ISS IBM ThinkPad Series A31p ™ Laptop Hardware Project Technical Requirements Specification

Engineering Directorate
Avionics Systems Division

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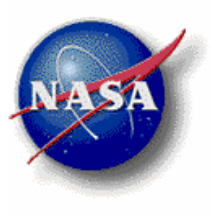
Revision B



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June 2005

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REVISION HISTORY PAGE

Revision	Description	Date
Baseline		May 2003
Rev A	Removed references to dual power supply as a result of re-design. Removed Appendix A – Requirements Verification Matrix due to redundancy; information is captured in JSC49735 – Verification and Validation Document: Plan and Report for the ISS IBM ThinkPad Series A31p Laptop System. Updated Section 3.2.1.4 Provide File Transfer Capabilities, to allow item numbering (a thru m) to correspond with the V&V Plan, JSC 49735. Updated Section 3.2.2.3.1 Data Interfaces to allow item numbering (a thru q) to correspond with the V&V Plan, JSC 49735.	September 2004
B	Added SSP Laptop Requirements (Per CRD 9480)	June 2005

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1.0 SCOPE

This document establishes the hardware performance, design and development requirements for the International Space Station (ISS) and Space Shuttle Program (SSP) laptop. The IBM ThinkPad Series A31p ™ Notebook has been selected by the International Space Station (ISS) program as a Commercial Off The Shelf (COTS) platform for the upgrade replacement of the current ISS and SSP laptops. The terms “ISS laptop” and “ISS laptop system” used within this document refers to the IBM ThinkPad Series A31p ™ Notebook based laptop. The laptop was pre-screened with risk mitigation testing to determine that it could most closely meet the requirements of Space Flight. However, because it is a Commercial Off The Shelf item some requirements may not be met to the fullest extent.

This document, with the Criticality I verification criteria, Section 4.3 Quality Conformance Verification, does not cover the integrated configuration of the Portable Computer System (PCS) software with the laptop. Also, this document does not cover the integrated configuration of Station Support Computer (SSC) applications and operating system software and associated user (payloads, SDTO's, etc.) configurations. This document does not cover the integrated configuration of the Payload and General Support Computer (PGSC) applications and operating system software and associated user (payloads, return to flight applications, etc.) configurations.

The PTRS defines the requirements, by verification method, by traceability to the Prime Item Development specification for Station Management and control, S684-10143; Development Specification for the Portable Computer System (PCS), JSC 27274; Project Technical Requirements Specification (PTRS) for Portable Computer System (PCS), JSC 27337, SSP 41172, SSP 50094, and JSC 28484. The IBM ThinkPad Series A31p ™ Notebook specifications performance requirements were not duplicated in this PTRS.

The following definitions differentiate between requirements and other statements.

Shall:	This is the only verb used for the binding requirements.
Should/May:	These verbs are used for stating non-mandatory goals.
Will:	This verb is used for stating facts or declaration of purpose.

1.1 RESPONSIBILITY AND CHANGE AUTHORITY

This document is prepared and maintained in accordance with work instruction EA-WI-023, Project Management of Government Furnished Equipment (GFE) Flight Projects and is based on the Prime Item Development specification for Station Management and control, S684-10143; Development Specification for the Portable Computer System (PCS), JSC 27274; Project Technical Requirements Specification (PTRS) for Portable Computer System (PCS), JSC 27337, SSP 41172, SSP 50094, and JSC 28484, Program Requirements Document for JSC Non-Critical Government Furnished Equipment. The responsibility for the development of this document lies with the Avionic Systems Division (EV). Change authority will be the Avionic Systems Division (EV), with the concurrence of the ISS Avionics and Software Office (OD).

2.0 APPLICABLE DOCUMENTS

The following documents are referenced in the requirements sections of this specification. Unless a specific issue is specified in this table, the exact issue shown in the current issue of SSP 50257 or SSP 50258 is the applicable version. The contents of this specification shall take precedence in the event of a conflict with the referenced documents.

Doc. Number	Document Title	Section Where Used
D684-10041-1A	ISS integrated Logistics Support Plan	3.5
ICD 3-0014-0, Basic	Integrated Aft Flight Deck, Space Shuttle Orbiter, 2/79	3.2.2.3.2c
JPR 5322.1F	JSC Contamination Control Requirements Manual	3.3.4.1,4.3.3.4.1
JPR 5335.3 Rev B	JSC Quality Manual	
JSC 25863 Rev A	Fracture Control Plan for JSC Flight Hardware	3.3.1.1b
JSC 27274 Rev K	Development Specification for the Portable Computer System (PCS)7/02	
JSC 27301, Rev. D	Materials Control Plan for JSC Space Station GFE	3.3.1.1a
JSC 27337, Rev. J	Project Technical Requirements Specification (PTRS) for the Portable Computer System (PCS) 6/02	
JSC 28484	Program Requirements Document of JSC Non-Critical Government Furnished Equipment, Change 3, 3/00	3.3.2.2 4.0c, 4.2,
JSC 61360, Rev. A	Engineering Directorate Certified Part Approval Process (EDCPAP) Selection, 7/98	3.2.1.1.c 3.3.1.2b, 4.3.3.1.2b
JSC SLP-4.15, C	Handling, Storage, Packaging, Preservation and Delivery, 3/97	3.2.6b, 4.3.2.6b
MIL-STD-130, Rev. B	Identification Marking of U.S. Military Property, 12/93	3.3.3a
MIL-STD-810, Rev. E	DOD Test Method Standard for Environmental Engineering Considerations and Laboratory Tests, 7/95	3.2.5.7a
MF0004-14, Rev. E	Environmental Requirements and Test Criteria for the Orbiter Vehicle, 7/01	3.2.5.1.2, 3.2.5.3.1, 3.2.5.3.2, 3.2.5.6.2, 4.3.2.5.1.2, 4.3.2.5.3.1, 4.3.2.5.3.2
NAS 5300.4 (3G-1)	Workmanship Standard for Interconnecting Cables, Harnesses, and Wiring	4.3.3.6.4.1.3b
NHB 5300.4 Vol. 3	Reliability and Quality Assurance Manual - Standards parts 3A-1, 3G, 3H, 3I, 3J, 3K	3.3.4, 4.3.3.4
JSC 20793, Basic	Manned Space Vehicle Battery Safety Handbook, 9/85	3.3.6.4.3, 4.3.3.6.4.3

Doc. Number	Document Title	Section Where Used
NSTS-07700 Volume 10 Book 1	Space Shuttle Flight and Ground System Specification	3.6.25.1
NSTS-21000- IDD-MDK, Rev. B	Shuttle/Payload Interface Definition Document for Middeck Accommodations, 12/96	3.2.2.1.1 3.2.5.1.1a, 3.2.5.2.1, 3.2.5.3.1, 3.2.5.4.1,, 3.2.5.6.1, 3.2.6a, 4.3.2.5.1.1a, 4.3.2.5.2.1, 4.3.2.5.3.1, 4.3.2.5.4.1, , 4.3.2.5.6.1, 4.3.2.6a
NSTS 07700 Volume 2, Book II, SSP Directive #138	Establishment of a Space Shuttle (SSP) Portable On-Board Computer Policy	
NSTS 37330	Bonding, Electrical, & Lightning Specifications, Space Shuttle	
SE-R-0006D	Space Shuttle System Requirements for Materials & Processes	
S684-10143	Prime Item Development Specification for Station Management and Control	3.3.6.1.3c,
SL-E-0002 Book 3 Volume 1	Space Shuttle Specification Electromagnetic Interference Characteristics, Requirements For Equipment	
SSP 30233, Rev. F	Space Station Requirements for Materials and Processes, 3/98	3.3.1.1a
SSP 30234, Rev. F	Instructions for Preparation of FMEA and Critical Items List, 7/02	6.2
SSP 30237 Rev F	Space Station Electromagnetic Emission and Susceptibility Requirements for EMC, 5/01	3.3.2.2, 4.3.3.2.2
SSP 30240 Rev C	Space Station Grounding Standard, 12/98	3.3.2.3, 4.3.3.2.3
SSP 30242 Rev E	Space Station Cable/Wire Design And Control Standard, 12/98	3.3.2.5, 4.3.3.2.5
SSP 30243 Rev F	Space Station Systems Electromagnetic Compatibility Requirements, 3/02	3.3.2.6, 4.3.3.2.6
SSP 30245 Rev E	Space Station Electrical Bonding Requirements, 10/99	3.3.2.4, 4.3.3.2.4
SSP 30257:002	Space Station Program Utility Outlet Panel Standard Interface Control Document 4/94	3.2.2.3.2a,

Doc. Number	Document Title	Section Where Used
SSP 30309 Rev E	Safety Analysis and Risk Assessment Requirements Document 10/94	4.3.3.6.1.1, 4.3.3.6.1.2, 4.3.3.6.5.1, 4.3.3.6.5.2
SSP 30312 Rev H	Electrical, Electronic, and Electromechanical Parts Management and Implementation Plan for the Space Station Program, 11/99	3.3.1.1c, 3.3.1.2a, 3.3.6.4.1.2 4.3.3.1.2a, 4.3.3.6.4.1.2
SSP 30512, Rev. C	Space Station Ionizing Radiation Design Environment, 6/94	3.2.5.8.2, 4.3.2.5.8.2
SSP 30558, Rev. C	Fracture Control Requirements for Space Station 8/01	3.3.1.1b
SSP 30599, Rev. A	Safety Review Process 1/95	4.3.3.6.1.3a, 4.3.3.6.1.3b, 4.3.3.6.1.3c, 4.3.3.6.1.3d
SSP 41172, Rev. R	International Space Station Alpha Program Qualification and Acceptance Environmental Test Requirements, 9/02	4.0c, 4.2,
SSP 50005, Rev. C	International Space Station Flight Crew Integration Standard (NASA-STD-3000/T), 12/99	3.2.5.4.2, 3.3.1.1d, 3.3.1.1e, 3.3.3b, 3.3.3d, 3.3.3e, 3.3.6.3, 3.3.6.4.2, 3.3.6.6.1.1, 3.3.6.6.1.2a, 3.3.6.6.1.2.b, 3.3.6.6.2.1, 3.3.7.1, 3.3.7.2, 3.3.7.3a, 3.3.7.3b, 4.3.2.5.4.2, 4.3.3.1.1d, 4.3.3.1.1e, 4.3.3.6.3, 4.3.3.6.4.2, 4.3.3.6.6.1.1, 4.3.3.6.6.1.2a 4.3.3.6.6.1.2b 4.3.3.6.6.2.1, 4.3.3.7.2
SSP 50007, Rev. B	Inventory Management System Label Specification, 5/01	3.3.3c
SSP 50257, Rev AD	Program Controlled Document Index 9/02	2.0
SSP 50258, Rev AD	Prime Controlled Document Index 9/02	2.0

Doc. Number	Document Title	Section Where Used
SSP 50094	NASA/RSA Joint Specifications Standards Document for the ISS Russian Segment	4.0c, 4.2,
SSP 52051 Vol. 1	User Electric Power Specifications and Standards: 120Volt DC Loads 10/01	3.2.2.3.2a
SSP 52051 Vol. 2	User Electric Power Specifications and Standards: Multi-Segment, Portable, 28 Volt DC Equipment 6/02	3.2.2.3.2d
R32928-103	Requirements for the International Partner Cargoes Transported on the Russian Progress and Soyuz Vehicles.	3.2.6d, 4.3.2.6d
TM102179	Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits	

2.1 ORDER OF PRECEDENCE

All specifications, standards, exhibits, drawings, or other documents that are invoked as "applicable" in this specification are incorporated as cited. All documents that are referred to within an applicable document are considered to be for guidance and information only. In the event of a conflict between the text of this specification and an applicable document cited herein, the text of the applicable document takes precedence.

3.0 REQUIREMENTS

3.1 ISS LAPTOP SYSTEM DEFINITION

The ISS laptop provides the on-orbit crew interface to display data and enter commands. The ISS laptop can be used by payloads or other non-C&DH (command & data handling) systems in support of their communication, computational, data retrieval and storage needs. The ISS laptop can also be used to manage Caution and Warning (C&W) functions on ISS and to store data prior to down linking to the ground.

The ISS laptop consists of an IBM ThinkPad Series A31p ™ Notebook Computer, Li-Ion battery pack, removable hard drives, DVD-ROM/CD-RW drives (digital video disk-read only memory/compact disc-read write), and removable 3.5 inch floppy drives, along with power supplies and data/power cables necessary to provide communication, data, and power interfaces to the ISS.3.1.1 Interface Definition

3.1.1 ISS Laptop System Interfaces

The ISS laptop System interfaces to the ISS laptop are shown in Figure I.

