 3.2.2.7.1A and B.

Integrated rack complex load impedance(s) shall be verified by test. *

* Verification may be performed by the PRCU or equivalent only if the PRCU or equivalent meets SSP 30482 Volume 1, Rev. C, source impedance requirements.

All active converters directly downstream of interface B shall be qualification or flight hardware. Loading of the downstream converter(s) can be simulated to provide full range of active converter loading.

Load impedance shall be tested under conditions of high and low voltage to the integrated rack and with these conditions for the active converters directly downstream shall be exercised through the complete range of their loading. Selected combinations of converters that can influence the measured load impedance at Interface B shall be tested. IRN 0002

The verification shall be considered successful when the test shows that all load impedances measured for high and low voltage conditions remain within specified limits. IRN 0002

4.3.2.2.7.2 INTERFACE C

EPCE complex load impedance(s) shall be verified by test. *

* Verification may be performed by the PRCU or equivalent only if the PRCU or equivalent meets SSP 30482 Volume 1, Rev. C, source impedance requirements.

All active converters directly downstream of interface B shall be qualification or flight hardware. Loading of the downstream converter(s) can be simulated to provide full range of active converter loading.

Load impedance shall be tested under conditions of high and low voltage to the integrated rack and with these conditions for the active converters directly downstream shall be exercised through the complete range of their loading. Selected combinations of converters that can influence the measured load impedance at Interface B shall be tested. IRN 0002

The verification shall be considered successful when the test shows that all load impedances measured for high and low voltage remain within specified limits. IRN 0002

4.3.5.1.17 DELETED

IRN 0002

4.3.6 VACUUM SYSTEM REQUIREMENTS

4.3.6.1 VACUUM EXHAUST SYSTEM REQUIREMENTS

4.3.6.1.1 VES PHYSICAL INTERFACE

NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

4.3.6.1.2 INPUT PRESSURE LIMIT

A. Integrated rack vented gas pressure shall be verified by test and analysis. The test shall utilize a PRCU or equivalent to measure the vented gas pressure at the interface plane. The integrated rack volumes that are connected to ISS VES/WGS shall be pressurized to the expected experiment pressures for the test.

B. The MDP of integrated rack volumes connected to the VES shall be verified by the test and analysis guidelines identified in SSP 52005, paragraph 5.1.3.

C. An analysis shall determine whether or not the payload system (including the experiment chamber) connected to the ISS VES/WGS system provides a two fault tolerant design to prevent venting gases at pressures greater than 276 kPa (40 psia) at the rack to station interface. Verification shall be considered successful when the analysis shows the payload system provides a two fault tolerant design to prevent venting gases to the ISS VES/WGS system at pressures greater than 276 kPa (40 psia) at the rack to station interface.

4.3.6.1.3 INPUT TEMPERATURE LIMIT

A. Integrated rack temperature shall be verified by test. The test shall utilize a PRCU or equivalent to measure the temperature at the interface plane. The integrated rack volumes that are connected to VES shall be pressurized to the expected pressures for the test. The experiment shall be subjected to the same heat generating operations that will be experienced on-orbit and vented at the same relative time during the experiment operation as would be experienced on-orbit.

C. An analysis shall determine whether or not the payload system (including the experiment chamber) connected to the ISS VRS/VVS system provides a two fault tolerant design to prevent venting gases at pressures greater than 276 kPa (40 psia) at the rack to station interface. Verification shall be considered successful when the analysis shows the payload system provides a two fault tolerant design to prevent venting gases to the ISS VRS/VVS system at pressures greater than 276 kPa (40 psia) at the rack to station interface.

4.3.6.2.3 VRS THROUGH-PUT LIMIT

The throughput to the VRS shall be verified by the test. The test shall utilize a PRCU or equivalent to measure the vented gas throughput at the interface plane.

4.3.6.2.4 ACCEPTABLE EXHAUST GASES

NVR

4.3.7 PRESSURIZED GASES INTERFACE REQUIREMENTS IRN 0002

4.3.7.1 NITROGEN INTERFACE REQUIREMENTS

4.3.7.1.1 NITROGEN INTERFACE CONTROL

A. Verification of nitrogen on and off flow control shall be by test. The verification shall be considered successful when the test results confirm that the integrated rack valve can turn on and off the flow of nitrogen. IRN 0002

B. Verification of nitrogen flow rate control shall be by test. The verification shall be considered successful when the test results confirm the integrated rack can control the flow to not exceed the maximum allowable nitrogen flow rate when connected to nitrogen supplied at the maximum and minimum of the specified pressure range.

4.3.7.1.2 NITROGEN INTERFACE MDP

The MDP of integrated rack volumes connected to the Nitrogen system shall be verified by test and analysis guidelines identified in SSP 52005, paragraphs 3.3.1, 3.3.1.1, 5.1.3, 5.3.2.2, 6.2.3, 6.2.4 and 7.4. The verification shall be considered successful if the test and analysis results show that the integrated rack can meet or exceed the requirements in SSP 52005. IRN 0002

4.3.7.1.3 NITROGEN INTERFACE TEMPERATURE

Verification that the integrated rack nitrogen system is compatible with the nitrogen interface temperature range shall be by test or analysis or both. The verification shall be considered successful when review of nitrogen system components, including component qualification data pack or test results, show that the integrated rack nitrogen system is compatible with the nitrogen temperature range specified.

4.3.7.1.4 NITROGEN LEAKAGE

Verification of integrated rack nitrogen leakage at MDP shall be by test at MDP or by test at MEOP and analysis to MDP. The verification shall be considered successful when the test or test and analysis results show that the leakage sources from the standoff UIP panel connection to the point to nitrogen on/off flow control in the integrated rack does not exceed the allowable leakage rate at MDP. IRN 0002

4.3.7.1.5 NITROGEN PHYSICAL INTERFACE

NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

4.3.7.2 ARGON INTERFACE REQUIREMENTS IRN 0002

4.3.7.2.1 ARGON INTERFACE CONTROL

A. Verification of argon on and off flow control shall be by test. The verification shall be considered successful when the test results confirm that the integrated rack valve can turn on and off the flow of argon. IRN 0002

B. Verification of argon flow rate control shall be by test. The verification shall be considered successful when the test results confirm the integrated rack can control the flow to not exceed the maximum allowable argon flow rate when connected to argon supplied at the maximum and minimum of the specified pressure range.

4.3.7.2.2 ARGON INTERFACE MDP

The MDP of integrated rack volumes connected to the Argon system shall be verified by test and analysis per the guidelines identified in SSP 52005, paragraphs 3.3.1, 3.3.1.1, 5.1.3, 5.3.2.2, 6.2.3, 6.2.4 and 7.4. The verification shall be considered successful if the test and analysis results show that the integrated rack can meet or exceed the requirements in SSP 52005. IRN 0002

4.3.7.2.3 ARGON INTERFACE TEMPERATURE

Verification that the integrated rack argon system is compatible with the argon interface temperature range shall be by test or analysis or both. Verification shall be considered successful when review of the argon system components, including component qualification data packs, or test results, show that the integrated rack argon system is compatible with the argon temperature range specified.

4.3.7.2.4 ARGON LEAKAGE

Verification of integrated rack argon leakage at MDP shall be by test at MDP or by test at MEOP and analysis to MDP. Verification shall be considered successful when the test or test and analysis results show that the leakage sources from the standoff UIP panel connection to the argon on/off flow control in the integrated rack does not exceed the allowable leakage rate at MDP. IRN 0002

4.3.7.2.5 ARGON PHYSICAL INTERFACE

NVR. Physical mating verification requirements are specified in Section 4.3.1.1.6.1.

4.3.7.3 CARBON DIOXIDE INTERFACE REQUIREMENTS IRN 0002

4.3.7.3.1 CARBON DIOXIDE INTERFACE CONTROL

A. Verification of carbon dioxide on and off flow control shall be by test. The verification shall be considered successful when the test results confirm that the integrated rack can turn on and off the flow of carbon dioxide. IRN 0002

B. Verification of carbon dioxide flow rate control shall be by test. The verification shall be considered successful when the test results confirm that the integrated rack can control the flow to not exceed the maximum allowable carbon dioxide flow rate when connected to carbon dioxide supplied at the maximum and minimum of the specified pressure range.

4.3.7.3.2 CARBON DIOXIDE INTERFACE MDP

The MDP of integrated rack volumes connected to the Carbon Dioxide system shall be verified by test and analysis per the guidelines identified in SSP 52005, paragraphs 3.3.1, 3.3.1.1, 5.1.3, 5.3.2.2, 6.2.3, 6.2.4 and 7.4. The verification shall be considered successful if the test and analysis results show that the integrated rack can meet or exceed the requirements in SSP 52005. IRN 0002

4.3.7.3.3 CARBON DIOXIDE INTERFACE TEMPERATURE

Verification that the integrated rack carbon dioxide system is compatible with the carbon dioxide interface temperature range shall be by test or analysis or both. The verification shall be considered successful when review of carbon dioxide system components, including qualification data packs, test results, show that the integrated rack carbon dioxide system is compatible with the carbon dioxide temperature range specified.

4.3.7.3.4 CARBON DIOXIDE LEAKAGE

Verification of integrated rack carbon dioxide leakage at MDP shall be by test at MDP or by test at MEOP and analysis to MDP. The verification shall be considered successful when the test or test and analysis results show that the leakage sources from the standoff UIP panel connection to the point to the carbon dioxide on/off flow control in the integrated rack does not exceed the allowable leakage rate at MDP. IRN 0002

4.3.7.3.5 CARBON DIOXIDE PHYSICAL INTERFACE

NVR. Physical mating verification requirements are specified in Section 4.3.1.1.6.1.

4.3.7.4 HELIUM INTERFACE REQUIREMENTS IRN 0002

4.3.7.4.1 HELIUM INTERFACE CONTROL

A. Verification of helium on and off flow control shall be by test. The verification shall be considered successful when the test results confirm that the integrated rack valve can turn on and off the flow of helium. IRN 0002

B. Verification of helium flow rate control shall be by test. The verification shall be considered successful when the test results confirm that the integrated rack can control the flow to not exceed the maximum allowable helium flow rate when connected to helium supplied at the maximum and minimum of the specified pressure range.

4.3.7.4.2 HELIUM INTERFACE MDP

The MDP of integrated rack volumes connected to the Helium system shall be verified by test and analysis per the guidelines identified in SSP 52005, paragraphs 3.3.1, 3.3.1.1, 5.1.3 5.3.2.2, 6.2.3, 6.2.4 and 7.4. The verification shall be considered successful if the test and analysis results show the integrated rack can meet or exceed the requirements in SSP 52005. IRN 0002

4.3.7.4.3 HELIUM INTERFACE TEMPERATURE

Verification that the integrated rack helium system is compatible with the helium interface temperature range shall be by test or analysis or both. Verification shall be considered successful when review of helium system components, including component qualification data packs, test results, show that the integrated rack helium system is compatible with the helium temperature range specified.

4.3.7.4.4 HELIUM LEAKAGE

Verification of integrated rack helium leakage at MDP shall be by test at MDP or by test at MEOP and analysis to MDP. Verification shall be considered successful when the test or test and analysis results show that the leakage sources from the standoff UIP panel connection to the helium on/off flow control in the integrated rack does not exceed the allowable leakage rate specified at MDP. IRN 0002

4.3.7.4.5 HELIUM PHYSICAL INTERFACE

NVR. Physical mating verification requirements are specified in Section 4.3.1.1.6.1.

4.3.7.5 PRESSURIZED GAS SYSTEMS

Verification of the expanded volume and flow rate for pressurized gas systems shall be by analysis. The verification shall be considered successful when the analysis of the drawings shows that the expanded volume of the gas in the pressurized system is below the limiting volume specified. If the volume exceeds the limiting specified volume, then an analysis must be performed verifying that the flow rate after a single failure does not exceed the maximum allowable amount after release of the limiting expanded volume.

4.3.7.6 MANUAL VALVES

Verification that manual valves used to control the flow of pressurized gases are accessible without rack rotation shall be by inspection. Verification shall be considered successful when inspection of the flight article shows that the manual valve is accessible for manual operation without having to rotate the rack and that the clearance around the valves meets the requirements specified in paragraph 3.12.5.3. IRN 0002

4.3.8 PAYLOAD SUPPORT SERVICES INTERFACES VERIFICATION REQUIREMENTS

4.3.8.1 POTABLE WATER

NVR

4.3.8.1.1 POTABLE WATER INTERFACE CONNECTION

NVR. Physical mating verification requirements are specified in section 4.3.1.1.6.1.

4.3.8.1.2 POTABLE WATER INTERFACE PRESSURE

Verification that the payload-provided container, and all hoses, tubing, and connectors used with the ISS potable water interface, do not leak when exposed to the ISS potable water interface pressure specified shall be by test. The verification shall be considered successful when the test shows that the container, and all hoses, tubing, and connectors used with the ISS potable water interface, do not visibly leak liquid water when pressurized to the maximum water pressure specified.

4.3.8.1.3 POTABLE WATER USE

A. Verification that the integrated rack use of water from the ISS water system that is not returned to the cabin air as humidity does not exceed the specified amount shall be by

[Note: This paragraph is continued on page 4–75 as a result of the A–page pagination and to prevent multiple page changes. The paragraph will be merged back together at the time of the next document revision.]

B. The payload drawer/tray contents will be verified by demonstration. The demonstration shall be performed on the flight hardware or hardware which replicates the flight hardware configuration. Verification shall be considered successful when a demonstration shows that the restrained payload drawer/tray contents (including the restraints mentioned in 4.3.12.6.1, A) do not jam the drawer when the drawer is opened or closed.

C. The restraints for the payload drawer/tray contents shall be verified by demonstration. The demonstration shall be performed on the flight hardware or hardware which replicates the flight hardware configuration. The verification shall be considered successful when the demonstration shows that the contents of the payload drawer/tray can be removed and/or replaced without using a tool.

4.3.12.6.2 STOWAGE AND EQUIPMENT DRAWERS/TRAYS

A. Verification of stowage equipment drawers/trays shall be done by inspection. Verification shall be considered successful when an inspection of the payload flight hardware drawings shows that all latches, handles, and operating mechanisms are designed to be latched/unlatched and opened/closed with one hand by the 95th percentile American male and accommodate the 5th percentile female.

B. Verification of stowage and equipment drawers/trays shall be done by inspection. Verification shall be considered successful when an inspection shows that latches shall be such that their status can be determined through visual inspection.

4.3.12.6.3 CAPTIVE PARTS

Captive parts shall be verified by inspection. Verification shall be considered successful when an inspection shows that all unrestrained parts that are temporarily removed on orbit are held captive.

4.3.12.6.4 HANDLE AND GRASP AREA DESIGN REQUIREMENTS

4.3.12.6.4.1 HANDLES AND RESTRAINTS

Verification of portable equipment grasp capability shall be by demonstration or inspection. The demonstration shall utilize personnel with hand dimensions within 10% of Table 3.12.6.4.1–1 to demonstrate sufficient grasp capability is provided for the 5th percentile Japanese female and 95th percentile American male. The inspection shall utilize drawings to verify that a handle or other suitable grasp area is provided for portable equipment. The demonstration or inspection shall be considered successful when it is shown that the portable equipment can be grasped by both 5th percentile Japanese female and 95th percentile American male personnel using one hand, and the item is larger than 1 ft^3.

IRN 0002

IRN 0002

4.3.12.6.4.2 DELETED

4.3.12.6.4.3 HANDLE LOCATION/FRONT ACCESS

Handle location and access requirements shall be verified by inspection of the integrated rack drawings. Verification shall be considered successful when inspection of the flight hardware confirms compliance with the requirement.

4.3.12.6.4.4 HANDLE DIMENSIONS

IVA handle dimensions for moveable or portable units shall be verified by analysis or demonstration. The verification shall be considered successful when demonstration of the flight hardware confirms compliance with the requirements.

4.3.12.6.4.5 NON-FIXED HANDLES DESIGN REQUIREMENTS

A. Nonfixed handle stop position shall be verified by analysis and demonstration. The verification shall be considered successful when demonstration of the flight hardware confirms compliance with the requirement.

B. Verification of one-handed operation shall be done by demonstration. The verification shall be considered successful when demonstration of this requirement is met.

C. The incorporation of tactile and/or visual indication of locked/unlocked status shall be verified by inspection and demonstration. The verification shall be considered successful when demonstration of the flight hardware confirms compliance with the requirement.

4.3.12.7 IDENTIFICATION LABELING

Labels on integrated racks, all (installed in the rack or separately) sub–rack elements, loose equipment, consumables, ORUs, crew accessible connectors and cables, switches, indicators, and controls shall be verified by inspection. The inspection shall be of the IPLAT approval documentation. The verification shall be considered successful when integrated racks, all sub–rack elements, loose equipment, consumables, ORUs, (installed in the rack or separately); crew accessible connectors and cables, switches, indicators, and controls have been shown to have IPLAT approved labels. The instructions for IPLAT to follow in granting approval of labels are located in Appendix C.

IRN 0002
IRN 0002
IRN 0002

APPENDIX A ABBREVIATIONS AND ACRONYMS

AC	Alternating Current
AIT	Analysis and Integration Team
APM	Attached Pressurized Module
APS	Automated Payload Switch
ANCP	Acoustics Noise Control Plan
ARIS	Active Rack Isolation System
ASI	Italian Space Agency IRN 0005
BPDU	Bitstream Protocol Data Unit
C	Centigrade
cc	cubic centimeters
cm	Centimeter
C&DH	Command & Data Handling
CCSDS	Consultative Committee for Space Data Systems
C&T	Communications & Tracking
C&W	Caution and Warning
CAM	Centrifuge Accommodations Module
CMG	Control Moment Gyroscope IRN 0002
COF	Columbus Orbiting Facility
COTS	Commercial Off The Shelf
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
CVIU	Common Video Interface Unit
DEAP	Dryden Early Access Platform
dB	deciBel
dBs	deciBels

IRE	Institute of Radio Engineers	
ISO	International Standards Organization	
ISPR	International Standard Payload Rack	
ISS	International Space Station	
ISSP	International Space Station Program	IRN 0005
ITCS	Internal Thermal Control System	
IVA	Intravehicular Activity	
JEM	Japanese Experiment Module	
kg	kilograms	
kHz	kiloHertz	
kPa	kiloPascal	
KSC	Kennedy Space Center	
kW	kiloWatt	
LAN	Local Area Network	
lbm	pounds mass	
LED	Light Emitting Diode	
LISN	Line Impedance Simulation Network	
LLC	Logical Layer Control	
LRDL	Low Rate Data Link	
mA	milliAmperes	
MATE III	Multiplexer/Demultiplexer Applications Test Environment	IRN 0005
Mbps	MegaBytes per second	
MDM	Multiplexer–Demultiplexer	
MDP	Maximum Design Pressure	
MEOP	Maximum Expected Operating Pressure	IRN 0002
MIL–STD	Military Standard	

APPENDIX C INSTRUCTIONS FOR LABELS AND DECALS

TABLE OF CONTENTS

PARAGRAPH		PAGE
C.1	INTRODUCTION	C – 3
C.2	ISS PAYLOAD LABEL APPROVAL PROCESS	C – 3
C.3	IPLAT APPROVAL INSTRUCTIONS	C – 4
C.3.1	GROUND ASSEMBLY AND HANDLING	C – 6
C.3.2	FUNCTION CONSIDERATIONS	C – 6
C.3.3	PAYLOAD ORIENTATION	C – 6
C.3.4	DELETED (MOVED TO C.3.5.4.1)	C – 6
C.3.5	LABELING DESIGN	C – 6
C.3.5.1	LABELING STANDARDIZATION	C – 6
C.3.5.2	READABILITY	C – 8
C.3.5.3	LABEL PLACEMENT	C – 9
C.3.5.4	EQUIPMENT LABELING	C – 15
C.3.5.4.1	EQUIPMENT IDENTIFICATION	C – 15
C.3.5.4.2	EQUIPMENT CODING	C – 16
C.3.5.4.2.1	UTILITY CODING	C – 16
C.3.5.4.2.2	COLOR CODING	C – 19
C.3.5.4.2.3	LOCATION AND ORIENTATION CODING	C – 21
C.3.5.5	DELETED	C – 22
C.3.5.6	OPERATING INSTRUCTION LABELS	C – 22
C.3.5.7	STOWAGE CONTAINER LABELING	C – 23
C.3.5.8	GROUPED EQUIPMENT ITEMS	C – 26
C.3.5.9	CAUTION AND WARNING LABELS	C – 27
C.3.5.10	ALPHANUMERIC	C – 29
C.3.5.10.1	FONT STYLE	C – 29
C.3.5.10.2	PUNCTUATION	C – 30
C.3.5.10.3	SPECIAL CHARACTER	C – 30
C.3.5.10.4	CHARACTER HEIGHT	C – 31
C.3.5.10.5	CHARACTER WIDTH	C – 32
C.3.5.10.6	STROKE WIDTH	C – 32
C.3.5.10.7	CHARACTER MEASUREMENT	C – 32
C.3.5.10.8	SPACE	C – 33
C.3.5.11	BAR CODING	C – 33
C.3.6	SCALE MARKING	C – 33
C.3.7	DELETED (MOVED TO C.3.6)	C – 35

IRN 0002

TABLES

TABLE		PAGE	
C.3.5.10.4–1	CHARACTER HEIGHT – 710 MM (28 IN) VIEWING DISTANCE	C – 31	IRN 0002

FIGURES

FIGURE		PAGE	
C.1–1	IPLAT PAYLOAD LABEL APPROVAL PROCESS	C – 5	IRN 0002
C.3.5.3–1	RACK LABEL PLACEMENT	C – 13	
C.3.5.3–2	CONTROL PANEL LABELING	C – 14	
C.3.5.3–3	MISCELLANEOUS LABEL PLACEMENT GUIDELINES	C – 15	
C.3.5.4.2.1–1	CABLE AND HOSE LABELING	C – 19	
C.3.5.6–1	OPERATING INSTRUCTION LABEL EXAMPLE	C – 23	
C.3.5.7–1	STANDARD PAYLOAD STOWAGE DRAWER LABELS	C – 25	
C.3.5.8–1	GROUPING LABEL EXAMPLES	C – 26	
C.3.5.9–1	CAUTION AND WARNING LABEL EXAMPLES	C – 29	

C.1 INTRODUCTION

The ISS Payload Label Approval Team (IPLAT) reviews and approves labels for all payload equipment that the crew will interface with during nominal operations, planned maintenance, and contingency operations. IPLAT does not approve Operations Nomenclature, procedures or displays. The Payload Operations Data File (PODF) group reviews and approves Operations Nomenclature and procedures. The Payload Display Review Panel (PDRP) reviews and approves all software displays. IPLAT, PODF and PDRP consult with one another regarding label issues that have implications for procedures and displays. IRN 0002

Appendix C provides the instructions for the approval of payload labels. The development of labels will be a joint process requiring the cooperative efforts of IPLAT and the PD. The process for developing labels, from the beginning to the delivery of flight certified labels which have been approved by the IPLAT, is documented in Figure C.1–1. IRN 0002 IRN 0002

To understand the priorities of the instructions, the following definitions need to be applied throughout Appendix C.