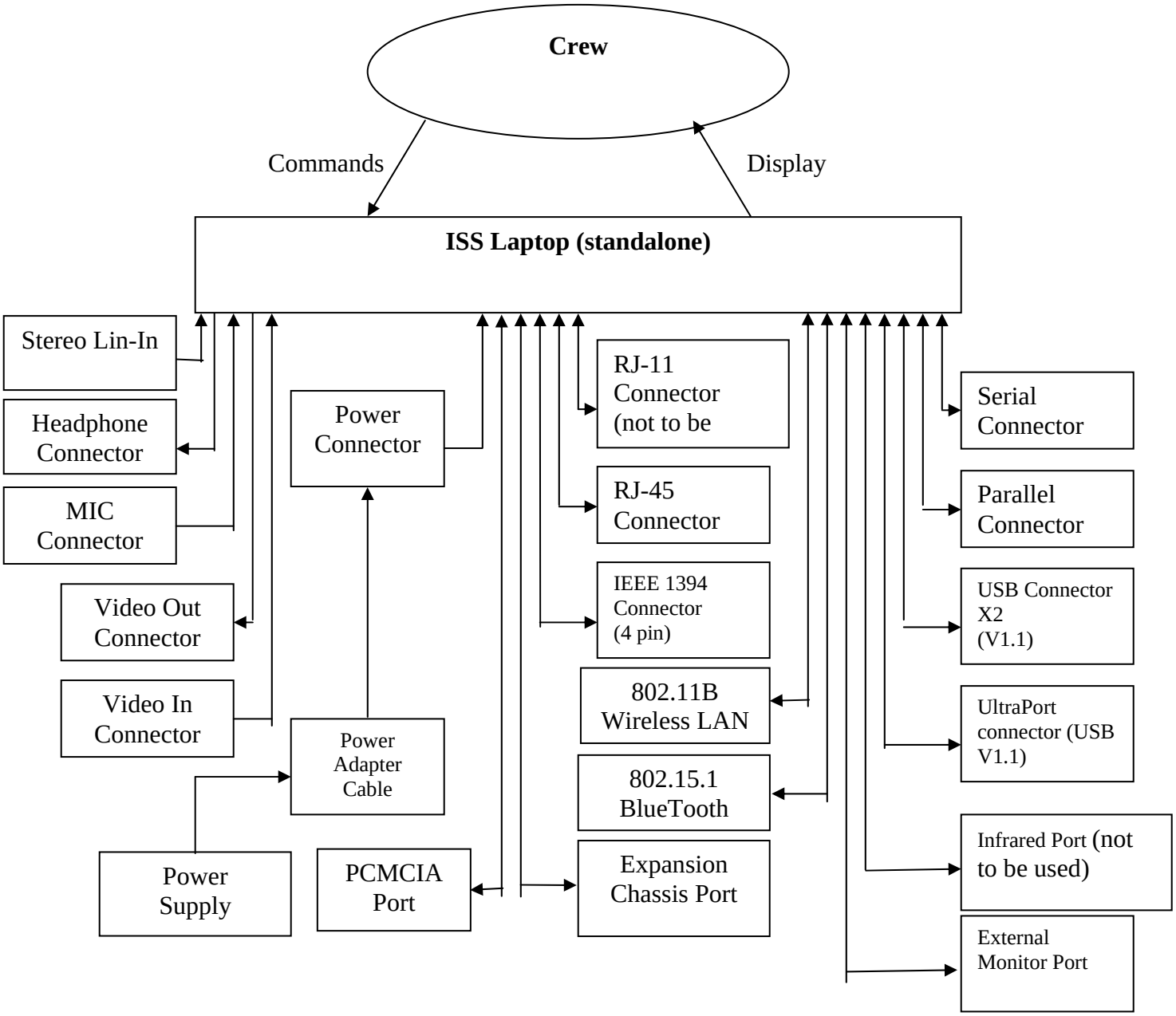

FIGURE 1 ISS LAPTOP EXTERNAL INTERFACES

3.1.1.1 External Data Interfaces

The following data interfaces are available with the ISS Laptop:

a. Stereo Line-in

b. Headphone connector

c. MIC connector

d. (2X) Personal Computer Memory Card International Association (PCMCIA) Cards

e. Expansion Chassis Port

f. RJ-11 (not to be used)

g. RJ-45

h. Institute of Electrical & Electronic Engineers (IEEE) 1394 connector (4 pin)

i. Serial connector (DB-9)

j. Parallel connector (DB-25)

k. (2X) Universal Serial Bus (USB) connector (V1.1)

l. Video In

m. Video Out

n. Expansion Chassis

o. VGA Out

p. Infrared Port (subject to operational constraint)

q. UltraPort Connector (USB v1.1)

r. 802.11b Wireless LAN

s. 802.15.1 Bluetooth

3.1.1.2 ISS Laptop System Physical Interfaces

The ISS laptop will be restrained on-orbit by a nylon hook-and-loop fastening system (commonly known as “Velcro” ™). The ISS laptop can be physically located in any pressurized volume. ISS laptop can interface to selected UOP's in the Lab for IEEE 802.3 Payload Ethernet data port connection. The ISS laptop will interface to the UOP to obtain 120 Volts Direct Current (VDC) power for primary power and to recharge the ISS laptop internal battery, and obtain the 1553 data port connection. The ISS laptop will automatically transition between UOP power and internal battery power if an interruption in power occurs. The ISS laptop will interface to a 28VDC (volts direct current) power interface for operations in the Russian Service

Module (SM). The laptop on shuttle will interface to orbiter power to obtain 28 Volts Direct Current (VDC) power.

3.1.1.3 Human Interfaces with the Portable Computer System

The ISS laptop human interface consists of a visual display and crew input devices.

3.1.2 Major Components List

The major components of the ISS laptop are:

TABLE 1 – Workstation and Support Equipment

Item Number	Hardware Item	Part Number	Crit. ISS	Crit. SSP	Program
1.	ISS laptop	SEG33115360-301, 302, 303	1R	1R	ISS/SSP
2.	Li-Ion Battery Pack	SEG33115356-301	1R	1R	ISS/SSP
3.	Removable 60 GB Hard Drive	SEG33115359-301	1R	1R	ISS/SSP
4.	DVD-ROM/CD-RW Drive	SEG33115357-301	1R	1R	ISS/SSP
5.	Removable Floppy Disk Drive	SEG33115358-301	1R	1R	ISS/SSP
6.	UltraPort Camera	SEG33115371-301	3	3	ISS/SSP
7.	UltraBay Adapter	SEG33115362-301	3	3	ISS/SSP
8.	A31P Backup Battery	02K6572	1R	1R	ISS/SSP
9.	IBM A31P Laptop Kit	SJG33116420-301	1R	1R	ISS/SSP
10.	A31P 28VDC Power Supply	SEG33116428-301	1R	1R	ISS/SSP
11.	A31P 120VDC Power Supply	SEG33116412-301	1R	N/A	ISS
12.	Cable Assembly, DC Power 16VDC	SDG33115374-301	1R	1R	ISS/SSP
13.	Enhanced 16VDC Power Cable	SEG33116458-301	IR	IR	ISS/SSP

3.2 ISS LAPTOP SYSTEM CHARACTERISTICS

3.2.1 Performance Characteristics

3.2.1.1 Provide General Computer Capabilities

3.2.1.1.1 Provide Display Capabilities

a. Reserved

b. Reserved

c. Reserved

d. Reserved

e. Reserved

f. Reserved

g. Reserved

h. Reserved

3.2.1.1.2 Provide Storage Capabilities

The ISS laptop shall provide storage capabilities as described in this section. Specific user's ISS laptop hardware/software system configuration of additional, specific or unique requirements are the responsibly of the user.

a. Reserved.

b. The ISS laptop shall provide removable mass storage for programs and data.

c. The ISS laptop shall be able to transfer data to and from mass storage devices, subject only to size limitations.

d. Reserved

e. Reserved

f. Reserved

g. The laptop will have a DVD-ROM/CD-RW drive that:
   1. Reads DVD media at 8X
   2. Reads CDR media at 24X
   3. Writes CD-RW media at 8X.

h. The laptop shall support a floppy drive & a CD/DVD drive simultaneously.

i. Reserved

3.2.1.1.3 Provide Execution Capabilities

a. Specific user's ISS laptop hardware/software system configuration execution capability requirements are the responsibility of the user. (b is reserved.)

b. Reserved.

3.2.1.1.4 Provide Startup Capabilities

The ISS laptop shall initialize and perform internal tests as provided by the COTS components, and will provide feedback.

3.2.1.2 Receive and Process External Data

Specific user's ISS laptop hardware/software system configuration requirements for receiving and processing data are the responsibility of the users.

3.2.1.3 Provide Caution and Warning Capabilities

Specific user's ISS laptop hardware/software system configuration requirements for caution and warning functionality are the responsibility of the user.

3.2.1.4 Provide File Transfer Capabilities

Specific user's ISS laptop hardware/software system configuration requirements to transfer files are the responsibility of the user. The ISS laptop shall support the transfer of files using the following interfaces: (a. through d. are reserved.)

a. Reserved

b. Reserved

c. Reserved

d. Reserved

e. PCMCIA Cards

f. 10 Base T (RJ-45)

g. IEEE 1394 connector (4 pin)

h. Serial connector (DB-9)

i. Parallel connector (DB-25)

j. USB connector (V1.1)

k. IEEE 802.11b Wireless LAN (RF)

l. IEEE 802.15.1 Bluetooth (RF)

m. Infrared Port (IR)

3.2.1.5 Provide Communication Capabilities

Specific user's ISS laptop hardware/software system configuration requirements to transfer files are out of scope of this PTRS. The ISS laptop shall support the transfer of data for communication with the following interfaces: (a. through t. are reserved.)

a. Reserved

b. Reserved

c. Reserved

d. Reserved

e. Reserved

f. Reserved

g. Reserved

h. Reserved

i. Reserved

j. Reserved

k. Reserved

l. Reserved

m. Reserved

n. Reserved

o. Reserved

p. Reserved

q. Reserved

r. Reserved

s. Reserved

t. Reserved

u. PCMCIA Cards

v. 10 Base T (RJ-45)

w. IEEE 1394 connector (4-pin)

x. Serial connector (DB-9)

y. Parallel connector (DB-25)

z. USB connector and UltraPort USB (2X) (V1.1)

aa. UltraPort USB

3.2.2 Physical Characteristics

3.2.2.1 Volume & Envelope

3.2.2.1.1 ISS Laptop Volume and Envelope

All ISS laptop hardware items, including packaging, shall be designed to fit within the internal dimensions of a middeck locker (16.95 inches by 20.0 inches by 9.52 inches) per NSTS-21000-IDD-MDK.

3.2.2.1.2 Reserved

3.2.2.2 Mass properties

3.2.2.2.1 ISS Laptop Weight Allocation

The ISS laptop, 120 VDC and 28VDC power supply, and 16 VDC power cable when combined with the weight of items listed in Table 1 shall not exceed 25 lbs.

TABLE 2 - Existing PCS Hardware Weights

Part Name	Part Number	Weight(lbs)	Volume ($in^{3)}$
Cable Assembly,UOP 120VDC	SEZ39129260-311	2.00	79
Cable Assembly, 1553 Data/120VDC Power	SEZ39129268-303	1.4	30.13
MIL-STD-1553 PCMCIA Card with Adapter Cable	SDG39129273-301	0.28	3.3
Cable Assembly DC Power, 28 VDC	SEG39129264-305	0.86	79
RS232 Y-Cable Assembly	SED39124826-307	1.50	20.63
1553 Node 1 Cable Assembly	SEG39135897-301,303	0.73,0.73	11.5

Cable Assembly, 1553 Data, Orbiter	SEG39129282-301	0.47	11.5
1 GB Microdrive PCMCIA Card	SEZ33112992-301	0.10	1.58
CD ROMs, QTY 2	SEZ39131210-301 or 307	0.20ea	10.13
Cable Assembly, 1553 Data/28VDC Power (Rs)	SEG39129274-301	0.83	20
Kit, PCS Computer,	SJG39129275-301 through -321	1.05 (worst case)	240

3.2.2.2.2 Reserved

3.2.2.3 Physical Interfaces

3.2.2.3.1 Data Interfaces

a. The laptop shall have a MIL-STD-1553B data interface. The laptop 1553 interface will consist of the existing MIL-STD-1553B PCMCIA card (Part # SDG39129273-301) and new application software drivers. The hardware/software integration requirements associated with this interface are addressed in the PCS Development Specification JSC-27274.

b. The ISS laptop shall have an Ethernet interface capable of supporting 10 base T.

c. The ISS laptop shall support an RS-232 data interface.

d. The ISS laptop shall support an RS-422 data interface.

e. The ISS laptop shall provide a male DB-9 type connector configured as the standard serial computer port.

f. Reserved.

g. The ISS shall provide a suitable cable interface for data transfer from an ISS laptop to another laptop computer through RS232 port connections.

h. The laptop shall, as a minimum, support two Type I, two Type II, or one Type III PCMCIA cards.

i. The laptop shall, at a minimum, have a Super Video Graphics Adapter (SVGA) interface that supports the connection of an external monitor.

j. The laptop shall provide a parallel port.

k. The laptop shall provide audio interfaces for line in, headphones, and microphone.

l. The expansion chassis/docking station shall replicate laptop data ports when docked with a laptop. (This requirement is only applicable if expansion chassis/docking station is part of the laptop system deliverables).

m. The laptop shall support S-video (line in/line out) video interfaces.

n. The laptop shall provide a USB (V1.1 minimum) interface.

o. The laptop shall provide an IEEE 1394 port.

p. The laptop shall provide an UltraPort USB interface.

q. The laptop shall provide a standard RJ-45 connector and a method for strain relief attachment of this interface cable.

All other additional, specific, or unique SSC user software and hardware integration requirements are the responsibly of the user.

3.2.2.3.2 Power System Interface

a. The ISS laptop workstation shall interface to the ISS 120 VDC power system as specified in SSP 52051 Vol. I and SSP 30257:002.

b. Reserved

c. The ISS laptop shall interface to the Shuttle 28VDC power system as specified in SSP 52051, Vol. II and ICD-03-0014-0.

d. The ISS laptop workstation shall interface Russian Segment 28 VDC power systems as specified in SSP 52051, Vol. II.

e. An ISS laptop with a fully charged battery and power supply combined shall not exceed 72 Watts average power during nominal operations.

f. The ISS laptop and power supply combined shall not consume more than 120 Watts for 60 minutes during battery charging operations.

g. 30 minute requirement is: The laptop shall be capable of a minimum of 30 minutes of operation on internal battery..

h. The laptop shall be capable of operating normally and charging the internal battery at the same time.

i. The power supply shall have an output power inhibit switch.

j. The power supply shall have an output power indicator.