Statements with “must” will be used for instructions which are required to be met for IPLAT to provide approval. IRN 0002

Statements with “should” will be used for instructions which are incorporated into the label unless adequate justification is provided to IPLAT to warrant exempting the label instruction. IRN 0002

The term “label” used throughout these instructions refers to any one of the following:

- Silk–screened labels: Markings that are silk–screened, with ink, onto hardware.
- Decals: Peel–off labels with adhesive backing that are applied onto hardware.
- Ink–stamped labels: Markings, stamped with ink, onto the hardware.
- Engraved or Etched labels: Markings carved onto the hardware surface.
- Placards: Cards which are inserted into pockets.
- Any other method of applying markings onto hardware.

SSP 50005, International Space Station Flight Crew Integration Standard (NASA–STD–3000/T) was used as the basis for the payload labeling guidelines contained herein.

C.2 ISS PAYLOAD LABEL APPROVAL PROCESS

The PD is responsible for providing label drawings, label location drawings and information sufficient to enable IPLAT to determine the instructions herein are met. The PD will coordinate with IPLAT before submitting the label drawings for approval. IRN 0002

IPLAT is responsible for reviewing all payloads labels, providing guidance to the PD and granting approval based on the instructions herein. IPLAT is also responsible for performing a human engineering assessment of the labels and ensuring the labels are appropriate from a human engineering perspective, including commonality, standardization, and terminology. IRN 0002 IRN 0002

The process for obtaining approval of ISS payload labels is shown in Figure C.1–1. IPLAT performs two evaluations. The initial label evaluation is performed at approximately the I–16 timeframe. This supports the start of crew training at I–13.5. The PD submits pre–released engineering drawings to IPLAT. Less formal materials are acceptable for this first review if they contain enough information for IPLAT to perform the evaluation. Upon receiving the drawings, or other materials, IPLAT has 10 working days to complete the evaluation. IPLAT will return a checklist that documents any requirement violations, and suggested solutions. The PD will then update the label designs based on IPLAT's recommendations.

The final label evaluation is to be completed before I–7, enabling the payload to meet the I–7 deadline for final procedures review and baselining; followed by shipping of flight hardware to KSC by L–6. Before this final evaluation, the payload's Operations Nomenclature (OpNom), must be baselined. The PD submits released engineering drawings to IPLAT. IPLAT has 10 working days to complete this final evaluation. If the labels meet the requirements, IPLAT returns JSC Form 732, approved, to the PD. Form 732 is the PD's official verification that the labels meet the requirements, and should be included in the payload's verification record. If the labels still do not meet the requirements, the PD will correct the label design per IPLAT's recommendations.

The PTR is responsible for resolving issues and disagreements between the PD and IPLAT.

Once final approval has been granted via Form 732, the PD can manufacture labels, or order labels from the Decal Design and Production Facility (DDPF) via JSC Form 733.

C.3 IPLAT APPROVAL INSTRUCTIONS

IPLAT will use the following instructions in reviewing and providing the approval of payload labels.

IRN 0002

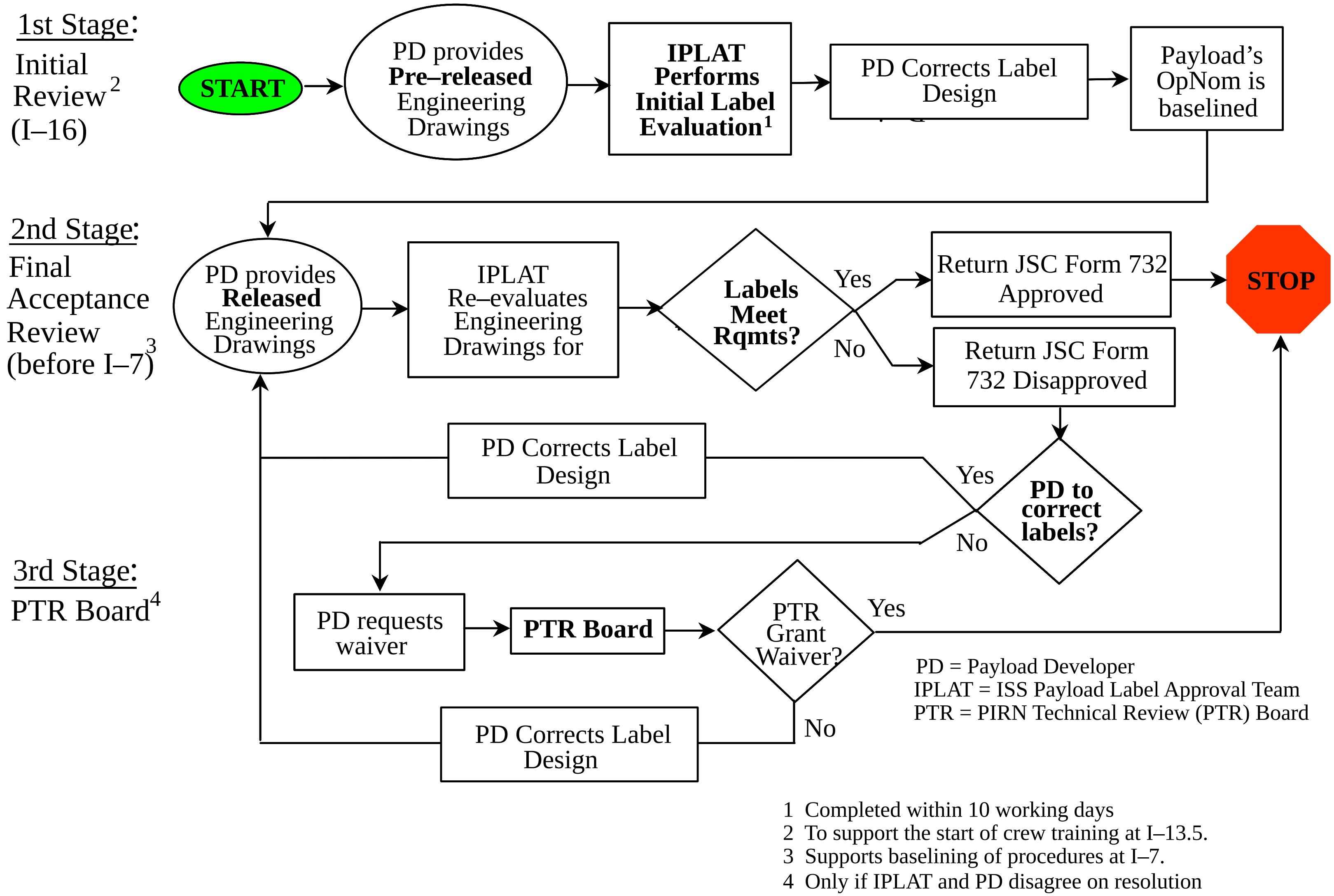


FIGURE C.1–1 IPLAT PAYLOAD LABEL APPROVAL PROCESS

C.3.1 GROUND ASSEMBLY AND HANDLING

Labels used for ground assembly and handling must not interfere with on–orbit crew interface labeling. Product marking for ground assembly and handling should be in accordance with MIL–STD–130, section 4, except paragraph 4.1.c. IRN 0002

C.3.2 FUNCTION CONSIDERATIONS

A. Decals and placards must contain information required by the user regarding the purpose, the function, and/or the functional result of the use of equipment items. Engineering characteristics or nomenclature may be described as a secondary consideration. IRN 0002

B. Instrument decals and placards, for example, should be labeled in terms of what is being measured or controlled. Calibration data may be included where applicable.

C.3.3 PAYLOAD ORIENTATION

A. Payload labeling, displays, and controls must have a consistent rack vertical orientation arrangement with the rack vertical axis origin at the bottom of the rack hinge point.

B. Payload labels required for operations with the rack(s) rotated should be oriented with respect to required crew positions.

C.3.4 DELETED (MOVED TO C.3.5.4.1)

C.3.5 LABELING DESIGN

C.3.5.1 LABELING STANDARDIZATION

A. Standard decals needed by the PD which are available in JSC 27260, Decal Process Document and Catalog must either be obtained from the Decal Design & Production Facility (DDPF) or designed to be identical to them. Examples of labels found in the catalog are: IMS, fire hole, toxicology, hazardous, caution and warning, rack power switch, fire indicators, cable/hose labels, etc. The DDPF is also available to the PDs for fabricating labels not found in JSC 27260. IRN 0002

B. Labeling must be standardized between and within systems. IRN 0002

C. Deleted IRN 0002

D. Operations Nomenclature (OpNom)

(1) Non–IMS Hardware Labels – Nomenclature on all non–IMS hardware labels must conform to the operational nomenclature guidelines for content (characters used) provided in SSP 50254, Operations Nomenclature. The format for these labels is upper case, as required in paragraph E below.

(2) IMS Labels – When nomenclature is used above the bar code of an IMS label:

(a) Such nomenclature must conform to SSP 50254 guidelines for both content and format (mixed case).

(b) Such nomenclature must match the nomenclature on the hardware label, except that IMS label test is in mixed case, and hardware label test is in upper case.

E. Label Text

(1) Upper Case – Labels for equipment, displays, controls, switch positions, connectors, cables/hoses, LEDs, stowage containers, etc., must be listed in upper case letters only. This includes abbreviations and acronyms.

(2) Payload Name Labels

(a) Spelling Out vs. Acronyms – The name label for the “main unit” of a payload must spell out the name, followed by the acronym in parentheses, even if the acronym is an approved OpNom. The OpNom acronyms may then be used on all subordinate equipment. For example: The rack for SRF should spell out “SCIENCE RESEARCH FACILITY (SRF)”. All subordinate equipment may then use the SRF acronym, like “SRF ANALYZER MODULE”.

(b) Font size for name labels – The font size for the name label of an item should not be less than 12 point.

(3) Title nomenclature must be consistent with procedural handbooks and checklists.

F. General To Specific Principle – More general, or important information should be placed above or to the left on a label(s). Increasingly more specific, or less important information should be placed lower or to the right, with the most specific, least important information on the bottom or furthest right.

G. Keypads – Non–COTS keypads on payloads should use mixed case (upper and lower case) letters.

C.3.5.2 READABILITY

A. Decals and placards should be as concise and direct as possible.

B. Abbreviations

(1) Deleted

(2) Periods should be omitted except when needed to preclude misinterpretation.

C. Decal and Placard Life

Payloads must provide labels that are readable for the duration of the payload's operation, which are replaceable.

D. Language

(1) Decals and placards must be written in the English language.

(2) If dual languages are used, English must be used first and with lettering at least 25% larger than the secondary language.

E. Decals and placards should be designed so as to minimize visual clutter.

F. Illumination – Labels and markings should be designed to be read at all general illumination levels and color characteristics of the illuminant as specified in Table 3.12.3.4–2.

G. Displays and Controls Title Selection

(1) Physical Hardware – When verbs are used to label physical hardware (buttons, switches, controls, etc.), the present tense should be used. For example: OPEN or CLOSE, BEGIN, or END, START or STOP, etc.

(2) Physical Hardware Linked to Software Displays – If physical hardware is linked to and/or represented by software displayed data or controls (i.e. LCD), the labels for the physical hardware and the software representation must use the same terminology.

C.3.5.3 LABEL PLACEMENT

A. All labels must be placed on the payload hardware in accordance to the label location drawings.

B. Payloads Operated From Rack Front Panels – Payloads operated from the front panel of racks must be labeled in accordance to Figure C.3.5.3–1.

(1) Rack IMS Label – The rack IMS label must be located on the top left corner of the rack. IRN 0002

(2) Rack Name Label

(a) The rack name label must be located to the right of the rack IMS label.

(b) The rack name label must spell out the name of the rack. The acronym, if applicable, should follow in parentheses. The acronym may then be used on all subordinate equipment.

(c) The font size of the rack name label should be the largest one for the entire rack, at 48 point font, minimum.

(3) Subrack IMS Label – The subrack IMS label must be located on the top left corner of the subrack drawer.

(4) Subrack Name Label

(a) The subrack name label must be located to the right of the subrack IMS label.

(b) The subrack name label must spell out the name of the subrack. The acronym, if applicable, should follow in parentheses. The acronym may then be used on all subordinate equipment. IRN 0002

1. If this subrack is part of a facility rack (i.e., HRF, MSG, FCF, etc.), and will never be relocated into another rack, then the subrack name label need not include the facility's acronym (e.g. "WORKSTATION", as opposed to "HRF WORKSTATION").

2. If there are several related subracks that are considered a "sub–facility", the first such subrack must spell out the name of the sub–facility. The remaining subracks may use the acronym if they are co–located and below this subrack. For example, in Figure C.3.5.3–1, MICROBIOLOGY FACILITY is the name of the sub–facility, and is spelled out on the first subrack (in location B2), with the acronym following in parentheses. The remaining subracks only use the acronym.

(c) The font size of the subrack name label should be smaller than the rack name label, between 28 and 36 point.

(5) Subrack location codes must be placed on the inside of the rack post in accordance to Figure C.3.5.3–1.

C. Payloads Not Operated From Rack Front Panels – This section applies to all self–contained payloads other than those controlled from front panels (mounted elsewhere, not on the face of a rack like subrack payloads). Examples: SAMS II Remote Triaxial Sensor System, HRF Phantom Torso and DOSMAP, etc. See Figure C.3.5.3–3. IRN 0002

(1) The IMS label should be placed in the upper left corner of the dominant face of the payload.

(2) Payload Name Label

(a) The payload name label should be placed to the right of the IMS label.

(b) The payload name label must spell out the name of the payload if it is considered the "main unit". The acronym, if applicable, should follow in parentheses. The acronym may then be used on all subordinate equipment.

(c) The font size of the payload Name label should be the largest one for the entire payload. IRN 0002

D. Loose Equipment

(1) The IMS label should be placed in the upper left corner (if there is one) of the dominant face of the item. If there is no upper left corner, place the IMS label either to the extreme left (see Example L of Figure C.3.5.3–3), or at the top of the dominant face.

(2) Name Label

(a) If the dominant face of the item is populated with controls, the name label should be placed immediately to the right, or below the IMS label. If the dominant face is blank (such as a binder or stowage bag, as in Example B of Figure C.3.5.3–3), then the name label should be placed in the center of the face.

(b) Small Items – In the case of very small equipment items, an IMS label with the equipment's name in the text portion above the bar code is sufficient to satisfy both the IMS and Name label requirements.

E. Control Panel Labels

(1) Positions – Labels must be centered above connectors, switches, LEDs, displays, controls, etc. Labels may be placed in other locations when they cannot dimensionally fit in the required location, or if they would be obstructed by items like cables and hoses, or to preclude misassocation with adjacent items.

(2) Size – Labels for controls on a panel should be smaller than the name label for the panel and should be between 10 and 20 point font. Different levels of controls should be graduated in size. For example, grouping label titles should be larger than the labels for the controls within them. Similar levels of controls should be the same size. See Figure C.3.5.3–2 for examples.

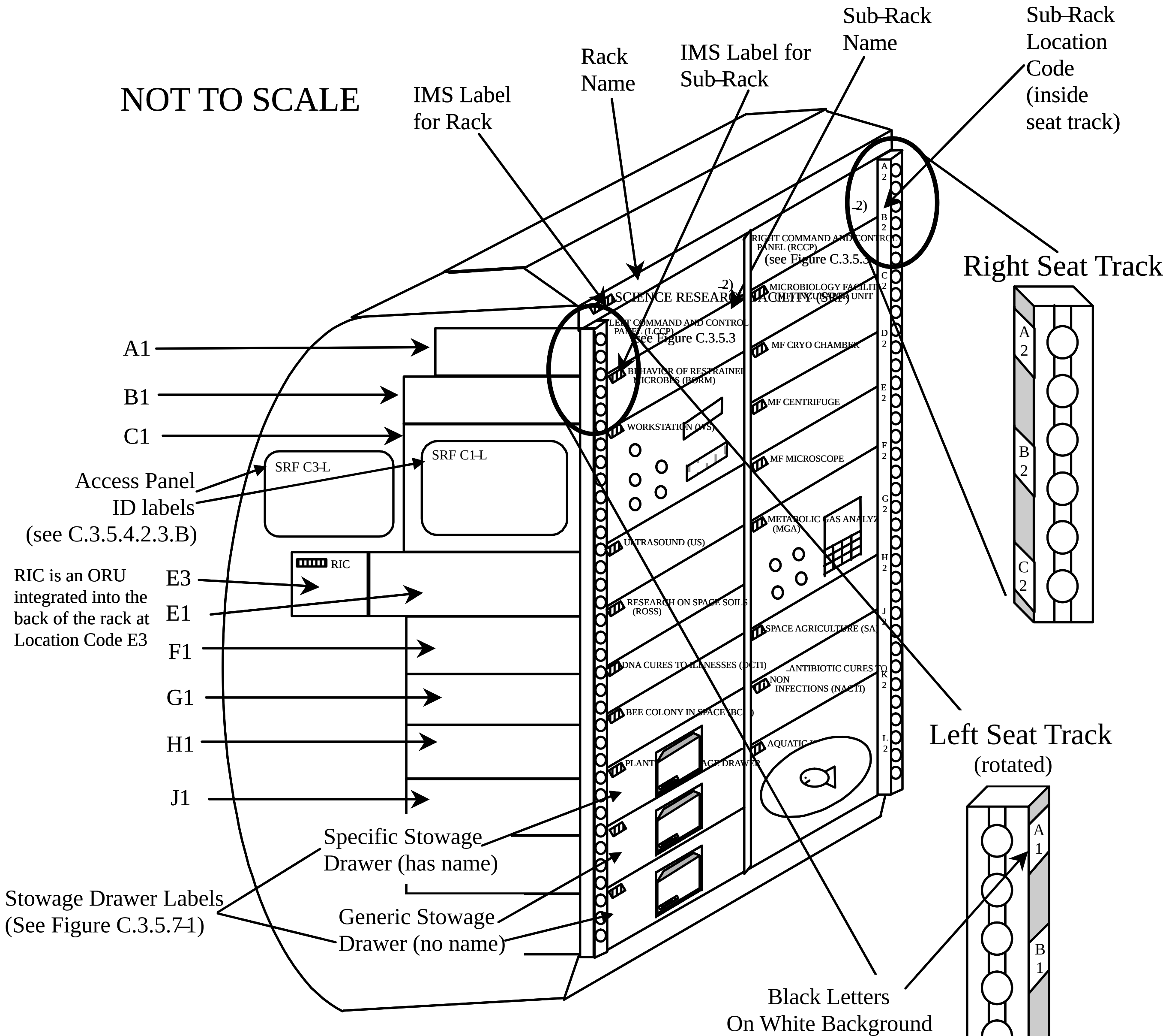
F. Part Number and Serial Number Labels – Part Number and Serial Number labels should be placed together for ease of identificaiton. The Part Numer label should be arranged to the left or above the Serial Number label. P/N and S/N, which are the standard OpNom representations of Part Number and Serial Number, respectively, should be used.

G. Orientation – All markings and labels must be oriented with respect to the local worksite plane so that they read from left to right. Vertical orientation, with letters arranged vertically if the text is short (e.g. DATA J3), or rotating the label 90 degrees when the text is long (e.g. PAYLOAD ELECTRONICS MODULE), is permissible when the marking or label does not fit in the required orientation. IRN 0002

H. Visibility – Labels must be placed on equipment so that they are visible when the equipment is used or accessed. Markings should be located such that they are perpendicular to the operator’s normal line of sight whenever feasible and should not be less than 45 degrees from the line of sight.

I. Association Errors – The arrangement of markings on panels should protect against errors of association of one marking or set of markings with adjacent ones.

IRN 0002



Rack IMS Label–Located on the top left corner of the rack.

Rack Name Label –Located to the right of the Rack IMS Label. Must be spelled out (48 point font minimum), with acronym following in parentheses. All subordinate equipment may then use the acronym.

Subrack IMS Label –Located on the top left corner of the subrack drawer.

Subrack Name Label –Located to the right of the Subrack IMS Label. Must be spelled out (between 28–36 point font) with acronym following in parentheses. All subordinate equipment may then use the acronym.

Subrack Location Codes–Located on the inside of the seat track. Letters A thru N, excluding I (18 point font). Letter/number pairs must be placed at intervals equal to the individual rack's smallest drawer unit (e.g. 4 PU (7 inches) for U.S. payloads, different for IP racks).

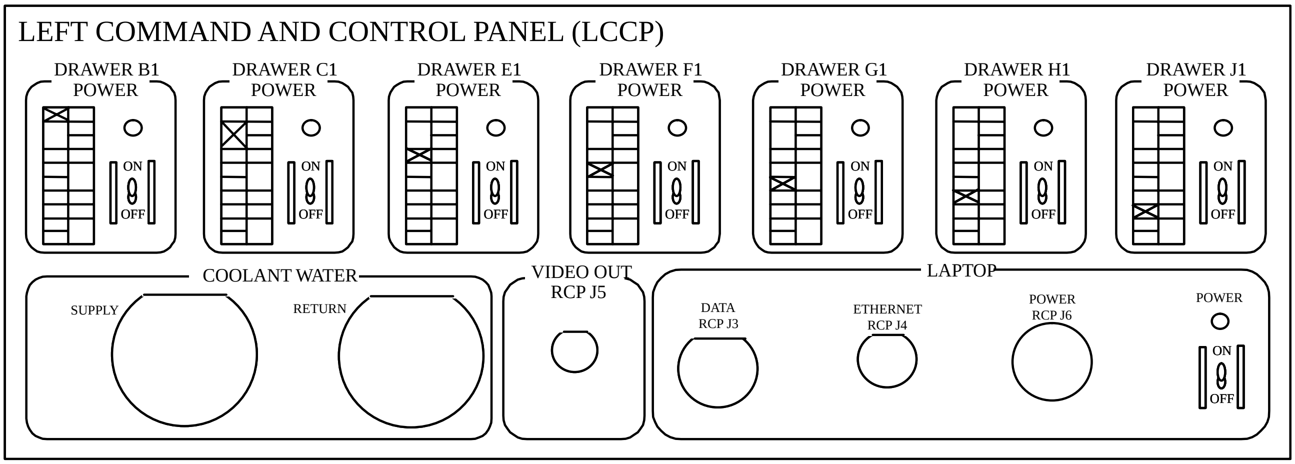
<u>Note</u> In above figure, MF is a sub–facility within SRF comprised of 4 subracks (B2 through E2). The name is spelled out on the first subrack. The acronym is then used on subsequent subracks.