3.2.2.3.3 Human Computer Interfaces

Reserved

3.2.3 Reliability

3.2.3.1 Failure Tolerance

Specific user's ISS laptop software system configuration requirements for failure tolerance levels are addressed in the PCS Development Specification JSC-27274. Hardware failure tolerance for functions that are single-failure tolerant will be performed by redundant ISS laptops.

3.2.3.2 Quantitative Reliability

Not applicable.

3.2.3.3 Failure Propagation

ISS laptop COTS hardware (workstation, printer, off-line mass storage device, etc.) will be analyzed to determine its intrinsic failure propagation capabilities. Failure propagations for specific user's ISS laptop hardware/software system configuration of data systems are addressed in the PCS Development Specification JSC-27274.

Custom designed ISS laptop hardware (power supplies and cables) shall be designed such that:

a. An ISS laptop failure shall not propagate into Utility Outlet Panel (UOP) systems.
b. A Utility Outlet Panel (UOP) system failure shall not propagate into the ISS laptop COTS hardware.
c. An ISS laptop failure shall not propagate into ISS 1553B.
d. An ISS 1553B failure shall not propagate into the ISS laptop COTS hardware.
e. An ISS laptop, power supply, and power cable failure shall not induce a failure that propagates into the Shuttle power or other interfacing hardware.

3.2.3.4 Screening for Early Failure

ISS laptop hardware shall be submitted to burn-in testing to detect material and workmanship defects, which can result in early component failure.

3.2.4 Maintainability

3.2.4.1 Installation/Removal

The times to remove, replace, or install any laptop removable component shall not exceed ten minutes.

3.2.4.1.1 Equipment Item Interconnecting Devices

a. ISS Laptop cables shall be designed to preclude inadvertent disconnect.

b. Reserved

c. The ISS laptop shall have a restraint system that secures the unit in place during use.

d. The ISS laptop shall be restrained on-orbit by a nylon hook-and-loop fastening system (commonly known as Velcro™). Attachment configuration on the ISS laptop components shall adhere to the following constraints:

1. The ISS laptop components shall have hook or pile strips attached to the component backside using flight-approved Velcro™.

2. Maximum size of each hook-and-loop section shall be four square inches.

3. Maximum length of each hook-and-loop section shall be four inches.

4. Minimum separation between non-interconnecting hook-and-loop components shall be two inches.

3.2.4.1.2 Equipment Installation

a. The ISS laptop shall contain physical provisions to assist in correct installation.

3.2.4.1.3 Lockwiring and Staking

No ISS laptop system planned maintenance equipment installations or operational interfaces shall be lockwired or staked.

3.2.4.2 ISS Laptop Maintenance

a. Reserved

b. The time to remove a failed ISS laptop shall be a maximum of ten minutes.

c. Reserved

d. The ISS laptop hard drive shall be removable and replaceable, without damage to itself or the ISS laptop.

e. Reserved

f. The ISS laptop battery shall be removable, replaceable, and rechargeable.

g. The ISS laptop CMOS back-up battery shall be removable and replaceable on-orbit.

3.2.4.3 Failure Detection, Isolation and Recovery (FDIR)

Specific user's ISS laptop hardware/software system configuration requirements to detect failures, isolate, and recover are addressed in the PCS Development Specification JSC-27274.

3.2.5 Environmental Conditions

3.2.5.1 Thermal Environment

3.2.5.1.1 Non-Operating Thermal Environment

a. The ISS laptop hardware components shall meet the performance requirements specified herein following exposure to the thermal environments, in accordance with NSTS-21000-IDD-MDK.

b. The ISS laptop shall meet the performance requirements specified herein after exposure to ambient temperatures ranging from 0° C to 60° C.

c. The ISS laptop hardware components shall meet the performance requirements specified herein following exposure to the thermal environments, in accordance with ISS-MPLM-IDD-006.

3.2.5.1.2 Operating Thermal Environment

The ISS laptop shall be operational and meet the performance requirements specified herein when exposed to an ambient temperature environment ranging from 10° C to 35° C and in accordance with MF0004-14, for operations on the Orbiter aft flight deck.

3.2.5.2 Pressure Environment

3.2.5.2.1 Non-Operating Pressure Environment

The ISS laptop hardware components shall meet performance requirements specified herein following exposure to the nominal launch and landing pressure environments, in accordance with NSTS-21000-IDD-MDK and ISS-MPLM-IDD-006.

3.2.5.2.2 Operating Pressure Environment

The ISS laptop shall meet performance requirements specified herein during exposure to an ambient pressure environment ranging from 9.5 to 16.0 pounds per square inch absolute (psia).

3.2.5.3 Humidity

3.2.5.3.1 Non-operating Humidity Environment

The ISS laptop hardware components shall meet the performance requirements specified herein following exposure to 95% relative humidity in the facility storage configuration, and to the

humidity environment in accordance with NSTS-21000-IDD-MDK, NSTS-21000-IDD-ISS, MF0004-14 and ISS-MPLM-IDD-006.

3.2.5.3.2 Operating Humidity Environment

The ISS laptop hardware components shall meet the performance requirements specified herein when exposed to 50+/- 25 percent relative humidity for ISS and in accordance with MF0004-14, for Orbiter aft flight deck operations.

3.2.5.4 Vibration

3.2.5.4.1 Non-Operating Vibration Environment

The ISS laptop hardware components shall meet the performance requirements specified herein following exposure to the random vibration environment in accordance with NSTS- 21000-IDD-MDK, and ISS-MPLM-IDD-006.

3.2.5.4.2 Operating Vibration Environment

The ISS laptop hardware components shall meet the performance requirements specified herein during and after exposure to the maximum on-orbit vibration levels for 8-hour reduced proficiency requirements as specified in SSP 50005, section 5.5.

3.2.5.5 Non-Operating Acoustic Environment

Not applicable for ISS Laptop.

3.2.5.6 Acceleration

3.2.5.6.1 Non-Operating Acceleration Environment

The ISS laptop hardware components shall meet the performance requirements specified herein following exposure to the acceleration environments in accordance with NSTS-21000-IDD-MDK and ISS-MPLM-IDD-006.

3.2.5.6.2 Operating Acceleration Environment

The ISS laptop hardware components shall meet the performance requirements specified herein, in an on-orbit acceleration environment having peak transient accelerations of up to 0.4 g, acting in any direction, assuming a free-free boundary. Minimum quasi-static accelerations as low as zero g's may be experienced. For other environments, the ISS laptop hardware components shall meet the performance requirements specified herein following exposure to the acceleration environments in accordance with MF0004-14.

3.2.5.7 Transportation Shock Environment

a. The ISS laptop hardware components shall meet specified performance after exposure, in its transportation configuration, to the shock environment, for unpackaged components

weighing 150 lbs or less, in accordance with MIL-STD-810, method 516.4, procedure VI.

b. The ISS laptop hardware components shall meet specified performance after exposure, in its transportation configuration, to the shock environment, for packaged components weighing 150 lbs or less, in accordance with FED-STD-101C.

3.2.5.8 Ionizing Radiation

3.2.5.8.1 Total Ionizing Dose

The ISS laptop hardware components shall meet specified performance when exposed to a total dose environment of 600 rads (Si), which is equivalent to 60 rads per year for a total of 10 years of orbital lifetime.

3.2.5.8.2 Nominal Single Event Effects

The ISS laptop hardware components shall meet specified performance when exposed to the nominal Single Event Effects (SEE) environment defined in SSP 30512.

The ISS laptop hardware components shall meet specified performance when exposed to the nominal Single Event Effects (SEE) environment defined in the Orbiter End Item Specification - MJ070-0001-1E, Performance & Design Rqmts, Sections: 3.5.20"Avionics Radiation Requirements" and 10.1.7 "Radiation".

3.2.5.9 Enriched Oxygen Environment

The ISS laptop hardware components shall meet specified performance when the atmosphere is at 10.2 +/- 0.2 psia with an oxygen concentration of up to 30 percent.

3.2.5.10 Meteoroids and Orbital Debris

Not Applicable.
Rationale: The ISS laptop system will be used only for IVA activities.

3.2.5.11 Atomic Oxygen

Not Applicable.
Rationale: The ISS laptop system will be used only for IVA activities.

3.2.5.12 External Contamination

Not Applicable.
Rationale: The ISS laptop system will be used only for IVA activities.

3.2.6 Transportability

a. The ISS laptop shall be launch-package transportable in the Shuttle middeck locker to and from orbit, as specified in NSTS-21000-IDD-MDK.

b. For ground transportation, flight hardware shall meet the packaging, handling and transportation requirements of JSC SLP- 4.15. COTS equipment is exempt until received at JSC.

c. The ISS laptop shall be launch-package transportable in the Multi-Purpose Logistics Module to and from orbit, as specified in ISS-MPLM-IDD-006.

d. The ISS laptop shall be launch-package transportable in the Russian Soyuz and Progress to orbit.

3.3 Design and Construction

3.3.1 Materials, Processes and Parts

3.3.1.1 Materials and Processes

a. Materials and processes shall meet the requirements of SSP 30233, Space Station Requirements for Materials and Processes, as implemented for JSC Government Furnished Equipment (GFE) by JSC 27301, Materials Control Plan for JSC Space Station GFE and SE-R-0006D, Space Shuttle System Requirements for Materials & Processes.

b. Fracture control shall meet the requirements of SSP 30558, Fracture Control Requirements for Space Station, as implemented by JSC 25863, Fracture Control Plan for JSC Flight Hardware.

c. ISS interface connectors shall be selected and designed in accordance with SSP 30312. For ISS laptop related in-house designed GFE, all EEE parts will be in accordance with the Engineering Directorate Certified Part Approval Process (EDCPAP) selection process, JSC 61360.

d. Connectors for intra-vehicular activities crew interfaces shall be selected and designed in accordance with SSP 50005, paragraph 11.10.3.

e. Except for COTS equipment, connector spacing shall be in accordance with SSP 50005, paragraph 11.10.3.6.

f. The ISS laptop monitor shall incorporate features to contain all glass particles and fluids if the monitor is broken.

3.3.1.2 Electrical, Electronic and Electromechanical Parts Selection

a. Electrical, Electronic and Electromechanical (EEE) parts shall be selected in accordance with SSP 30312 Rev H paragraph 3.16 for COTS or existing hardware.

b. EEE parts for in house designed flight hardware elements shall be selected in accordance with JSC 61360, EDCPAP.

.Deleted

3.3.2 Electromagnetic Radiation

3.3.2.1 Electromagnetic Compatibility

This paragraph is not applicable.

3.3.2.2 Electromagnetic Interference

The ISS laptop hardware components shall comply with applicable requirements in JSC 28484, 3.3.4 for ISS with electromagnetic interference and susceptibility requirements in the applicable sections of SSP 30237and SSP 50094 section 3.4.

The ISS laptop hardware components shall comply with electromagnetic interference and susceptibility requirements in the applicable requirements of SL-E-0002 Book 3 Volume 1.

3.3.2.3 Electrical Grounding

Except for COTS equipment, the ISS laptop grounding requirements shall be in accordance with SSP 30240.

Except for COTS equipment, the ISS laptop grounding requirements shall be in accordance with NSTS 37330.

3.3.2.4 Electrical Bonding

Except for COTS equipment, the ISS laptop bonding requirements shall be in accordance with SSP 30245.
Except for COTS equipment, the ISS laptop bonding requirements shall be in accordance with NSTS 07700 Volume X – Book 1, Section 3.6.14 and NSTS 37330.

3.3.2.5 Cable and Wire Design

Except for COTS equipment, the ISS laptop interconnect, interconnect cable, and wire design shall be in accordance with SSP 30242.

Except for COTS equipment, the ISS laptop interconnect, interconnect cable, and wire design shall be in accordance with TM102179, Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits.

3.3.2.6 Electrostatic Discharge

Except for COTS equipment, the ISS laptop shall be in accordance with the electrostatic discharge requirements of SSP 30243

Except for COTS equipment, the ISS laptop shall be in accordance with the electrostatic discharge requirements of NSTS 07700 Volume X – Book 1, Section 3.6.25.

3.3.3 Nameplates and Product Marking

a. Product marking for ground assembly and handling shall be in accordance with MIL-STD-130, except paragraph 4.1c.

b. Equipment labeling and marking for the on-orbit crew interface shall be in accordance with SSP 50005, paragraph 9.5.3.1.

c. Space shall be provided on loose equipment, consumables, and ORU's for an inventory management label attached in accordance with SSP 50007.

d. Test, adjustment, and alignment points shall be identified and labeled in accordance with SSP 50005, paragraph 12.3.2.2, items D and E.

e. Connectors and connections shall have durable strips, arrows, or other indications to show the positions of alignment pins or equivalent devices for proper insertion, in accordance with SSP 50005, paragraph 11.10.3.5.

3.3.4 Workmanship

Except for COTS equipment, the design, manufacture and inspection of electrical / electronic equipment shall conform to the following workmanship requirements, where applicable:

1. Rigid Printed Wiring Board (PWB) Design
   Rigid printed boards (single, double, metal-core, or multi-layer structures), incorporating plated-through and non-plated-through holes, with or without buried or blind vias shall meet the Performance Class 3 qualification and performance specifications of the following standards:
   a) IPC-2221A – “Generic Standard On Printed Board Design”, May 2003
   b) IPC-2222 – “Sectional Design Standard For Rigid Organic Printed Boards”, February 1998
   c) IPC-6011 – “Generic Performance Specification for Printed Boards”, July 1996
   d) IPC-6012B – “Qualification and Performance Specification for Rigid Printed Boards”, August 2004
   e) Printed Wiring Board Coupons
      Coupons shall be included in the printed wiring board panelization, and shall comply with IPC-6012 [4.0], Tables 4-1 through 4-4. Coupon analysis shall comply with IPC

Class 3 requirements. Coupon analysis may be performed by the vendor; an independent certified third party lab; NASA/JSC; or, as agreed upon by NASA/JSC and the PWB vendor. All tested and untested coupons shall be delivered to NASA / JSC as part of the procurement.

3. Electronic Assembly and Soldering
   For the assembly and manufacture of electrical and electronic assemblies, requiring soldering of through-hole and surface mount technology devices, using hand, wave, or reflow processes, the following shall be applicable:

   a. Surface Mount Technology (SMT) Soldering - Soldering of surface mount technology shall meet the workmanship requirements of: NASA-STD-8739.2 – "Workmanship Standard for Surface Mount Technology", August 1999.

   b. Through-hole and Discrete Soldering - Soldering of through-hole technology devices and discrete solder terminations, using hand, wave, or reflow processes shall meet the workmanship requirements of NASA-STD-8739.3 - "Soldered Electrical Connections", December 1997.

4. Staking and Conformal Coating
   Staking processes and conformal coating of printed circuit boards and electronic assemblies shall meet the workmanship requirements of NASA-STD-8739.1 – "Workmanship Standard for Staking and Conformal Coating of Printed Wiring Boards and Electronic Assemblies", August 1999.

5. Crimping, Interconnecting Cable, and Harness Assemblies
   Crimp terminations and interconnecting cable and harness assemblies shall meet the workmanship requirements of NASA-STD-8739.4 – "Crimping, Interconnecting Cables, Harnesses and Wiring", February 1998.

6. Fiber Optics
   Fiber optic terminations and cabling, incorporating single- and multi-mode fiber shall meet the workmanship requirements of NASA-STD-8739.5 – "Fiber Optic Terminations, Cable Assemblies, and Installation", February 1998.

7. Electrostatic Discharge (ESD) Control
   Electrostatic discharge sensitive parts, assemblies, and equipment shall be controlled in accordance with the requirements of NASA-STD-8739.7, Electrostatic Discharge Control (Excluding Electrically Initiated Explosive Devices), as implemented through ANSI / ESD S20.20 - 1999 – "ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)", August 1999.

8. Wire and Cable
   Wire and Cable Wire and cable for flight and critical ground support applications shall be compliant with JPR 8080.5, "JSC Design and Procedural Standards Manual", Standard E-24, "Electrical Wire and Cable Acceptance Tests", as implemented through JSC-49879, "JSC Wire & Cable Integrity Compliance Program", November 2003 3.3.2.4 – Soldering

9. Commercial-Off-The-Shelf (COTS)

All commercial-off-the-shelf (COTS) hardware that cannot provide objective evidence (OE) of material certification, part traceability, or workmanship processes shall be evaluated for further testing that will be used to supplement the acceptance testing for that hardware. COTS hardware workmanship will be evaluated and modifications will be incorporated as required to ensure safe operation in the application and environment(s) specified herein.

3.3.4.1 Cleanliness

Exterior surfaces of ISS laptop hardware components shall conform to the cleanliness requirements as specified in JPG 5322.1.

3.3.5 Interchangeability

All removable items, subassemblies, and parts with the same part numbers shall be interchangeable.

3.3.6 Safety

3.3.6.1 General

A Risk Assessment Executive Summary Report (RAESR) or Safety Assessment Report (SAR) will be prepared, submitted, and approved in accordance with the following procedures:

a. NT3–GFE–014, Preparation of Risk Assessment Executive Summary Report (RAESR) and Risk Reports

b. NT3–GFE–011, JSC GFE Flight Safety Review Process

The following paragraphs of this section define technical requirements related to the control or elimination of hazards. Any deviation or waiver to these requirements will be documented in the RAESR. Approval of the RAESR constitutes approval of the deviation/waiver.

3.3.6.1.1 Catastrophic Hazards

ISS laptop system design shall be implemented such that no combination of two failures, two operator errors, or one of each can result in a disabling or fatal personal injury or loss of the Orbiter or ISS.

3.3.6.1.2 Critical Hazards

ISS laptop system design shall be implemented such that no single failure or single operator error can result in a non-disabling personal injury, severe occupational illness, loss of an ISS major element, loss of an ISS on-orbit life-sustaining function or emergency system, or damage to the Orbiter.

3.3.6.1.3 Design for Minimum Risk

a. Custom-designed ISS laptop hardware shall be designed to minimize risk.

b. COTS ISS laptop hardware shall be analyzed to determine its risk potential.

c. Hazards related to “Design for Minimum Risk” (as defined in S684-10143 sec 6.1) areas of design shall be controlled by the safety related properties and characteristics of the design, such as margin of safety, factors of safety, that have been baselined by ISS Program requirements.

d. The failure tolerance criteria of 3.3.6.1.1 and 3.3.6.1.2 shall only be applied to these designs as necessary to assure that credible failures that may affect the design do not invalidate the safety related properties of the design.

3.3.6.1.4 Control of Functions Resulting in Critical Hazards

a. The ISS laptop system shall not directly control any ISS operations that could result in critical hazards. This requirement is based on the function being performed by the hardware and software as a system and is beyond the scope of this document. The PCS functions will be verified in accordance with the PCS Development Specification JSC-27274.

b. The ISS laptop system shall not be relied upon to mitigate the potential risks of any ISS operations that could result in critical hazards. This requirement is based on the function being performed by the hardware and software as a system and is beyond the scope of this document. The PCS functions will be verified in accordance with the PCS Development Specification JSC-27274.

c. The ISS laptop system will provide a hardware platform which supports command and control functions meeting the 1R/3 criticality. Certification of the ISS Laptop system (hardware and software) as 1R/3 criticality is the user’s responsibility.

3.3.6.1.5 Control of Functions Resulting in Catastrophic Hazards

a. The ISS laptop shall not directly control any ISS operations that could result in catastrophic hazards. This requirement is based on the function being performed by the hardware and software as a system and is beyond the scope of this document. The PCS functions will be verified in accordance with the PCS Development Specification JSC-27274.

b. The ISS laptop shall not be relied upon to mitigate the potential risks of any ISS operations that could result in catastrophic hazards. This requirement is based on the function being performed by the hardware and software as a system and is beyond the scope of this document. The PCS functions will be verified in accordance with the PCS Development Specification JSC-27274.

3.3.6.1.6 Environmental Compatibility

The ISS laptop shall be certified as safe in the applicable worst-case natural and induced environments defined in section 3.2.5, "Environmental conditions."

3.3.6.2 Command and Computer Control of Hazardous Functions

Specific user requirements of any ISS laptop system capability to command and control of hazardous functions are addressed in the PCS Development Specification JSC-27274.

3.3.6.3 Non-Ionizing Radiation

The ISS laptop shall limit the levels of non-ionizing radiation of the ISS laptop in accordance with SSP 50005, paragraphs 5.7.3.2 and 5.7.3.2.1, to provide protection to personnel.

3.3.6.4 Electrical safety

3.3.6.4.1 Electrical Power Circuit Overloads

3.3.6.4.1.1 Circuit Overload Protection

Electrical power distribution circuitry shall include protective devices to guard against circuit overloads which could result in distribution circuit damage, excessive hazardous products in pressurized areas, and to prevent damage to other safety critical circuits.

3.3.6.4.1.2 Protective Device Sizing

Circuit protective devices shall be sized such that steady state currents in excess of the values allowed by SSP 30312 Rev H, Appendix B, Section B 3.5.2 are precluded for ISS and are allowed by TM102179, , Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits, for SSP.

3.3.6.4.1.3 Bent Pin or Conductive Contamination

a. ISS laptop electrical design shall ensure that shorts between any pin within a connector, that could be caused by conductive contamination or a pin bent prior to or during connector mating, cannot invalidate more than one inhibit to a hazardous function.

b. Conductive contamination as a similar cause shall be precluded by proper inspection procedures.

3.3.6.4.2 Crew Protection for Electrical Shock

The crew shall be protected from electrical hazards in accordance with SSP 50005, Section 6.4.3.

3.3.6.4.3 Batteries

ISS laptop batteries, which can pose a hazard, shall be modified such that they are in accordance with NSTS 20793.

3.3.6.4.4 Reapplication of Power

ISS laptop hardware shall include design features that allow input power to be disconnected.

3.3.6.4.5 Corona

ISS laptop hardware that contains voltage potential in excess of 300 volts shall be designed to preclude hazards caused by corona.

3.3.6.5 Constraints

3.3.6.5.1 Pressure Differential Tolerance

ISS laptop equipment located in pressurized volumes shall be capable of withstanding the differential pressure of depressurization, repressurization, and the depressurized condition, shown below without resulting in a hazard:

Depressurization 8 psi per minute,
Repressurization 9 psi per minute.

3.3.6.5.2 Operation During Pressure Changes

Equipment required to function during depressurization or repressurization shall operate without producing hazards. The ISS laptop hardware components are not required to meet the operational requirements specified herein, after exposure to pressures below the operational limit.

3.3.6.5.3 Component Hazardous Energy Provision

The ISS laptop may retain hazardous energy potential after the equipment is turned off. In this case, the ISS laptop shall

a. contain provisions for confirming that components containing hazardous energy potential have been saved, or

b. be located where crew members cannot contact any hazardous energy potential while performing maintenance, or

c. rely on crew procedures to ensure that a minimum time has elapsed before cables that allow the crew to inadvertently discharge stored energy are disconnected.

3.3.6.6 Human Engineering Safety

3.3.6.6.1 Internal Volume Touch Temperature

3.3.6.6.1.1 Continuous Contact - High Temperature

Surfaces, which are subject to continuous contact with crew member bare skin and whose temperature exceeds 113 degrees Fahrenheit, shall be provided with guards or insulation to prevent crew member contact in accordance with SSP 50005, section 6.5.3.B.

3.3.6.6.1.2 Incidental or Momentary Contact - High Temperature

For incidental or momentary contact (30 seconds or less), the following apply:

a. Crew member warning - Surfaces which are subject to incidental or momentary contact with crew member bare skin and whose temperatures are between 113 and 122 degrees Fahrenheit shall have warning labels that will alert crew members to the temperature levels, in accordance with SSP 50005, section 6.5.3.C.1.

b. Crew member protection - Surface temperatures which exceed 122 degrees Fahrenheit shall be provided with guards or insulation that prevent crew member contact in accordance with SSP 50005, section 6.5.3.C.2.

3.3.6.6.1.3 Internal Volume Low Touch Temperature

When surfaces below 39 degrees Fahrenheit which are subject to continuous or incidental contact are exposed to crew member's bare skin, protective equipment shall be provided to the crew and warning labels shall be provided at the surface site.

3.3.6.6.2 Internal Corner and Edge Protection

3.3.6.6.2.1 Equipment Exposed to Crew Activity

Surfaces of ISS laptop equipment located in pressurized volumes and exposed to crew activity shall protect the crew from injury due to sharp edges and corners within the habitable volume in accordance with SSP 50005, Paragraphs 6.3.3.1, Corner and edge requirements for facilities and mounted equipment, Paragraphs 6.3.3.2, Exposed corner requirements from facilities and mounted hardware, Paragraphs 6.3.3.3, Protective covers, and Paragraphs 6.3.3.11, Loose equipment.

3.3.6.6.2.2 Equipment Exposed Only During Planned Maintenance Activities

Corners and edges of material, equipment or ORU's which are exposed only during planned maintenance activities shall be rounded to a minimum radius or chamfer of 0.03 inches.

3.3.6.6.3 Burrs

Exposed surfaces shall be smooth and free of burrs.

3.3.6.6.4 Holes

Round or slotted holes that are uncovered shall be less than 0.4 inches or greater than 1.0 inches in diameter for equipment located inside habitable volumes.

3.3.6.6.5 Moving Parts

Moving parts such as fans, belt drives, turbine wheels, and similar components that could cause personnel injury or equipment damage due to inadvertent contact or entrapment of floating objects shall be provided with guards or other protective devices.

3.3.7 Human Engineering

3.3.7.1 Strength Requirements

The ISS laptop hardware which will have a crew interface under normal operations shall accommodate the strength limitations in the fifth percentile American female as defined in accordance with SSP 50005, paragraph 4.9, Strength Design Requirements.

3.3.7.2 Maintenance

The internal components of the ISS Laptop, which will have crew interfaces for maintenance only, shall accommodate the strength limitations of the fifth percentile American male population in accordance with SSP 50005, section 4.9, Strength Design Requirements.

3.3.7.3 Controls and Displays

a. Except for COTS and existing design hardware, the internal controls, such as knobs, switches, toggles, push buttons etc., shall be selected to meet the specific applicable control requirements in accordance with SSP 50005, section 9.3.

b. Except for COTS and existing design hardware, the internal displays, such as legend lights, flags, Light Emitting Diodes (LED's), etc., shall be selected to meet the specific application display requirements in accordance with SSP 50005, section 9.4.

3.3.8 Nuclear Control

This paragraph is not applicable.

3.3.9 Portable Computer System Security

This paragraph is not applicable.

3.3.10 Environmental Constraints

3.3.10.1 Acoustic Emission Limits

The ISS laptop shall not exceed the US NC40 criterion shown in Table 6 when averaged over a minimum ten second interval. This requirement does not apply during alarm or warning conditions.

TABLE 3 - US NC40 Sound Pressure Levels at Octave Band Center Frequencies

Frequency (Hertz)	Sound Pressure Level (dB)
63	63
125	56
250	50
500	45
1000	41.4
2000	39
4000	37.5
8000	37

3.3.10.2 Ionizing radiation emission limits

Not applicable. The ISS laptop is not a source of ionizing radiation.