FIGURE C.3.5.3–1 RACK LABEL PLACEMENT

IRN 0002

NOT TO SCALE

This panel is at the ”A1” postion in Figure C.3.5.3–1:



This panel is at the ”A2” position in Figure 3.5.3–1:

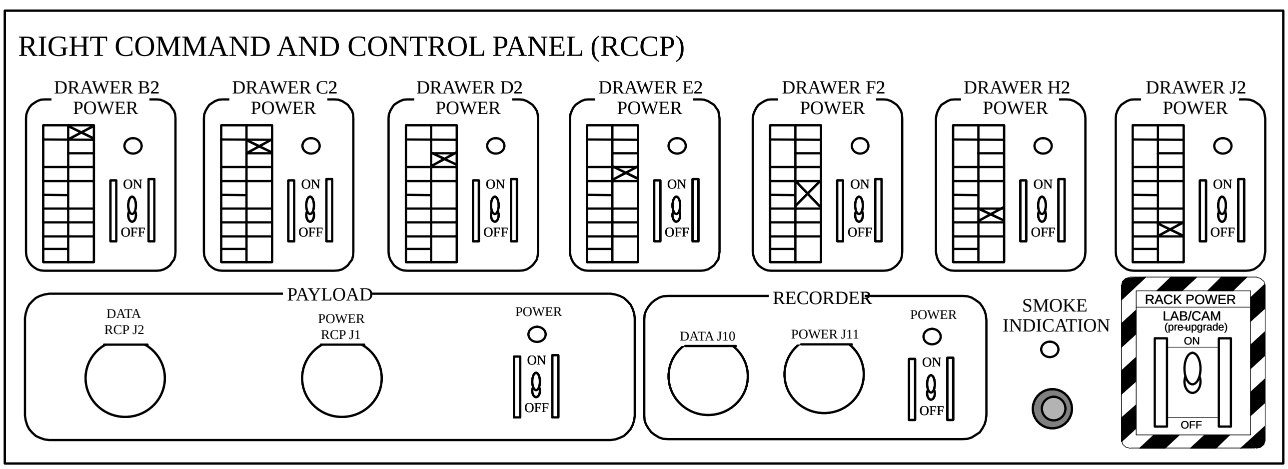


FIGURE C.3.5.3–2 CONTROL PANEL LABELING

IRN 0002

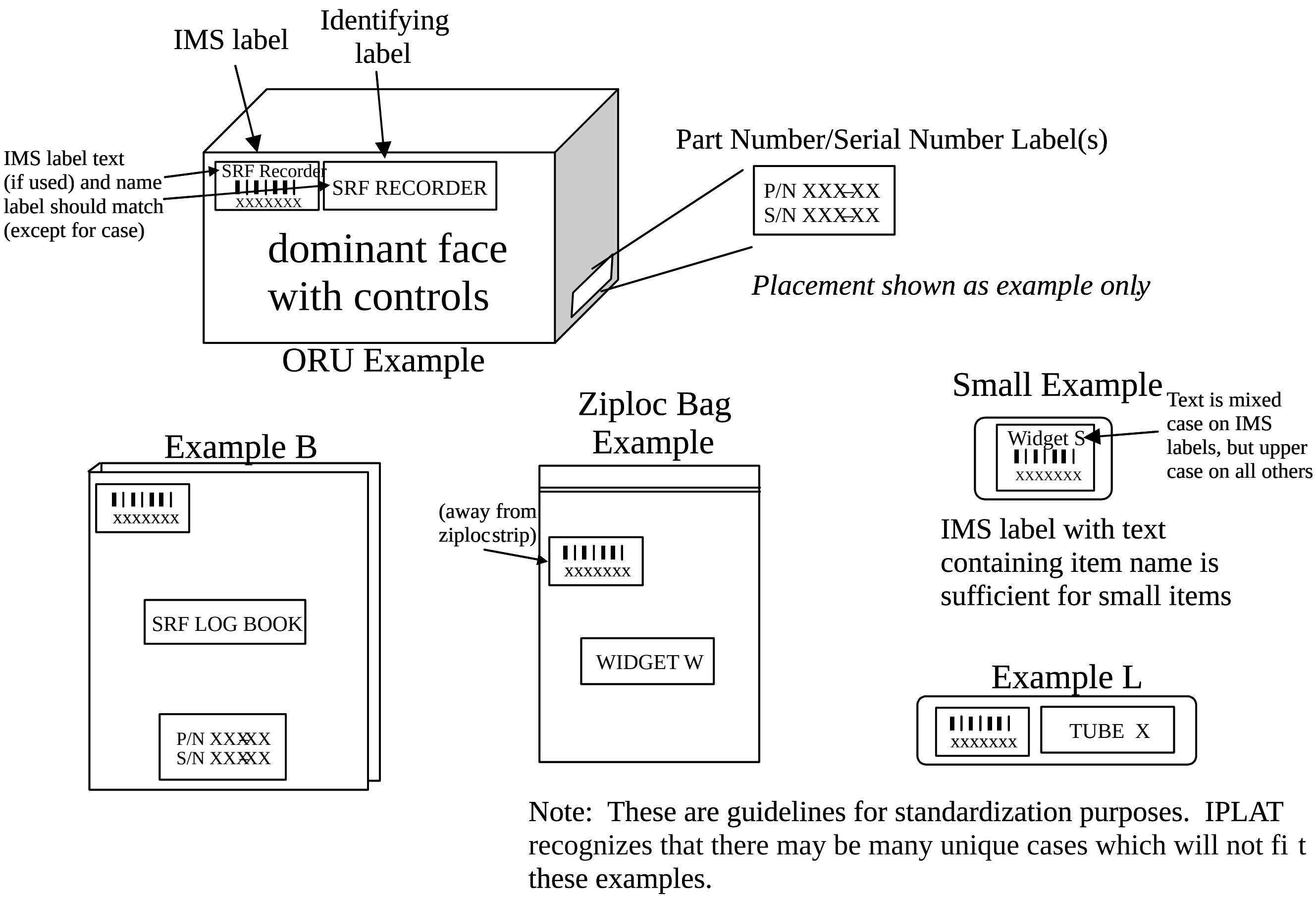


FIGURE C.3.5.3–3 MISCELLANEOUS LABEL PLACEMENT GUIDELINES

C.3.5.4 EQUIPMENT LABELING

C.3.5.4.1 EQUIPMENT IDENTIFICATION

A. All items on a payload must be identified with a label, including, but not limited to: displays, controls, switches, connectors, LEDs, containers, vents, etc., such that these items can be clearly referenced in crew procedures. Only those items whose use is obvious to the crew (e.g., food table, windows, etc.) are exempt from this instruction. The font size for these labels must be smaller than the main label naming the payload.

B. Containers must be labeled to identify their contents.

C. Loose equipment must be marked with nomenclature that describes the function of the item and its pertinent interfaces.

D. Multi–quantity Items

(1) Multi–quantity items that require individual distinction but are not serialized must be individually numbered. Control level items should be logically numbered/lettered left to right or top to bottom in descending order (e.g. “DRIVE A”, “DRIVE B”, “DRIVE C”). IRN 0002

(2) Serial Numbers – Multi–quantity items that are serialized should display the serial number as part of the identification.

(3) Containers containing multiple quantities of the same item should use a number in parentheses, after the name, to indicate the quantity (i.e. ”TEST TUBES (4)”, indicates there are four test tubes in the container).

E. Logos – If organizational or commercial logo(s) are used, they must not be distracting to the crew while operating the payload. For front panels, the size of a logo should be smaller than the main name label. IRN 0002

C.3.5.4.2 EQUIPMENT CODING

C.3.5.4.2.1 UTILITY CODING

IRN 0002

A. Crew Interface Cables and Hoses Definition – Electrical cables and hoses which are intended to be interfaced with by the crew for nominal operations (e.g. experiment operations), planned maintenance (e.g. ORU replacement), or are designed to have a crew interface in the event of a contingency situation, are considered “Crew Interface Cables and Hoses”, and are subject to the format requirements below.

B. Crew Interface Cables and Hoses must be labeled to indicate the equipment to which they belong and the connectors to which they mate.

(1) Electrical Cable end Plugs and Corresponding Electrical Connector Ports

(a) The cable end plug must be designated with a “P” (e.g. P1), regardless of gender.

(b) The connector port on the hardware must be designated with a “J”, regardless of gender, and should be preceded by a descriptive name (e.g. DATA J1 or POWER J2).

IRN 0002

(c) The plug number and receptacle number for a mating pair should be identical (e.g. P1 mates with J1), except when not possible because a cable is generic.

(2) Cable and Hose Label General Characteristics

(a) Font Size – The font size of the text on these labels should be 12 point preferred, or 10 point minimum.

(b) Text/Background Color – The text should be black on a white background.

(c) Abbreviations – When long names would result in an unreasonably large label, text can be abbreviated.

(d) Continuation Lines For Long names – Long names are discouraged, but if necessary, additional lines can be added to the cable/hose identification and ends labels described below.

(3) Cable and Hose Identifying Labels

(a) Cables and hoses must contain a main identifying label with the information below. This label must be placed at the mid–length position of the cable/hose, or at intervals not to exceed 2 meters for long utility lines. See Figure C.3.5.4.2.1–1 for examples.

- The name of the cable/hose. For a hose, if the pressure is known and constant, it should be indicated in parentheses after the name (e.g. psi). The flow direction should be indicated with an arrow below the name if the hose ends are not interchangeable.
- The Part Number of the cable or hose
- The Serial Number of the cable or hose (if applicable)

(4) Cable and Hose IMS Labels – A cable/hose must contain one (and only one) IMS label. It must be placed to the left of the main identifying label, at the mid–length position, as shown in Figure C.3.5.4.2.1–1. If the cable/hose requires mutliple main identifying labels spaced at 2 meter intervals per #3 above, the IMS label should be placed at the center of the line.

(5) Cable and Hose End Labels – Labels at the terminal ends of cables/hoses must contain the information below. Vertical order, center justified, is the preferred arrangement. When the circumference of the cable/hose is too small to accommodate a label that wraps around the line with text arranged vertically, a flag style label should be used. For cases where wear and tear of such flags is a concern (i.e. through frequent use), a horizontal arrangement of the information is allowed as long as the text is short. See Figure C.3.5.4.2.1–1 for cable/hose label examples. IRN 0002

– First Line: The name of this end of the cable/hose (e.g. for cables, P1). For a hose, if the end does not have a specific identifier, this line may be left off. If the hose end needs to have a unique identifier, do not use a “P” number (”P”s are reserved for cables).

– Second Line: The word “TO” followed by the name of the piece of equipment to which this end of the cable/hose mates with. If this end can interface to multiple connector ports (e.g. generic cables), this line may be left off.

– Third Line: The exact name of the receptacle on the hardware that this end of the cable/hose mates with (e.g. DATA J1 or OXYGEN OUT). If this end can interface to multiple connector ports (i.e. generic cables), this line may be left off.