3.4 COMPUTER RESOURCE REQUIREMENTS

3.4.1 Computer Hardware Design Considerations

The computer is a COTS IBM ThinkPad Series A31p ™ Notebook with no performance modification.

a. The ISS laptop shall have a minimum of 32 megabytes of random access memory. The ISS Laptop will have a minimum of 1 gigabyte of random access memory.

b. The ISS laptop shall contain a minimum of 2 gigabytes of non-volatile mass storage. The ISS Laptop will contain a minimum of 60 gigabytes of removable non-volatile mass storage.

c. The ISS laptop removable non-volatile mass storage shall provide a minimum capacity of 80 megabytes. The ISS Laptop removable non-volatile mass storage will provide a minimum capacity of 500 megabytes. Can be met by a PCMCIA hard drive card.

d. Reserved

e. Reserved

f. The ISS laptop shall have internal speakers.

g. The ISS laptop shall be able to operate for a minimum of 30 minutes after being detached from all peripherals and external power.

h. The ISS laptop display shall have a minimum resolution of 800 x 600 pixels, a minimum diagonal of 11 inches, and be capable of displaying a minimum of 256 colors simultaneously. The ISS laptop display will have a resolution of 1600 x 1200 pixels, a

minimum diagonal of 15 inches, and be capable of displaying 32-bit color depth (True Color) simultaneously at the 1600 x 1200 resolution.

i. The ISS laptop shall have the capability to connect to a COTS expansion chassis (docking station) for the purpose of, as a minimum, adding expansion cards and/or peripherals to the computer.

j. The ISS laptop shall provide the capability to import RS-170A National Television Standards Committee (NTSC) video for display in a window of up to 640 x 480 pixels.

k. The ISS laptop shall, as a minimum, have an interface that supports two Type I, two Type II, or one Type III PCMCIA cards.

l. The laptop will have updateable flash Basic Input/Output System (BIOS).

m. The laptop will support plug-and-play operating systems.

n. The laptop will use a Pentium 4 processor (minimum).

o. Central Processing Unit (CPU) internal frequency (speed) will be at a minimum 1200 MHz.

p. The laptop will provide audio support (chipset) to the supported operating systems.

q. The expansion chassis (docking station) will support a PCI expansion card slot for additional peripheral devices.

r. The laptop will provide a suitable cursor pointer control device that works in zero-g.

s. The materials mitigation shall not impact the use of embedded wireless networking antennas in the laptop.

t. The laptop shall have strain relief for the 1553 PCMCIA card. Strain relief is a design goal for other PCMCIA cards.

3.4.2 Software

All firmware/BIOS on the ISS laptop shall be in accordance with SKG33115373, IBM A31P Firmware/BIOS Configuration drawing.

The operating system and software loads that utilize the ISS laptop are out of the scope of this PTRS. A system test of the PCS Development Specification for PCS requirements as well as the parent requirement specification for the LCS for Shuttle shall be verified by the system integrator.

3.5 LOGISTICS

All ISS laptop flight hardware, which is a new design or modified commercial off-the-shelf, COTS, will meet the intent of D684-10041-1 and all sub-plans therein.

3.5.1 Maintenance

3.5.1.1 On-Orbit Laptop Workstation Maintenance

a. Except for the software, maintenance for a defective ISS laptop workstation shall be to remove and replace the ORU, cables, drives and internal batteries.

b. Reserved

3.5.1.2 Reserved

3.5.1.3 Ground Maintenance

ISS laptop ORU's designated as repairable shall be designed for ground maintenance.

3.5.1.4 Lifetime

Laptop battery shall be within shelf life.

3.5.2 Supply

This paragraph is not applicable.

3.5.3 Facilities and Faculty Equipment

This paragraph is not applicable.

3.6 PERSONNEL AND TRAINING

This paragraph is not applicable.

3.7 ISS LAPTOP MAJOR COMPONENT CHARACTERISTICS

This paragraph is not applicable.

4.0 QUALITY ASSURANCE PROVISIONS

This section contains the formal qualification requirements that are necessary to show compliance with each "shall" statement in Section 3 of this document. Non "shall" statements will not, and are not to be quality assurance checked for compliance. This qualification consists of:

a. Data for the reliability analysis, which will be collected and recorded during qualification.

b. Engineering (development) evaluations and tests may be required for analyzing design approaches to ensure that requirements encompassing materials selection, tolerances and operational characteristics are satisfied. If development test data is intended to be used to qualify hardware, its intent shall be pre-declared.

c. Qualification requirements are specified in Section 4.3. Qualification represents the broadest scope of verification within design tolerances to which a configuration/end item is subjected. This encompasses the entire range of activity to verify that the design conforms to requirements when subjected to environmental life-cycle conditions. Flight-like hardware is normally used for qualification testing. If actual flight hardware is used for qualification testing, it shall be in accordance with SSP 41172 and SSP 50094. Environmental models shall be used to represent environments that cannot be achieved under the conditions of ground testing. Simulators, used for verifying requirements require validation so that the item undergoing qualification cannot distinguish between the simulator and actual operational hardware/software.

d. Integration testing and checkout shall be conducted during end item buildup. Activities such as continuity checking and interface mating will be performed. Activities such as major component operation in the installed environment, support equipment compatibility, and documentation verification will be proven during qualification.

e. Formal verification of performance characteristics occurs for the full range of performance requirements during qualification.

4.1 QUALITY ASSURANCE

The Quality Management System (QMS) for this project will be in accordance with JPR 5335.3, “JSC Quality Manual” for onsite design, development, manufacturing, and testing. For offsite activities the QMS will be ANSI/ISO/ASQ Q9001-2000 Quality Management Systems-Requirements, as tailored for that particular procurement. Where existing JSC contracts are used for design, development, manufacturing, or testing the contract required QMS shall prevail.

4.2 GENERAL

Compliance with the requirements in Section 3 shall be proven using one or more of the following methods:

Inspection (I) Inspection is a method that determines conformance to requirements by the review of drawings, data or by visual examination of the item using standard quality control methods, without the use of special laboratory procedures.

Analysis (A) Analysis is a process used in lieu of, or in addition to, other methods to ensure compliance to specification requirements. These selected techniques may include, but not be limited to, engineering analysis, statistical and quantitative analysis, computer and hardware

simulations, and analog modeling. Analysis may also include assessing the results of lower level qualification activity. Verification by similarity is the process of analyzing the specification criteria for the hardware configuration and application for an article to determine if it is similar or identical in design, manufacturing process, and quality control to an existing article that has been qualified to equivalent or more stringent specification criteria. Special effort will be made to avoid duplication of previous tests from this or similar programs. If the previous application is considered to be similar, but not equal to or greater in severity, additional qualification tests shall concentrate on the areas of new or increased requirements.

Demonstration (D) Demonstration consists of a qualitative determination of the properties of a test article. This qualitative determination is made through observation, with or without special test equipment or instrumentation, which verifies characteristics such as human engineering features, services, access features, and transportability. Demonstration requirements are normally implemented within a test plan, operations plan, or test procedures.

Test (T) Test is a method in which technical means, such as the use of special equipment, instrumentation, simulation techniques, and the application of established principles and procedures, are used for the evaluation of components, subsystems, and systems to determine compliance with requirements. Test shall be selected as the primary method when analytical techniques do not produce adequate results; failure modes exist which could compromise personnel safety, adversely affect flight systems or payload operations, or result in a loss of mission objectives; or for any components directly associated with Space Station and Orbiter interfaces. The analysis of data derived from tests is an integral part of the test program, and should not be confused with analysis as defined above. Tests shall be used to determine quantitative compliance to requirements and produce quantitative results.

4.2.1 Responsibility For Verification

Unless otherwise specified in the contract, the supplier is responsible for the performance of verification activities as specified herein. Except as otherwise specified in the contract, the supplier may utilize its own facilities or any other facility suitable for the performance of the verification activities specified herein, unless disapproved by the US Government. The US Government reserves the right to perform any of the inspections set forth in this specification.

4.3 ISS LAPTOP QUALITY CONFORMANCE INSPECTIONS

Mandatory qualification tests are specified in SSP 41172, SSP 50094, and JSC 28484. Verifications are to be performed to the most stringent of these requirements, which may be applicable to the hardware classification being evaluated. Demonstrations, analyses, inspections, and any additional test requirements are specified herein. Individual verification requirements and any additional test requirements are specified herein. Individual verification requirements do not require a stand-alone verification to be performed but may be combined with activities satisfying other verification requirements to prevent redundancy and optimize commonalty.

4.3.1 Requirement/Verification Cross Reference Matrix

JSC 49735 and JSC 62949, Verification and Validation Document: Plan and Report for the ISS IBM ThinkPad Series A31p™ Laptop System correlates performance requirements in Section 3 to the applicable verification requirements specified in Section 4.3.

The verification types are listed as “I” (Inspection), “A” (Analysis), “D” (Demonstration), or “T” (Test).

4.4 QUALITY CONFORMANCE VERIFICATION

4.4.1 General

This section describes the specific verification procedure to be used in executing the method.

A combination of IBM COTS test software and ISS program supplied application software will be used to verify laptop requirements. All firmware/BIOS on the ISS laptop shall be in accordance with SKG33115373, IBM A31P Firmware/BIOS Configuration drawing.

The operating system and software loads that utilize the ISS laptop are out of the scope of this PTRS. A system test of the PCS Development Specification for PCS requirements as well as the parent requirement specification for the LCS for Shuttle shall be verified by the system integrator.

4.4.2 ISS laptop system characteristics

No verification required.

4.4.2.1 Performance Characteristics

No verification required.

4.4.2.1.1 Provide General Computer Capabilities

No verification required.

4.4.2.1.1.1 Provide Display Capabilities

a. Reserved

b. Reserved

c. Reserved

d. Reserved

e. Reserved

f. Reserved

g. Reserved

h. Reserved

4.4.2.1.1.2 Provide Storage Capabilities

a. Reserved

b. This requirement shall be verified by demonstration. The demonstration shall be considered successful when the demonstration of the ISS laptop hardware shows that removable mass storage is available on the ISS laptop.

c. This requirement shall be verified by demonstration using a flight equivalent unit, Flight Equivalent Unit (FEU) ISS laptop workstation. The verification shall be considered successful when a data file is correctly written (saved) to the hard drive, floppy drive and CD-RW and a data file can be correctly read from the hard drive, floppy, DVD, DVD-R, and CD-R, CD-RW.

d. Reserved

e. Reserved

f. Reserved

g. No verification required. Will statement.

h. This requirement shall be verified by demonstration using an FEU ISS laptop workstation. The verification shall be considered successful when it is shown the ISS laptop allows the addition of a floppy drive & a CD/DVD drive simultaneously.

i. Reserved

4.4.2.1.1.3 Provide Execution Capabilities

a. This requirement is not verifiable by the hardware provider. Specific user's ISS laptop hardware/software system configuration execution capability requirements are the responsibility of the end user

b. Reserved.

4.4.2.1.1.4 Provide Startup Capabilities

This requirement shall be verified by demonstration. The demonstration shall be performed on FEU ISS laptop workstation. . The verification shall be considered successful when it is shown that the FEU ISS laptop workstation initialize and perform internal self test and provide feedback.

4.4.2.1.2 Receive and Process External Data

No verification required.

4.4.2.1.3 Provide caution and warning (C&W) capabilities

No verification required.

4.4.2.1.4 Provide file transfer capabilities

Sections a. through d. are reserved.

a. Reserved.
b. Reserved.
c. Reserved.
d. Reserved.

e. This requirement shall be verified by test using an FEU ISS laptop workstation. The verification shall be considered successful when it is shown that the ISS laptop transfers a file through PCMCIA Cards and that the file data has not been corrupted.

f. This requirement shall be verified by test using an FEU ISS laptop workstation communicating through the 10 Base T (RJ-45) interface. The verification shall be considered successful when it is shown that the ISS laptop can transfer and receive a file stored on the ISS laptop through the 10 Base T (RJ-45) interface and that the file data has not been corrupted.

g. This requirement shall be verified by test using an FEU ISS laptop workstation communicating through the IEEE 1394 connector (4-pin) interface. The verification shall be considered successful when it is shown that the ISS laptop can transfer and receive a file stored on the ISS laptop through the IEEE 1394 connector (4-pin) interface and that the file data has not been corrupted.

h. This requirement shall be verified by test using an FEU ISS laptop workstation communicating through the Serial connector (DB-9) interface. The verification shall be considered successful when it is shown that the ISS laptop can transfer and receive a file stored on the ISS laptop through the Serial connector (DB-9) interface and that the file data has not been corrupted.

i. This requirement shall be verified by test using an FEU ISS laptop workstation communicating through the Parallel connector (DB-25) interface. The verification shall be considered successful when it is shown that the ISS laptop can print a file stored on the ISS laptop through the Parallel connector (DB-25) interface and that the file data has not been corrupted.

j. This requirement shall be verified by demonstration using an FEU ISS laptop workstation communicating through the UltraPort USB and the USB interface. The verification shall be considered successful when it is shown the ISS laptop can at least receive video from the UltraPort camera.

k. This requirement shall be verified by test using an FEU ISS laptop workstation communicating through the 802.11b Wireless LAN interface. The verification shall be considered successful when it is shown that the ISS laptop can transfer and receive a file stored on the ISS laptop through the Wireless LAN (RF) interface and that the file data has not been corrupted. This test shall be performed in an environment with no other known RF interference.

l. This requirement shall be verified by test using an FEU ISS laptop workstation communicating through the Bluetooth interface. The verification shall be considered successful when it is shown that the ISS laptop can transfer and receive a file stored on the ISS laptop through the Bluetooth (RF) interface and that the file data has not been corrupted. This test shall be performed in an environment with no other known RF interference.

m. This requirement shall be verified by test using an FEU ISS laptop workstation communicating through the IR interface. The verification shall be considered successful when it is shown that the ISS laptop can transfer and receive a file stored on the ISS laptop through the IR interface and that the file data has not been corrupted. This test shall be performed in an environment with no other known IR interference.