(6) Hose Hazard Labels – Hoses must have standard hazard class decals indicating the appropriate hazard level for the substance transported through the hose. This label must be placed to the right of the identifying label.

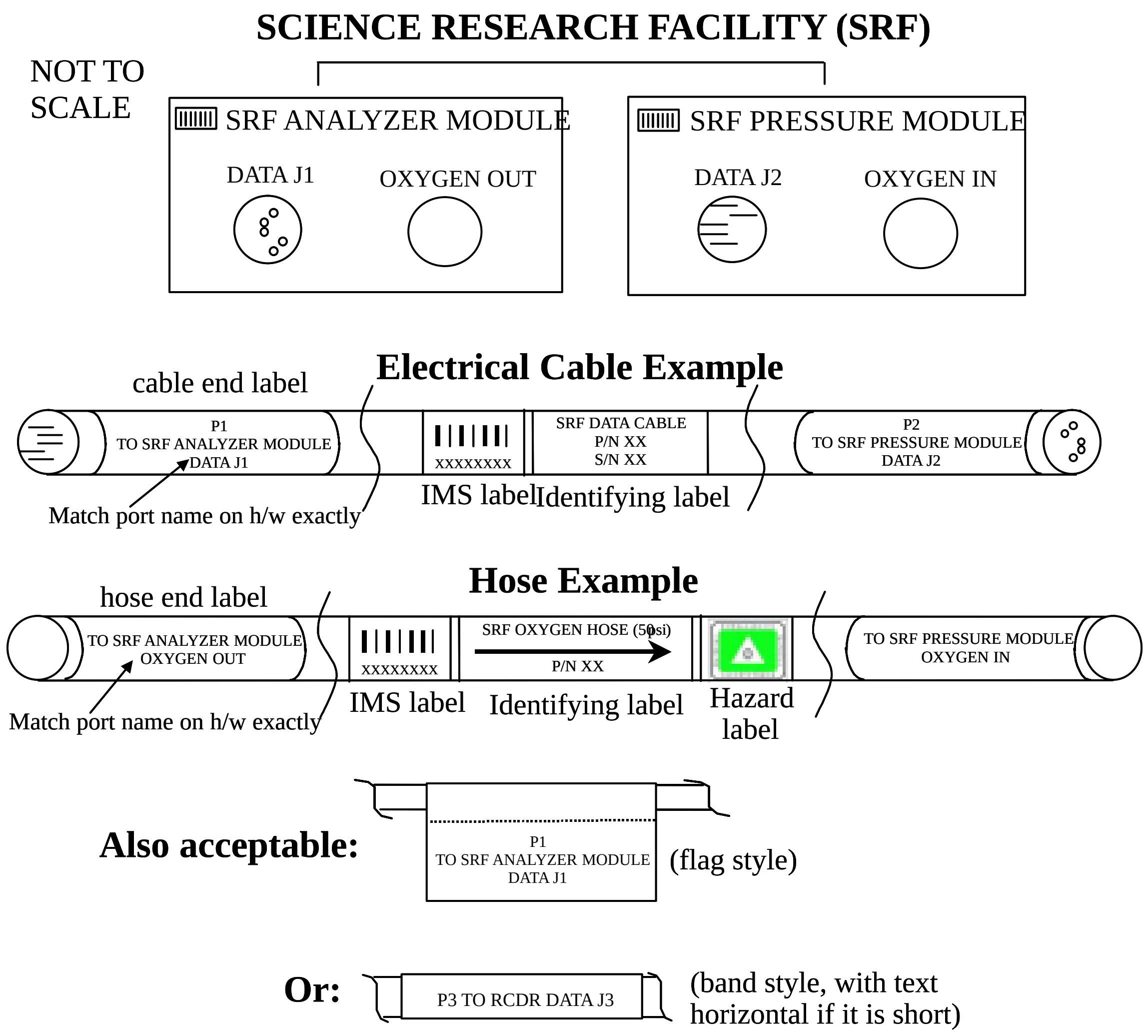
(7) Labels at the terminal ends of a payload utility line must contain the information below. Vertical order is the preferred arrangement. When the circumference of the utility line is too small to accommodate a label that wraps around the line with text arranged vertically, a tag, or flag style label should be used. For cases where wear and tear of such flags is a concern (i.e. through frequent use), a horizontal arrangement of the information is allowed. See Figure C.3.5.4.2.1–1 for cable label examples.

– The name of this end of the payload utility line (i.e. for cables, P1).

– The word ”TO” followed by the name of the piece of equipment to which this end of the payload utility line connects to. If this end can attach to multiple connector ports (i.e. generic cables), this requirement is not necessary.

– The name of the receptacle that this end of the payload utility line connects to (i.e. for cables, J1). If this end can attach to multiple connector ports (i.e. generic cables), this requirement is not necessary.

IRN 0002



Notes:

Electrical cables/ports: "P" designates cable end plugs and "J" designates receptacles on hardware regardless of gender (pins/sockets).

Hose End Labels: The first line of the end label may be left off (as shown above) if the hose end does not have a specific identifier. In this case, only the second and third lines are needed. If hose ends must be identified, do not use a "P" number.

Hose Identifying Labels: Pressure should be indicated only if it is constant. Flow direction should be shown if the hose ends are not interchangeable.

FIGURE C.3.5.4.2.1–1 CABLE AND HOSE LABELING

C.3.5.4.2.2 COLOR CODING

A. Red must only be used to mark emergency use items. Yellow must only be used to mark Caution and Warning items. See section C.3.5.9 for Caution & Warning labeling requirements. IRN 0002

B. Hazard Labels – Hazard labels have their own, unique coding scheme, of which color is one factor. See Section C.3.5.9.I for instructions.

C. Identification/Connectivity – Color coding used for component identification or to denote connectivity relationships must combine color with nomenclature (i.e. hardware name and the payload it belongs to, simple number, part number, etc.) such that when those components are referred to within procedures, it is clear which components the procedures are referring to. The only color restriction is listed in paragraph A (red and yellow cannot be used).

D. Color Difference

(1) Only one hue within a color category (e.g., blues, greens) should be used on the decals or placards within the same integrated rack. IRN 0002

(2) That color must always be associated with a single meaning within the same system or integrated rack.

E. Number of Colors – No more than 9 colors, including white and black, must be used in a coding system.

F. Markings/Background Color – Markings and background colors on labels must have sufficient contrast such that the labels are readable in ambient ISS lighting conditions. Labels should adhere to the accepted combinations of markings and background color listed below: IRN 0002

Markings	Background
Black	White
Black	Yellow
Black	Silver (metal photo labels)
White	Black
White	Red
White	Grey
Yellow	Blue
Red	White
Blue	Yellow

C.3.5.4.2.3 LOCATION AND ORIENTATION CODING

IRN 0002

A. Subrack Location Codes:

(1) At the Rack level – Subrack location codes must be placed along the inside surface of the seat track at intervals equal to the individual rack's smallest drawer unit (e.g: 4 PU (7 inches) for U.S. payloads, different for IP racks), as shown in Figure 3.5.3–1. Each letter/number pair must be 18 point font and placed at the top of the particular drawer interval. Locations other than the inside of the seat track are permissible only if there is a permanent obstruction that would cover the labels.

(2) For Control Panels that Control Multiple Subracks – Each subrack's controls must be mapped to its location using the letter/number code (e.g. "A1", "A2", "B1", "B2", etc.), and a graphic (matrix with appropriate box checked) showing the individual locker's location in the rack. See Figure C.3.5.3–2 for examples.

B. Access Panels – maintenance access panels must be labeled to assist the crew in locating the panel for maintenance activities.

(1) Access panel identification labels should be located in the upper left corner position on the panel with respect to the local vertical orientation.

(2) Access panel identification labels for access panels on the side or back of a rack must be labeled as in Figure C.3.5.3–1 and include:

(a) The acronym for the rack (e.g. "SRF").

(b) Its height location using the subrack location code (e.g. "C3").

(c) Its left, right, or back location on the rack preceded by a hyphen (e.g. "–L" for left, "–R" for right, "–B" for back).

For example, a complete access panel label might be "SRF C3–L" or "SRF C3–R".

C. Alignment Marks/Interface Identification

(1) Alignment Marks – Alignment marks or other orientation markings must be used to aid the crew with the installation/mating of equipment when the hardware requires a specific orientation. IRN 0002

(2) Visibility – Alignment marks, arrows, or other labels showing required orientation must be visible during alignment and attachment.

(3) Tethered Equipment – Interface identification should not be used for movable items tethered to a mating part (e.g., dust cap for an electrical connector, hinged lid for a stowage container).

C.3.5.5 DELETED

C.3.5.6 OPERATING INSTRUCTION LABELS

Operating instruction labels are hardware labels (affixed to hardware) that contain procedural steps. The procedural text should be coordinated with the PODF prior to final IPLAT approval and conform to ODF standards as documented in ODF Standards, SSP 50253. See Figure C.3.5.6–1 for an example.

A. Location – Equipment operating instructions should be located on or adjacent to equipment.

B. Equipment Name – The instructions should have the title of the equipment to be operated centered above the text.

C. Grouping – Instructions should be grouped and titled by category (e.g., installation, removal, activation, calibration, etc.).

D. Title Selection – The titles of instructional text for equipment, displays, controls, switch positions, connectors, etc., must be in upper case letters only and bold. IRN 0002

(1) Title nomenclature must be consistent with procedural handbooks and checklists.

E. Instructional Text – Instructional text below titles must use upper and lower case letters. Direct references to hardware items should be in upper case so they match the hardware labels. IRN 0002

F. Required Tools – Instruction for removal of stowage items should list any tools required prior to the instructional text.

(1) When tools are required to remove stowage items, markings should be used for the location of the fasteners to be removed.

IRN 0002

CAMERA EQUIPMENT OPERATING INSTRUCTIONS ← Title in upper case and bold

<u>ACTIVATION</u> ← Upper case and underlined

1. √BALLAST PWR ON/OFF (2) – OFF
2. Connect Ballast to main power supply
3. Connect Photoflood to Ballast ← Instructional text in mixed case, except for direct hardware label references.
4. VOLTAGE PWR ON/OFF – ON (as req’d)
5. pb LIGHT ON – Press Hold (until Photoflood Light Illuminates)

<u>DEACTIVATION</u>

6. pb LIGHT OFF Press
7. Wait 10 minutes
8. VOLTAGE PWR ON/OFF – OFF

FIGURE C.3.5.6–1 OPERATING INSTRUCTION LABEL EXAMPLE

C.3.5.7 STOWAGE CONTAINER LABELING

IRN 0002

This section applies to stowage containers provided by the payload, located within the payload, not in general ISS stowage containers.

A. Each stowage container must display the contents on its front surface visible to the crewmember.

IRN 0002

For drawer, box, or bag style stowage containers that are mounted as subracks as in Figure C.3.5.3–1, the following requirements apply:

(1) The contents label should be as shown in Figure C.3.5.7–1a when the location is known and fixed. The contents label should be as shown in Figure C.3.5.7–1b when the location is not known or is variable.

(2) If the drawer/box/bag is being launched individually in the MPLM or the Space Shuttle Middeck, then the drawer must have the ascent label as shown in Figure C.3.5.7–1c, in the front of the pocket. This label is then removed upon transfer to ISS, revealing the label in Figure C.3.5.7–1a or C.3.5.7–1b.