4.4.2.1.5 Provide communication capabilities

Sections a. through t. are reserved.

a. Reserved.
b. Reserved.
c. Reserved.
d. Reserved.
e. Reserved.
f. Reserved.
g. Reserved.
h. Reserved.
i. Reserved.
j. Reserved.
k. Reserved.

l. Reserved.
m. Reserved.
n. Reserved.
o. Reserved.
p. Reserved.
q. Reserved.
r. Reserved.
s. Reserved.
t. Reserved.
u. Verified per 4.3.2.1.4 e.
v. Verified per 4.3.2.1.4 f.
w. Verified per 4.3.2.1.4 g.
x. Verified per 4.3.2.1.4 h.
y. Verified per 4.3.2.1.4 i.
z. Verified per 4.3.2.1.4 j.
aa. Verified per 4.3.2.1.4 j

4.4.2.2 Physical characteristics

4.4.2.2.1 Volume & Envelope

4.4.2.2.1.1 ISS Laptop Volume & Envelope

This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows that ISS Laptop, power supply and cables when added to volume of items listed in table 1 Existing PCS hardware weights,. stowed package configuration is less or equal to the volume and dimensions of a middeck locker (16.95 inches by 20.0 inches by 9.52 inches).

4.4.2.2.1.2 Reserved

4.4.2.2.2 Mass Properties

4.4.2.2.2.1 ISS Laptop Weight Allocation

This requirement shall be verified by test and analysis. The test shall be conducted to determine the actual weight of the ISS laptop (laptop, power supply, and cables). The verification shall be considered successful when the test and analysis results show the weight of the ISS laptop (laptop, power supply, and cables) is less than or equal to the specified maximum of 25 pounds.

4.4.2.2.2.2 Reserved

4.4.2.2.3 Physical Interfaces

4.4.2.2.3.1 Data Interfaces

a. This requirement shall be verified by demonstration and previous test of MIL-STD-1553B PCMCIA card (Part # SDG39129273-301) using a Windows OS platform. The

verification shall be considered successful when the demonstration shows that the ISS laptop hardware has the capability to communicate using a 1553 interface. The MIL-STD-1553B data interface, which consists of the existing MIL-STD-1553B PCMCIA card (Part # SDG39129273-301) shall be met by providing MIL-STD-1553B test data from previous certification.

b. This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows that the ISS laptop hardware has the capability to communicate using Ethernet using a Windows OS platform.

c. This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows that the PCS hardware has a RS-232 interface using a Windows OS platform.

d. This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows that the PCS hardware has a RS-422 interface using a Windows OS platform.

e. This requirement shall be verified by inspection. The verification shall be considered successful when an inspection of the ISS laptop hardware or manufacturer's documentation shows that the ISS laptop provides a DB-9 male connector as a serial computer port.

f. No verification required.

g. This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows that the ISS laptop hardware has the capability to connect serially to another laptop computer using a Windows OS platform.

h. This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows the ISS laptop hardware provides the data interfaces specified by the requirement.

i. This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows that the ISS laptop provides a Super Video Graphics Array (SVGA) interface that supports the connection of an external monitor using a Windows OS platform.

j. This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows that the ISS laptop hardware provides the data interfaces specified by the requirement.

k. This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows that the ISS laptop hardware provides the data interfaces specified by the requirement.

l. This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows the expansion chassis/docking station replicates laptop data ports when docked. This requirement is only applicable if the docking station is part of the ISS laptop system deliverables.

m. This requirement shall be verified by demonstration. This verification shall be considered successful when the demonstration shows that the ISS laptop hardware has the capability to support S video (line in/line out) video interfaces.

n. This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows that the ISS laptop hardware has the capability to provide a USB (V1.1 minimum) interface using a Windows OS platform.

o. This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows that the ISS laptop hardware has the capability to provide an IEEE 1394 port using a Windows OS platform.

p. This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows the ISS laptop has the capability to provide a USB UltraPort interface using a Windows OS platform.

q. This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows the ISS laptop has a RJ-45 connector and the capability for strain relief attachment of this interface cable.

4.4.2.2.3.2 Power System Interface

a. This requirement shall be verified by test. The verification shall be considered successful when qualification test results shows that an ISS laptop and power supply meets specifications or approval of waiver for any exceedances.

b. Reserved

c. This requirement shall be verified by test. The verification shall be considered successful when qualification test results shows that an ISS laptop and power supply meets specifications or approval of waiver for any exceedances.

d. This requirement shall be verified by demonstration. The demonstration shall be done on hardware equivalent to ISS laptop flight hardware. The verification shall be considered successful when the demonstration shows that the ISS laptop workstation interfaces to the Russian Segment 28 V DC power system as specified.

e. This requirement shall be verified by test. The verification shall be considered successful when qualification test results show that a ISS laptop and power supply combined draw no more than the specified maximum while operating at the maximum operating voltage.

f. This requirement shall be verified by test. The verification shall be considered successful when qualification test results show that a ISS laptop and power supply combined draw no more than the specified maximum while operating at the maximum operating voltage

g. This requirement shall be verified by test. The verification shall be considered successful when qualification test results show that an ISS laptop is capable of being powered by a battery pack for a minimum of 30 minutes.

h. This requirement shall be verified by test. The verification shall be considered successful when qualification test results show that a ISS laptop is capable of operating normally and charging the internal battery at the same time

i. This requirement shall be verified by inspection. The verification shall be considered successful when inspection of drawings show output power inhibit switch.

j. This requirement shall be verified by inspection. The verification shall be considered successful when inspection of drawing shows an output power indicator.

4.4.2.2.3.3 Human Computer Interfaces

Reserved

4.4.2.3 Reliability

4.4.2.3.1 Failure Tolerance

No verification required.

4.4.2.3.2 Quantitative Reliability

No verification required.

4.4.2.3.3 Failure Propagation

a. This requirement shall be verified by analysis. The verification shall be considered successful when an analysis of the ISS laptop system shows that a ISS laptop failure does not propagate into the ISS power.

b. This requirement shall be verified by analysis. The verification shall be considered successful when an analysis shows that precautions have been taken to prevent an ISS power system failure from propagating into the ISS laptop system.

c. This requirement shall be verified by analysis. The verification shall be considered successful when an analysis of the ISS laptop system shows that a PCS failure does not propagate into the ISS 1553B system.

d. This requirement shall be verified by analysis. The verification shall be considered successful when an analysis shows that precautions have been taken to prevent a ISS 1553B failure from propagating into the ISS laptop system.

e. This requirement shall be verified by analysis. The verification shall be considered successful when an analysis shows that precautions have been taken to prevent failure of a ISS laptop, power supply, and power cable from propagating into Shuttle power or other interfacing hardware.

4.4.2.3.4 Screening for Early Failure

This requirement shall be verified by test. The verification shall be considered successful when the burn-in test shows that the ISS laptop hardware has no failures which indicate material and workmanship defects.

4.4.2.4 Maintainability

4.4.2.4.1 Installation/Removal

This requirement shall be verified by demonstration. The demonstration shall be performed on a system equivalent to the ORU flight configuration. The verification shall be considered successful when the demonstration shows that each ISS laptop ORU can be replaced in ten minutes or less. The time limit does not include retrieving or returning the ORU to stowage, nor does it include loading software on the laptop.

4.4.2.4.1.1 Equipment Item Interconnecting Devices

a. This requirement shall be verified by analysis. The verification shall be considered successful when an analysis shows that the ISS laptop cables incorporate physical provisions that preclude inadvertent disconnects.

b. Reserved

c. This requirement shall be verified by inspection. The verification shall be considered successful when the inspection shows that the ISS laptop restraint system conforms to SDG33115360.

d. This requirement shall be verified by inspection. The verification shall be considered successful when the inspection shows that the ISS laptop adheres to the following constraints:

1. ISS laptop components have hook or pile strips attached to the backside using flight approved hook-and-loop materials.

2. No hook-and-loop section is larger than 4 square inches.

3. No hook-and-loop section is longer than 4 inches.

4. Each hook-and-loop section is separated by at least 2 inches.

4.4.2.4.1.2 Equipment Installation

This requirement shall be verified by inspection. The verification shall be considered successful when an analysis shows that the ISS laptop hardware has provisions to assist in correct installation.

4.4.2.4.1.3 Lockwiring and Staking

This requirement shall be verified by inspection. The inspection shall be done on a system equivalent to the ISS laptop flight system. The verification shall be considered successful when the inspection shows that no lockwires or staking has been used on operational interfaces or planned maintenance interfaces.

4.4.2.4.2 ISS Laptop Maintenance

a. Reserved

b. This requirement shall be verified by demonstration. The demonstration shall be performed using hardware components equivalent to the ISS laptop flight components. The verification shall be considered successful when the demonstration shows that each ISS laptop hardware component can be removed in ten minutes or less. The time limit does not include retrieving or returning the ORU to stowage.

c. Reserved

d. This requirement shall be verified by demonstration. The demonstration shall be performed on a system equivalent to the flight ISS Laptop. The verification shall be considered successful when the demonstration shows that the hard drive can be removed and replaced without damage to the hard drive or ISS Laptop. The demonstration shall include showing that the hard drive can be written to and read from after replacement.

e. Reserved.

f. This requirement shall be verified by demonstration. The demonstration shall be done on a system equivalent to the ISS laptop flight system. The verification shall be considered successful when the demonstration shows that the ISS laptop battery is removable, replaceable, and rechargeable.

g. This requirement shall be verified by demonstration. The demonstration shall be performed on a system equivalent to the flight ISS Laptop. The verification shall be considered successful when the demonstration shows that the CMOS Battery can be removed and replaced without damage to the ISS Laptop.

4.4.2.4.3 Failure Detection, Isolation, and Recovery (FDIR)

No verification required.

4.4.2.5 Environmental Conditions

4.4.2.5.1 Thermal Environment

4.4.2.5.1.1 Non-Operating Thermal Environment

a. This requirement shall be verified by test. The verification shall be considered successful when the test shows that the ISS laptop can meet performance requirements after exposure to the thermal environment defined in NSTS-21000-IDD-MDK, for launch, ascent, entry and landing.

b. This requirement shall be verified by test. The verification shall be considered successful when the test shows that the ISS laptop can meet performance requirements after exposure to ambient temperatures ranging from 0 degrees C to 60 degrees C.

c. This requirement shall be verified by test. The verification shall be considered successful when the test shows that the ISS laptop can meet performance requirements after exposure to the thermal environment defined in ISS-MPLM-IDD-006, for launch, ascent, entry and landing.

4.4.2.5.1.2 Operating Thermal Environment

This requirement shall be verified by test. The verification shall be considered successful when the test shows that the ISS Laptop can meet performance requirements after exposure to temperatures ranging from 10 degrees C to 35 degrees C for station operations and to temperatures defined in MF0004-14 for orbiter aft flight deck operations.

4.4.2.5.2 Pressure Environment

4.4.2.5.2.1 Non-Operating Pressure Environment

a. This requirement shall be verified by test. The verification shall be considered successful when the test shows that the ISS laptop can meet performance requirements after exposure to the nominal launch, ascent, entry and landing pressure environments defined in NSTS-21000-IDD-MDK and ISS-MPLM-IDD-006.

4.4.2.5.2.2 Operating Pressure Environment

This requirement shall be verified by test . The verification shall be considered successful when the test data shows that the ISS laptop meets the performance requirements when exposed to a pressure environment which ranges from 9.5 to 16 psia for ISS operations and Orbiter Operations.

4.4.2.5.2.3 Deleted

4.4.2.5.2 Humidity

4.4.2.5.3.1 Non-Operating Humidity Environment

This requirement shall be verified by analysis. The verification shall be considered successful when the analysis of vendor provided documentation shows that the ISS laptop can meet the performance requirements after non-operational exposure to 95% relative humidity in its storage configuration and to the humidity environment in accordance with NSTS-21000-IDD-MDK, NSTS-21000-IDD-ISS, MF0004-14 and ISS-MPLM-IDD-006.

4.4.2.5.3.2 Operating Humidity Environment

This requirement shall be verified by analysis. The verification shall be considered successful when the analysis of the vendor documentation shows that the ISS laptop can meet the performance requirements when exposed to a humidity environment, which ranges from 25 percent to 75 percent relative humidity for ISS operations and the operational humidity environment defined in MF0004-14 for operations on the orbiter aft flight deck.

4.4.2.5.4 Vibration

4.4.2.5.4.1 Non-Operating Vibration Environment

This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows that the ISS laptop can meet the performance requirements when exposed to the random vibration environments defined in NSTS-21000-IDD-MDK, and ISS-MPLM-IDD-006 for launch, ascent, entry and landing. The analysis shall take into consideration the packaging, storage and handling methods for the ISS laptop.

4.4.2.5.4.2 Operating Vibration Environment

This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows that the ISS laptop can meet the performance requirements during and after exposure for 8 hours at the maximum on orbit vibration level, reduced proficiency requirements as specified in SSP 50005 for ISS operations.

4.4.2.5.5 Non-Operating Acoustic Environment

Not applicable for ISS Laptop

4.4.2.5.6 Acceleration

4.4.2.5.6.1 Non-Operating Acceleration Environment

This requirement shall be verified by test and analysis. The verification shall be considered successful when the test and analysis shows that the ISS laptop can meet performance requirements following exposure to the acceleration environment specified in NSTS-21000-IDD-

MDK and ISS-MPLM-IDD-006 for launch, ascent, entry and landing. The test and analysis shall take into account packaging, storage, and handling methods.

4.4.2.5.6.2 Operating Acceleration Environment

This requirement shall be verified by test and analysis. The verification shall be considered successful when the test and analysis shows that the ISS laptop can meet performance requirements following exposure to the on-orbit acceleration environment as specified in section 3.2.5.6.2. The test and analysis shall take into account packaging, storage, and handling methods.