B. Provisions should be made to permit in-flight revisions to or replacement of stowage labels on all stowage containers. IRN 0002

C. Subdivided Containers:

(1) If a stowage container is subdivided internally into smaller closed containers, the sub-containers must carry a list of contents.

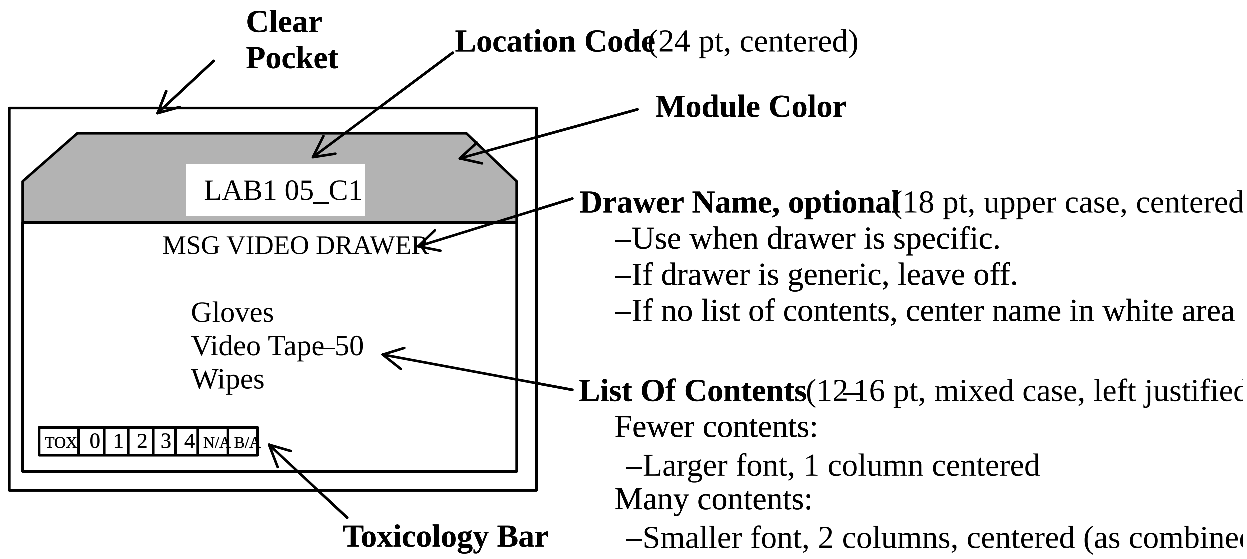
(2) If the available marking space on a sub-container is insufficient to display the complete content titles, a contents list must be displayed elsewhere and clearly identified as belonging to the sub-container.

(3) The specific contents of each sub-container must be listed on the front surface of its container or near it. IRN 0002

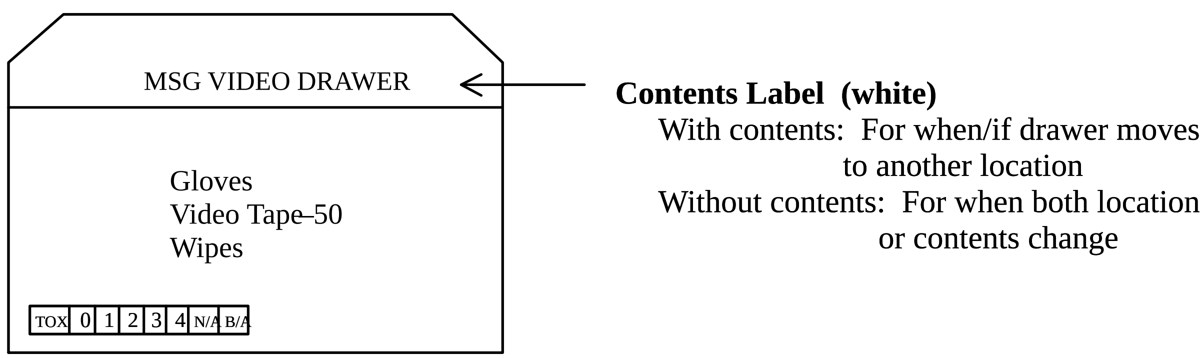
D. Individual–Crew Items – Items allocated to a specific crewmember should be identified on the listing with the user’s title, name, or other coding technique.

E. Tool/Accessory Kit Labeling – Containers with designated locations for placement of equipment set (e.g., socket wrenches in a tool kit) should have each location identified with the title of the item stowed. IRN 0002

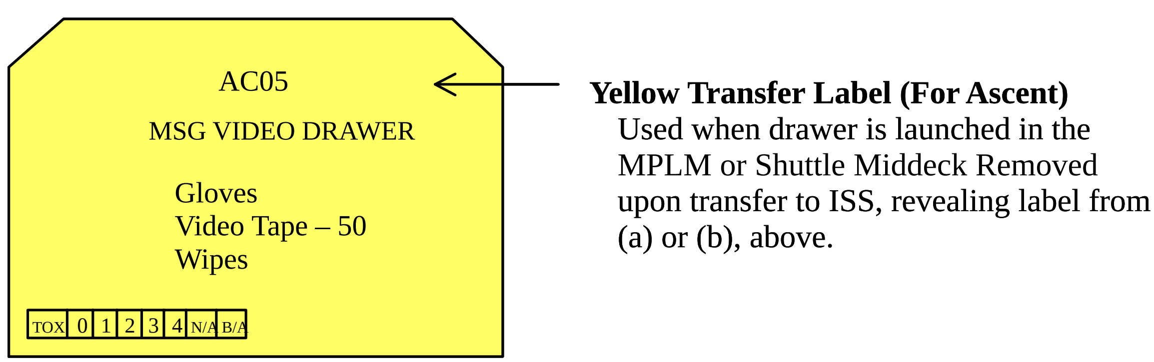
IRN 0002



a) Standard Drawer Title/Contents Label With Location Information



b) Standard Drawer Contents Label Without Location Information



c) Ascent Drawer Contents Label

Note: IPLAT must review the proposed label. The PD can then order this label from the Decal Design & Production Facility (DDPF). Reference Drawing #SEG32106109 “Crew Transfer Bag Standard Label”.

FIGURE C.3.5.7–1 STANDARD PAYLOAD STOWAGE DRAWER LABELS

C.3.5.8 GROUPED EQUIPMENT ITEMS

A. Functional groups of three or more equipment items (i.e. displays, controls, switch positions, connectors, LEDS, etc.) must be identified (e.g., by common color, by boundary lines). Functional groups of equipment items are all associated or connected with a common system or purpose. (e.g., CABIN AIR, FURNACE A, EXPERIMENT "M", PANEL LIGHTING). Two functionally related items should be grouped when such grouping provides clarification of purpose and/or distinguishes them from surrounding items. See Figure C.3.5.8–1 for grouping label examples.

B. Labels must be located above the functional groups they identify.

C. When a line is used to enclose a functional group and define its boundaries, the labels must be centered at the top of the group, in a break in the line. When it is not possible to center the text at the top, the text may be placed elsewhere along the perimeter of the boundary line, but local vertical orientation or the text must be maintained.

(1) The width of the line must not be greater than the stroke width of the letters.

(2) The line must form an enclosed rectangle, or box, with rounded corners. Deviations from the rectangular shape are allowed when dimensional restrictions preclude a perfect rectangle.

D. When displays and controls are used together in adjustments or activation tasks, visible labels or markings must indicate their functional relationships.

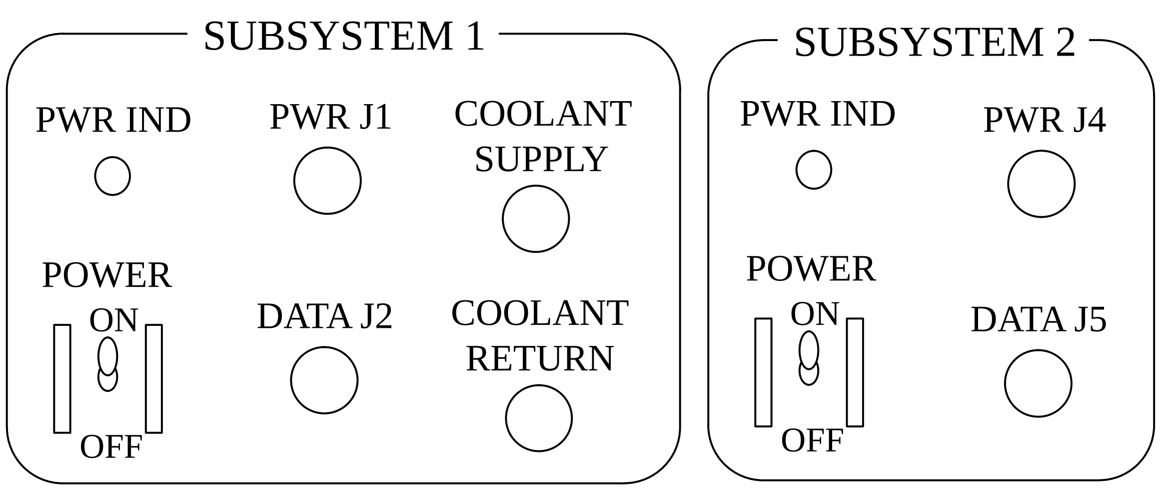


FIGURE C.3.5.8–1 GROUPING LABEL EXAMPLES

IRN 0002

C.3.5.9 CAUTION AND WARNING LABELS

Caution and warning labels are required for indicating potentially undesirable conditions. See Figure C.3.5.9–1 for examples. IRN 0002

A. Caution and warning labels must be standardized between and within systems.

B. Caution and warning labels must be distinct from one another.

C. Caution and warning labels must identify the type of hazard and the action that would prevent its occurrence.

D. The caution and warning markings must be located in a visible area.

E. Emergency-Use Label Specifications IRN 0002

(1) Labels on emergency–use items (e.g., repair kits, emergency lighting, fire extinguisher, etc.) must be surrounded by diagonal red and white stripes either on the item or adjacent to it.

(2) The emergency type warning stripes must be alternate red and white.

(3) The red and white stripes should be of equal width.

(4) There must be no fewer than four red stripes and three white stripes.

(5) The striping must be applied at a 45 degree angle rotated clockwise from the vertical.

(6) The striping must begin and end with a red stripe.

(7) The text must be white letters on the red background or red letters on a white background.

(8) For items located within a storage container, the diagonal striping must be applied to the door of the container and the titles of the emergency items must be included on the marking. IRN 0002

F. Caution and Warning Label Specifications IRN 0002

(1) Caution/warning decals and placards must be surrounded by diagonal yellow and black stripes.

(2) The caution/warning type stripes must be alternate yellow and black.

(3) The yellow and black stripes should be of equal width.

(4) There must be no fewer than four yellow stripes and three black stripes.

(5) The striping must be applied at a 45 degree angle rotated clockwise from the vertical.

(6) The striping must begin and end with a yellow stripe.

(7) The text must be black letters on the yellow background.

G. Switches and Buttons

(1) The striping around a switch or button must not be wider than 25mm (1 in.) or narrower than 3 mm (0.125 in.).

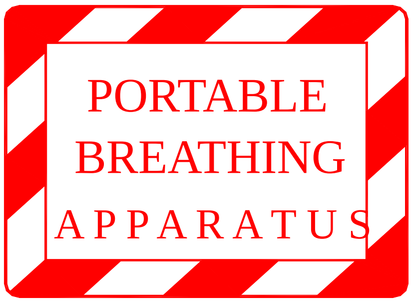
(2) If one side of a switch or button has less than 3 mm (0.125 in.) space, no striping must be applied to that side.