4.4.2.5.7 Transportation Shock Environment

a. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows that the ISS laptop can meet performance requirements following exposure to the transportation shock environment as specified in 3.2.5.7a. The analysis shall be done assuming the ISS laptop component is packed in foam for transportation to and from orbit.

b. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows that the ISS laptop can meet performance requirements following exposure to the transportation shock environment as specified in 3.2.5.7b. The analysis shall be done assuming the ISS laptop component is packed in foam for transportation to and from orbit.

4.4.2.5.8 Ionizing Radiation

4.4.2.5.8.1 Total Ionizing Dose (TID)

This requirement shall be verified by test and done in conjunction with the single event effects (SEE) testing. The total ionizing dose TID placed on a test article in SEE testing more than meets the TID requirement.

4.4.2.5.8.2 Nominal Single Event Effects

Proton induced single event upset and single event latch ups will be establish by testing the ISS laptop at the Indiana University Cyclotron Facility (IUCF) or equivalent Facility. A composite proton induced functional interrupt rate for the ISS laptop as a system in the environment of SSP 30512, will be reported as a test result along with any destructive latch up phenomena observed.

At the conclusion of the proton test regimen at IUCF the risk remaining for destructive latchup is from an on orbit exposure to flux of heavy ions that is equivalent to a 6-year heavy dose inside an ISS module.

For the case of heavy ion induced upsets, experience has shown that the upset rate from heavy ions will not be unreasonably different (large or small) from that measured with protons for devices with reasonable performance in the proton environment. Reasonable proton performance will be used to infer reasonable upset rate performance in the on orbit heavy ion environment.

4.4.2.5.9 Enriched Oxygen Environment

This requirement shall be verified by analysis. The verification shall be considered successful when an analysis shows that the ISS laptop meets performance requirements when exposed to the specified enriched oxygen environment.

4.4.2.5.9.1 Meteoroids and Orbital Debris

Not Applicable.
Rationale: The ISS laptop system will be used only for IVA activities.

4.4.2.5.9.2 Atomic Oxygen

Not Applicable.
Rationale: The ISS laptop system will be used only for IVA activities.

4.4.2.5.9.3 External Contamination

Not Applicable.
Rationale: The ISS laptop system will be used only for IVA activities.

4.4.2.5.9.4 Transportability

a. This requirement shall be verified by inspection and analysis. The verification shall be done on a system equivalent to the ISS laptop flight hardware. The verification shall be considered successful when the analysis shows that a ISS laptop can be transported in the shuttle middeck locker in accordance with NSTS-21000-IDD-MDK. Those ISS laptop ORU's which cannot be verified by similarity to the Shuttle PGSC, shall be verified by inspection. The verification shall be considered successful when the inspection of a ISS laptop ORU packed in a shuttle middeck locker meets the requirements of NSTS-21000-IDD-MDK.

b. This requirement shall be verified by inspection of the shipping procedures. The verification shall be considered successful when the inspection shows the procedures are compliant with JSC SLP-4.15.

c. This requirement shall be verified by inspection and analysis. The verification shall be done on a system equivalent to the ISS laptop flight hardware. The verification shall be considered successful when the analysis shows that a ISS laptop can be transported in the Multi-purpose Logistics Module (MPLM) in accordance with ISS-MPLM-IDD-006. The verification shall be considered successful when the inspection of an ISS laptop ORU meets the requirements of ISS-MPLM-IDD-006.

d. This requirement shall be verified by inspection. The verification shall be considered successful when the inspection shows compliance with the Russian document R32928-103 section 2.8.

4.4.3 Design and Construction

4.4.3.1 Materials, Processes and Parts

4.4.3.1.1 Materials and Processes

a. This requirement shall be verified by analysis. Verification shall be provided by a Materials Certification.

b. This requirement shall be verified by analysis. Verification shall be provided by a Materials Certification.

c. This requirement shall be verified by analysis. Verification shall be provided by an EDCPAP analysis memo.

d. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows that the ISS laptop connectors for intra-vehicular crew interfaces meet the design and selection criteria of the specified paragraph of SSP 50005. The analysis for custom hardware shall use design drawings, design documentation and parts list.

e. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows that the connector spacing for custom built ISS laptop hardware meet the requirements of the specified paragraph of SSP 50005.

f. This requirement shall be verified by analysis. The analysis shall be performed on a ground version of the ISS laptop display. The verification shall be considered successful when the analysis shows that the ISS laptop display would contain all glass particles and fluids if the monitor glass breaks.

4.4.3.1.2 Electrical, Electronic and Electromechanical Parts Selection

a. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows that the EEE parts for COTS or existing hardware have been selected in accordance with SSP 30312 Rev H, paragraph 3.16.

b. This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows that the EEE parts for newly designed hardware have been selected in accordance with JSC 61360.

4.4.3.1.3 Deleted

4.4.3.2 Electromagnetic Radiation

4.4.3.2.1 Electromagnetic Compatibility

No verification required.

4.4.3.2.2 Electromagnetic Interference

This requirement shall be verified by test. The test shall be performed on hardware, which is functionally equivalent to the ISS laptop flight hardware. The verification shall be considered successful when an analysis of the test results shows that the ISS laptop meets the electromagnetic interference and susceptibility requirements of JSC 28484, 3.3.4, SSP 30237, SSP 50094 section 3.4, and SL-E-0002 Book 3 Volume 1

4.4.3.2.3. Electrical Grounding

This requirement shall be verified by analysis. An analysis of item drawings, for custom design ISS laptop hardware, shall be performed to verify that the electrical grounding requirements as specified in SSP 30240 and NSTS 37330 have been satisfied.

4.4.3.2.4 Electrical Bonding

This requirement shall be verified by analysis. An analysis of item drawings, for custom design ISS laptop hardware, shall be performed to verify that the electrical bonding requirements as specified in SSP 30245, NSTS 07700 Vol. X, Book 1, and NSTS 37330 have been satisfied.

4.4.3.2.5 Cable and Wire Design

This requirement shall be verified by analysis. An analysis shall be performed on item drawings for custom designed ISS laptop hardware to verify that the ISS laptop interconnect, interconnect cable and wire design meet the design and control requirements of SSP 30242 and TM 102179.

4.4.3.2.6 Electrostatic Discharge

This requirement shall be verified by analysis. The analysis shall be performed on newly developed hardware, which is functionally equivalent to ISS laptop flight hardware. The verification shall be considered successful when an analysis shows that the ISS laptop meets the electrostatic discharge requirement of SSP 30243 section 3.2.9. The verification shall be considered successful when an analysis shows that the ISS laptop meets the electrostatic discharge requirement of NSTS-07700 Volume 10 Book 1, Space Shuttle Flight and Ground System Specification, 3.6.25.1.

4.4.3.3 Nameplates and Product Marking

a. The ISS laptop product marking requirements shall be verified by inspection of the ISS laptop drawings. The verification shall be considered successful when the inspection shows that the product markings are incorporated into the design as specified.

b. The ISS laptop equipment labeling requirements shall be verified by inspection of the ISS laptop drawings. The verification shall be considered successful when the inspection shows that the labels are incorporated into the design as specified.

c. The ISS laptop inventory management labeling requirements shall be verified by inspection of the ISS laptop drawings. The verification shall be considered successful when the inspection shows that space has been provided for the inventory management labels.

d. The ISS laptop test, adjustment and alignment points labeling requirements shall be verified by inspection of the ISS laptop drawings. The verification shall be considered successful when the inspection shows that labels are incorporated into the design as specified.

e. The ISS laptop connectors and connections labeling requirements shall be verified by inspection of the ISS laptop drawings. The verification shall be considered successful when the inspection shows that labels and product markings are incorporated into the design as specified.

4.4.3.4 Workmanship

This requirement shall be verified by inspection. The verification shall be considered successful when an inspection of the custom designed ISS laptop hardware component(s) verifies that the applicable workmanship standards specified in 3.3.4 have been met.

4.4.3.4.1 Cleanliness

This requirement shall be verified by inspection. The verification shall be considered successful when an inspection of the ISS laptop hardware components and drawings verifies that the hardware conforms to the cleanliness requirements in the specified paragraph of JPG 5322.1.

4.4.3.5 Interchangeability

This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows that the ISS laptop hardware components, with the same part numbers, are interchangeable.

4.4.3.6 Safety

4.4.3.6.1 General

This requirement shall be verified by analysis. An analysis shall be performed to prepare A Risk Assessment Executive Summary Report (RAESR) or Safety Assessment Report (SAR) compliant with NT3–GFE–012 and NT3–GFE–011. Approval of the RAESR constitutes approval of the deviation/waiver.

4.4.3.6.1.1 Catastrophic Hazards

A hazard analysis shall be performed to identify hazards, determine their severity and identify controls. The verification shall be considered successful when the hazard analysis has identified the catastrophic hazards, using the process specified in SSP 30309, and controls have been implemented which can tolerate two failures, two operator errors, or one of each and not result in a disabling or fatal personal injury, or loss of the Orbiter or ISS.

4.4.3.6.1.2 Critical Hazards

A hazard analysis shall be performed to identify hazards, determine their severity and identify controls. The verification shall be considered successful when the hazard analysis has identified the critical hazards, using the process specified in SSP 30309, and controls have been implemented which can tolerate a failure or operator error without resulting in a non-disabling personal injury, severe occupational illness, loss of an ISS major element, loss of an ISS on-orbit life-sustaining function or emergency system, or damage to the Orbiter.

4.4.3.6.1.3 Design For Minimum Risk

a. This requirement shall be verified by analysis. An analysis shall be performed on the custom designed ISS laptop hardware using design documentation and drawings. Items which shall be evaluated for design for minimum risk include structures, pressure vessels, pressurized lines and fittings, pyrotechnic devices, mechanisms in critical applications, material compatibility, flammability etc. Minimum supporting engineering data, as specified in SSP 30599, Appendix B, paragraph B.2 “Support Data” shall be provided as part of the hazard closure process. The verification shall be considered successful when the analysis shows that the custom designed ISS laptop hardware has been designed to minimum risk and that identified hazards have controls implemented.

b. This requirement shall be verified by analysis. An analysis shall be performed on the COTS ISS laptop hardware using vendor documentation. Items which shall be evaluated for design for minimum risk include structures, pressure vessels, pressurized lines and

fittings, pyrotechnic devices, mechanisms in critical applications, material compatibility, flammability, etc. Minimum supporting engineering data, as specified in SSP 30599, Appendix B, paragraph B.2 “Support Data” shall be provided as part of the hazard closure process. The verification shall be considered successful when the analysis shows that the risk potential for the COTS ISS laptop hardware is acceptable and that controls are in place for identified hazards.

c. This requirement shall be verified by analysis. An analysis shall be performed on the custom designed ISS laptop hardware using design documentation and drawings. Items which shall be evaluated for design for minimum risk include structures, pressure vessels, pressurized lines, and fittings, pyrotechnic devices, mechanisms in critical applications, material compatibility, flammability etc. Minimum supporting engineering data, as specified in SSP 30599, Appendix B, paragraph B.2 “Support Data” shall be provided as part of the hazard closure process. The verification shall be considered successful when the analysis shows that the custom designed ISS laptop hardware has been designed to minimum risk and that identified hazards have controls implemented.

d. This requirement shall be verified by analysis. An analysis shall be performed on the custom designed ISS laptop hardware using design documentation and drawings. Items which shall be evaluated for design for minimum risk include structures, pressure vessels, pressurized lines, and fittings, pyrotechnic devices, mechanisms in critical applications, material compatibility, flammability etc. Minimum supporting engineering data, as specified in SSP 30599, Appendix B, paragraph B.2 “Support Data” shall be provided as part of the hazard closure process. The verification shall be considered successful when the analysis shows that the custom designed ISS laptop hardware has been designed to minimum risk and that identified hazards have controls implemented.

4.4.3.6.1.4 Control of Function Resulting in Critical Hazards

a. An analysis should be done of the ISS laptop operational constraints, system documentation and flight rules. The verification of this requirement is based on the function being performed by the hardware and software as a system and is beyond the scope of this document. The PCS functions will be verified in accordance with the PCS Development Specification JSC-27274.

b. An analysis should be done of the ISS laptop operational constraints, system documentation and flight rules. The verification of this requirement is based on the function being performed by the hardware and software as a system and is beyond the scope of this document. The PCS functions will be verified in accordance with the PCS Development Specification JSC-27274.

c. No verification required.

4.4.3.6.1.5 Control of Functions Resulting in Catastrophic Hazards

a. An analysis should be done of the ISS laptop operational constraints, system documentation and flight rules. The verification of this requirement is based on the function being performed by the hardware and software as a system and is beyond the scope of this document. The PCS functions will be verified in accordance with the PCS Development Specification JSC-27274.

b. An analysis should be done of the ISS laptop operational constraints, system documentation and flight rules. The verification of this requirement is based on the function being performed by the hardware and software as a system and is beyond the scope of this document. The PCS functions will be verified in accordance with the PCS Development Specification JSC-27274.

4.4.3.6.1.6 Environmental Compatibility

This requirement shall be verified by analysis. The verification shall be considered successful when an analysis shows that the ISS laptop poses no safety hazards in the specified environments. The analysis shall use test data from the ISS laptop qualification tests.

4.4.3.6.2 Command and Computer Control of Hazardous Functions

No verification required.

4.4.3.6.3 Non-Ionizing Radiation

This requirement shall be verified by analysis. The verification shall be considered successful when an analysis shows that the ISS laptop limits the levels of non-ionizing radiation in accordance with the specified paragraphs of SSP 50005.