H. Deleted IRN 0002

I. Hazard Labels

(1) Chemicals – The standard hazard class decals must be used to identify the proper hazard class of payload chemicals (i.e. chemicals in solid, liquid, or gaseous states) as deemed by the payload's toxicology representative. The developer may obtain these decals from JSC 27260, Decal Process Document and Catalog, or must produce identical labels. See NSTS 07700, Volume 14, Appendix 9, Section 5.6.3 for hazard class definitions. IRN 0002

(2) Other hazards – When biological, radiation, sharps, battery, or other hazards are identified by safety personnel, the appropriate standard label (if available) must be applied in a prominent location. The developer may obtain these decals from JSC 27260, Decal Process Document and Catalog, or must produce identical labels. IRN 0002



Emergency Label Example

Caution/Warning Label Example

Toxic Hazard Label Examples

FIGURE C.3.5.9–1 CAUTION AND WARNING LABEL EXAMPLES

C.3.5.10 ALPHANUMERIC

C.3.5.10.1 FONT STYLE

A. The font style used on decals, placards, and labels must be Helvetica or Futura demibold. If there are fit problems:

– The use of condensed type (Helvetica Condensed) or abbreviations is the preferred method of solving line length.

or

– For engraved markings which are not able to exactly match the above required font, the engraved marking should match the Helvetica font as nearly as possible.

Note: Helvetica is the preferred font.

B. Stenciled Characters – Stencil–type characters should not be used on display/control panels or other equipment.

C.3.5.10.2 PUNCTUATION

A. Periods & Commas – Periods (.) and commas (,) should not be used in equipment labels, except to preclude misinterpretation. IRN 0002

B. Hyphens – Hyphens (–) should not be used in equipment labels, except in part and serial numbers, and to preclude misinterpretation. IRN 0002

C. Parentheses and Ampersands – In general, parentheses and ampersands should not be used on payload equipment. Parentheses may be used to enclose acronyms after spelled out names (See Section C.3.5.3) and to designate multiple quantities of an item (See Section C.3.5.4.1.D.3). Ampersands may be used where the substitution of backslashes (/) would remove or distort the intended meaning (i.e. PUSH & HOLD vs. PUSH/HOLD).

D. Slashes – The slash (/) may be used in place of the words ”and” and ”or” and may be used to indicate multiple functions. IRN 0002

C.3.5.10.3 SPECIAL CHARACTER

A. Subscript and Superscript Size – Subscripts and superscripts should be 0.6 to 0.7 times the height of associated characters.

B. Subscripts – Numeric subscripts and upper case letter subscripts should be centered on the baseline of associated characters.

C. Lower Case Letter Subscripts –The base of lower case letters and the ovals of g, p, q, etc., should be at the same level as the base of adjacent capital letters.

D. Degree Symbol – The degree symbol should be centered on an imaginary line extended from the top of the F or C symbols.

E. Pound or Number Symbol (#) – The pound or number symbol should be centered on an imaginary line extended from the top of the associated numerals and placed two stroke widths away from them.

C.3.5.10.4 CHARACTER HEIGHT

A. Character Height – Character height depends on viewing distance and luminance level. At a viewing distance of 710 mm (28 in.), the height of letters and numerals should be within the range of values given in Table C.3.6.10.4–1.

B. Variable Distance – For a distance (D) other than 710 mm (28 in.), multiply the values in Table C.3.5.10.4–1 by D/710 mm (D/28 in.) to obtain the appropriate character height.

TABLE C.3.5.10.4–1 CHARACTER HEIGHT – 710 mm (28 in) VIEWING DISTANCE

Markings	Character Height	
	3.5 cd/m^2 (1ft–L) or below	Above 3.5 cd/m^2 (1ft–L)
For critical markings, with position variable (e.g., numerals on counters and settable or moving scales)	5–8 mm (0.20–0.31 in.)	3–5 mm (0.12–0.20 in.)
For critical markings, with position fixed (e.g., numerals on fixed scales, controls, and switch markings, or emergency instructions)	4–8 mm (0.16–0.31 in.)	2.5–5 mm (0.10–0.20 in.)
For noncritical markings (e.g., identification labels, routine instructions , or markings required only for familiarization)	1.3–5 mm (0.05–0.20 in.)	1.3–5 mm (0.05–0.20 in.)

C. Size Categories – Characters used in hierarchical labeling (e.g. rack name, subrack name, controls groupings, port names, etc.) should be graduated in size. There should be at least a 25 percent difference in the character height between each of these categories. IRN 0002

D. Space Limitations – The use of the same size letters and numerals for all categories on a label is acceptable for solving space limitation and clarity problems. The height of lettering and numerals should be not less than 3 mm (0.12 in.).

C.3.5.10.5 CHARACTER WIDTH

A. Letters – The width of letters should be 0.6 of the height, except for the letter ”I,” which should be one stroke in width, the letters ”J” and ”L”, which should be 0.5 of the height, the letter ”M”, which should be 0.7 of the height, and the letter ”W,” which should be 0.8 of the height.

B. Numerals – The width of numerals should be 0.6 of the height, except for the numeral ”4”, which should be one stroke width wider and the numeral ”1”, which should be one stroke in width.

C. Wide Characters – When wider characters are used on a curved surface, the basic height–to–width ratio should be increased to 1:1.

C.3.5.10.6 STROKE WIDTH

A. Height–to–Stroke Ratio – Marking letters and numerals should have a height–to–stroke ratio of 5:1 to 8:1.

B. Transillumination Background – Opaque markings on a transilluminated lighted background should have a height–to–stroke ratio of 5:1 to 6:1.

C. Transilluminated Markings – Transilluminated markings on a dark background or markings used on integrally lighted instruments should have a height–to–stroke ratio of 7:1 to 8:1.

D. General Purpose Illumination – Characters used on display panels and equipment when viewed under general purpose flood lighting or normal display conditions as specified in Table 3.12.3.4–2 should have a height–to–stroke ratio of 6:1 to 7:1.

C.3.5.10.7 CHARACTER MEASUREMENT

A. Measurement – All letters and numeral measurement should be made from the outside edges of the stroke lines for other than machine engraving on opaque surfaces.

B. Engravings – For all mechanical engraving on opaque surfaces, the dimensions controlling the size of letters and numerals should be measured from centerline to centerline of the stroke.

C.3.5.10.8 SPACE

A. Character Spacing – The spacing between letters within words and between digits in a multi–digit number should be the equivalent of one stroke width between two straight–sided letters such as H and l. (This instruction intended to accommodate the normal commercial typographical practice of spacing letters to achieve a, consistent visual continuity. This permits close spacing of open letters such as C and T to avoid large apparent gaps.)

B. Word Spacing – The spacing between words should be the equivalent of the letter W between two straight–sided letters such as N and F.

C. Line Spacing

(1) The spacing between lines of related text should be 0.5 of upper case letter height.

(2) Spacing between headings and text should be 0.6 to 1.0 of upper case letter height.

C.3.5.11 BAR CODING

PDs will coordinate with NASA/JSC organization OC for Inventory Management System (IMS) label registration. IRN 0002

A. Racks, subracks, stowage trays, loose equipment, consumables, and ORUs must have an inventory management label in accordance with SSP 50007. IMS labels, or their placeholders, must be present on engineering drawings. If the PD orders their IMS labels from the DDPF, the Decal Catalog decal part number should be included in a note on the engineering drawing. IRN 0002

B. Deleted

C. Deleted.

C.3.6 SCALE MARKING

IRN 0002

A. Accuracy

(1) The precision of scale marking should be equal to or less than the precision of the input signal.

(2) In general, scales that are to be read quantitatively to the nearest graduation mark should be designed so that interpolation between graduation marks is not necessary. Interpolation should be limited to one half the distance between minor graduation marks.

(3) Scales should have a zero reference. IRN 0002

(4) If precise measurements are needed, scale graduation marks should be marked clearly to allow for unambiguous measurements.

B. Interval Values

(1) The graduation intervals should progress by 1, 5, or 2 units of decimal multiples thereof, in that order of preference.

(2) The number of graduation marks between numbered graduation marks should not exceed 9.

C. Scale Markings (High Luminance – above 1 ft–L)

(1) The minimum width of major, intermediate, and minor marks should be 0.32 mm (0.0125 in.)

(2) The length of major, intermediate, and minor graduation marks should be at least 5.6 mm, 4.1 mm, and 2.5 mm (0.22, 0.16, and 0.09 in.), respectively.

(3) The minimum distance between major graduation marks should be 13 mm (0.5 in.).

(4) Minor graduation marks may be spaced as close as 0.89 mm (0.035 in.), but the distance should be at least twice the stroke width for white marks on black dial faces and at least one stroke width for black marks on white dial faces.

D. Scale Markings (Low Luminance – below 1 ft–L)

(1) The minimum width of a major graduation should be 0.89 mm (0.035 in.), the minimum width of an intermediate graduation should be 0.76 mm (0.030 in.), and the minimum width of a minor graduation should be 0.64 mm (0.025 in.). IRN 0002

(2) The length of major, intermediate, and minor graduation marks should be at least 5.6 mm, 4.1 mm, and 2.5 mm (0.22, 0.16, and 0.10 in.), respectively.

(3) The minimum distance between major graduation marks should be 16.5 mm (0.65 in.).

(4) Graduation marks should be spaced a minimum of 1.5 mm (0.06 in.) between centerlines.

C.3.7 DELETED (MOVED TO C.3.6)

IRN 0002

(This Page Intentionally Left Blank)

TABLE E–2 TO BE RESOLVED ITEMS
(Page 2 of 3)

IRN 0002

5	Deleted	3.5.1.17	NASDA JEM Boeing/PEI	9/1/00
6	NASDA does not concur with the defined equivalent shielding thickness of 25.4 mm defined in Section 3.9.3.3. NASDA proposes to change the equivalent shielding thickness to 4.8. NASA to provide the technical rationale used to derive an equivalent shielding thickness of 25.4 mm of aluminum.	3.9.3.3	NASDA JEM NASA OZ3	9/1/00
7	Additional thermal boundary conditions are required to allow Payloads to perform the necessary design analysis to insure that their hardware design will be compatible with the JEM. NASA to incorporate the JEM thermal interface boundary requirements for integrated racks.	Table 3.9.4–1	NASDA JEM Boeing/PEI	9/1/00
8	Thermal Conditions – APM module wall temperature	Table 3.9.4–1	ESA/McGrath	9/1/00
9	Thermal Conditions – CAM module wall temperature	Table 3.9.4–1	NASDA / Centrifuge Project	3/1/01
10	NASDA is unsure as to whether parameter monitoring can provide for automatic shut–off function of payloads in response to a potential fire event. What are the joint NASA/NASDA verification methods of this capability. NASA to provide NASDA the details of the MBF and PSIV software verification functions.	3.10.2.2	NASDA JEM NASA OZ3	9/1/00
11	NASA desires that the ISS module integrator will analyze and verify the vent gases compatibility with ISS module VES/WGS wetted surface materials for the gas not specified in Appendix D. NASDA desires that Integrated Rack Provider will analyze and verify the vent gases compatibility with ISS module VES/WGS wetted surface materials for the gas not specified in Appendix D.	4.3.6.1.5.A	NASDA JEM NASA OZ3	9/1/00