4.4.3.6.4 Electrical Safety

4.4.3.6.4.1 Electrical Power Circuit Overloads

4.4.3.6.4.1.1 Circuit overload protection

This requirement shall be verified by inspection. The inspection shall be done on a system equivalent to the ISS laptop flight hardware. The verification shall be considered successful when the inspection shows that the ISS laptop hardware has incorporated protective devices to guard against circuit overloads which could result in distribution circuit damage, or excessive hazardous products. The protective devices shall also prevent damage to safety critical circuits.

4.4.3.6.4.1.2 Protective Device Sizing

This requirement shall be verified by analysis. An analysis shall be done on the ISS laptop hardware drawings. The verification shall be considered successful when the analysis shows that the ISS laptop has incorporated protective devices that have been sized appropriately to prevent steady state currents in excess of the values allowed by SSP 30312 Appendix B, Section B 3.5.2.

4.4.3.6.4.1.3 Bent Pin or Conductive Contamination

a. This requirement shall be verified by analysis. An analysis shall be performed using the ISS laptop connector pin out diagrams and system documentation. The verification shall be considered successful when the analysis shows that a short between any pin, within a

connector, cannot invalidate more than one inhibit to a hazardous function. The short can be caused by conductive contamination or a pin bent prior to or during connector mating.

b. This requirement shall be verified by analysis of the hardware drawings. The verification shall be considered successful when the analysis shows that the hardware drawings include requirements for inspection of the hardware per NAS 5300.4.

4.4.3.6.4.2 Crew Protection for Electrical Shock

This requirement shall be verified by analysis. An analysis shall be performed using ISS laptop hardware drawings and vendor documentation. The verification shall be considered successful when the analysis shows that the ISS laptop design protects the crew from electrical shock and that caution and warning labels have been incorporated. The analysis shall also verify that the design meets the electrical hazard control defined in SSP 50005.

4.4.3.6.4.3 Batteries

This requirement shall be verified by analysis. An analysis shall be performed to verify that the batteries which have been identified as hazardous have been modified to preclude the buildup or venting of flammable, corrosive or toxic gasses and reaction products; the explosion of electrolyte; and failure modes of over temperature, shorts, reverse current, cell reversal , leakage, cell grounds and over pressures. The verification shall be considered successful when the analysis shows that the batteries comply with NSTS 20793.

4.4.3.6.4.4 Reapplication of Power

This requirement shall be verified by analysis of the ISS laptop hardware design and drawings. The verification shall be considered successful when the analysis shows that the ISS laptop hardware design includes features that allow input power to be disconnected.

4.4.3.6.4.5 Corona

This requirement shall be verified by analysis of the ISS laptop hardware design and drawings. The verification shall be considered successful when the analysis shows that the ISS laptop hardware design that contains voltage potential in excess of 300 volts has features to preclude hazards caused by corona.

4.4.3.6.5 Constraints

4.4.3.6.5.1 Pressure Differential Tolerance

This requirement shall be verified by analysis. The verification shall be considered successful when the analysis shows that the ISS laptop hardware is capable of withstanding the differential pressure of depressurization, repressurization and the depressurized condition without creating a hazard as defined in SSP 30309.

4.4.3.6.5.2 Operation During Pressure Changes

This requirement shall be verified by analysis. The analysis shall use ISS laptop qualification data. The verification shall be considered successful when the analysis shows that the ISS laptop can operate during depressurization and repressurization without producing hazards, as defined in SSP 30309. The ISS laptop is only required to meet performance criteria when the pressure is within the operational limits specified in section 3.2.5.

4.4.3.6.5.3 Component Hazardous Energy Provision

This requirement shall be verified by analysis. The analysis shall be performed using data from ISS laptop hardware drawings, operational constraints and procedures, maintenance procedures and qualification data. The verification shall be considered successful when the analysis shows that the components which contain hazardous potential are:

a. safed or

b. located where crew members cannot come in contact with them, or

c. that crew procedures have been written ensuring that a minimum time has elapsed before cables which can discharge stored energy are disconnected.

4.4.3.6.6 Human Engineering Safety

4.4.3.6.6.1 Internal Volume Touch Temperature

4.4.3.6.6.1.1 Continuous Contact - High Temperature

This requirement shall be verified by test. A test shall be performed to identify surfaces where the temperature can exceed 113 degrees F, and have the potential for crewmember contact. The verification shall be considered successful when the test of the hardware verifies that surfaces exposed to crew activity meet the requirements of SSP 50005, section 6.5.3.B.

4.4.3.6.6.1.2 Incidental or Momentary Contact - High Temperature

a. This requirement shall be verified by test. A test shall be performed to identify surfaces where the temperature can range from 113 to 122 degrees F and have the potential for incidental or momentary crew contact (less than 30 seconds). The verification shall be considered successful when the test of the hardware verifies that surfaces exposed to crew activity meet the requirements of SSP 50005, section 6.5.3.C.1.

b. This requirement shall be verified by test. A test shall be performed to identify surfaces where the temperature can exceed 122 degrees F, and have the potential for incidental or momentary crew contact (less than 30 seconds). The verification shall be considered successful when the test of the hardware verifies that surfaces exposed to crew activity meet the requirements of SSP 50005, section 6.5.3.C.2.

4.4.3.6.6.1.3 Internal Volume Low Touch Temperature

This requirement shall be verified by analysis and inspection. An analysis shall be performed using hardware drawings, qualification data and ISS laptop operational procedures to identify surfaces below 39 degrees F which have the potential for continuous or incidental (less than 30 seconds) to a crew members bare skin. The verification shall be considered successful when the inspection of the hardware drawings verifies that protective devices have been installed to prevent crew contact with these surfaces.

4.4.3.6.6.2 Internal Corner and Edge Protection

4.4.3.6.6.2.1 Equipment Exposed To Crew Activity

This requirement shall be verified by inspection. An inspection shall be performed on ISS laptop flight hardware. The verification shall be considered complete when the inspection verifies that the ISS laptop surfaces exposed to crew activity meet the requirements of the specified paragraphs in SSP 50005.

4.4.3.6.6.2.2 Equipment Exposed Only During Planned Maintenance Activities

This requirement shall be verified by inspection. The inspection shall be performed on ISS laptop flight hardware. The verification shall be considered successful when the inspection verifies that the corners and edges exposed during maintenance activities are rounded to a minimum radius or chamfer of 0.03 inches. For COTS hardware the inspection shall verify that tape is used on corners and edges, or that crew procedures call out the taping of corners and edges prior to performing maintenance activities.

4.4.3.6.6.3 Burrs

This requirement shall be verified by inspection. The inspection shall be performed on ISS laptop flight hardware. The verification shall be considered successful when the inspection verifies that there are no burrs on exposed surfaces of ISS laptop hardware.

4.4.3.6.6.4 Holes

This requirement shall be verified by inspection. The verification shall be considered successful when the inspection shows that any uncovered holes, round or slotted, are less than 0.4 inches in diameter or greater than 1.0 inches in diameter, or are guarded.

4.4.3.6.6.5 Moving Parts

This requirement shall be verified by inspection. The verification shall be considered successful when it has been shown that all moving parts have been provided with guards or other protective devices.

4.4.3.7 Human Engineering

4.4.3.7.1 Strength Requirements

This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows that the crew interfaces do not require strength greater than fifth percentile American female as defined in SSP 500005, paragraph 4.9.

4.4.3.7.2 Maintenance

This requirement shall be verified by demonstration. The verification shall be considered successful when the demonstration shows that crew interfaces required for maintenance do not require strength greater than the fifth percentile American male as defined in SSP 50005, paragraph 4.9.

4.4.3.7.3 Controls and Displays

a. This requirement shall be verified by inspection. The verification shall be considered complete when the inspection has shown that newly designed hardware meets the requirements for internal controls as stated in the specified document.

b. This requirement shall be verified by inspection. The verification shall be considered complete when the inspection has shown that newly designed hardware meets the requirements for internal displays as stated in the specified document.

4.4.3.8 Nuclear Control

No verification required.

4.4.3.9 Portable Computer System Security

No verification required.

4.4.3.10 Environmental Constraints

4.4.3.10.1 Acoustic Emissions Limits

This requirement shall be verified by test. The verification shall be considered successful when an analysis of the test results shows that the ISS laptop does not exceed the criteria in Table 2 when averaged over a minimum ten second interval. The test shall be done for non-alarm conditions.

4.4.3.10.2 Ionizing Radiation Emission Limits

No verification required.

4.4.4 Computer Resource Requirements

4.4.4.1 Computer Hardware Design Considerations

a. This requirement shall be verified by demonstration of hardware. The verification shall be considered successful when the demonstration of the hardware verifies that the ISS laptop has at least a 32 megabytes random access memory.

b. Verified by inspection to the vendor's documentation.

c. Verified by inspection to the vendor's documentation.

d. Reserved

e. Reserved

f. Verified by inspection to the vendor's documentation.

g. This requirement shall be verified by demonstration. The demonstration shall be performed on hardware functionally equivalent to the ISS Laptop flight laptop hardware. The verification shall be considered successful when the demonstration shows that the ISS laptop can operate for 30 minutes on internal power, after it has been detached from all peripheral equipment and external power sources. "Operate" is defined as sustaining the software on the ISS laptop at the time of power disconnect. Software Execution during this period is application dependant and not verified by this requirement.

h. Verified by inspection to the vendor's documentation.

i. Verified by inspection to the vendor's documentation.

j. Verified by inspection to the vendor's documentation.

k. Verified by inspection to the vendor's documentation.

l. No verification requirements.

m. No verification requirements.

n. No verification requirements.

o. No verification requirements.

p. No verification requirements.

q. No verification requirements.

r. No verification requirements.

s. Inspection of drawings to confirm that any changes to the COTS hardware does not use materials that would impact wireless antenna patterns.

t. This requirement shall be verified by inspection. The inspection shall be performed on hardware functionally equivalent to the ISS Laptop flight laptop hardware. The verification shall be considered successful when the inspection shows that the laptop has strain relief for the 1553 PCMCIA card.

4.4.4.2 Software

This requirement shall be verified by inspection. The verification shall be considered successful when inspection of firmware/BIOS utilized with the ISS laptop is in accordance with SKG33115373, IBM A31P Firmware/BIOS Configuration drawing.

4.4.5 Logistics

No verification required.

4.4.5.1 Maintenance

4.4.5.1.1 On-Orbit Laptop Workstation Maintenance

a. This requirement shall be verified by analysis. The verification shall be considered successful when an analysis of the ISS laptop In-Flight Maintenance Procedures verify that maintenance of a defective ISS laptop workstation is limited to removal and replace of ISS laptop ORU's, cables, drives and internal batteries.

b. Reserved

4.4.5.1.2 Reserved

4.4.5.1.3 Ground Maintenance

This requirement shall be verified by analysis of this hardware. The verification shall be considered successful when the analysis shows that the ISS laptop hardware can be maintained on the ground.

4.4.5.1.4 Lifetime

This requirement shall be verified by inspection of hardware.

4.4.5.2 Supply

No verification required.

4.4.5.3 Facilities and Faculty Equipment

No verification required.

4.4.6 Personnel and Training

No verification required.

4.4.7 ISS Laptop Major Component Characteristics

No verification required.

5.0 PREPARATION FOR DELIVERY

ISS laptop deliveries shall be made to the Flight Equipment Processing Contract contractor for packaging and shipment.

6.0 NOTES

This section contains information of a general explanatory nature that may be helpful, but is not mandatory.

6.1 ISS LAPTOP GOALS

This subsection lists some desirable ISS laptop capabilities that are not requirements, for various reasons.

a. Reserved

b. Reserved

c. The ISS work area for attachment of the ISS laptop should have loop pile strips (commonly known as Velcro ^{TM}), which follow the requirements of 3.2.4.1.1d .The pattern should be at least four inches from any obstructions.

d. Reserved

e. Reserved

6.2 ISS LAPTOP SAFETY RULES

The Reliability & Maintainability Integrated Product Team (R&M IPT) has performed an assessment of the ISS laptop, which concludes that it has a Criticality of 1R. This has been derived per SSP 30234, Instructions for Preparation of Failure Modes and Effects Analysis and Critical Items List, by considering the worst-case effect of not being able to perform the functions commanded by the ISS Laptop. The ISS laptop performs unlimited commands and is the prime interface between the astronauts and the MDM's. Some of the functions, if not performed, could result in loss of life, injury to crew, loss of station, and/or damage to station.

It is acceptable for the ISS laptop to use COTS equipment and software in this criticality 1R function. The ISS laptop will meet the requirements and safety guidelines as stated in this document. The ISS laptop will be verified as defined in section 4. No additional hardware testing is required to allow the ISS laptop to be used in a criticality 1R function.

1. Safety rules 1-10 per PCS Development Specification JSC-27274 apply to software. Rule 11 is applicable to hardware and states the following: For Fail Operational operations involving crew, you must have two redundant online PCs (i.e., there is a time-to-criticality less than the time to bring a second computer online following a failure). This would be for critical operations such as assuming manual control of an automated protective control loops like automatic FDIR, but not for routine orbit ops, where time-to-criticality on non-automated functions is universally longer than 24 hours.

APPENDIX A - Acronyms and Abbreviations

ANSI	American National Standards Institute
APM	Attached Pressurized Module
BIOS	Basic Input/Output System
C	Celsius
C&C	Command & Control
CD	Compact Disk
C&DH	Command and Data Handling
CD-RW	Compact Disks- Read Write
C&W	Caution and Warning
CDS	Command and Data Software
CI	Configuration Item
COTS	Commercial-Off-The-Shelf
CPS	Color Printer Subsystem
CPU	Central Processing Unit
DC	Direct Current
DOD	Department of Defense
DVD/ROM	Digital Video Disk/Read-Only Memory
EDCPAP	Engineering Directorate Certified Part Approval Process
EEE	Electrical, Electronic, and Electromechanical
EIS	End Item Specification
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EMU	Extravehicular maneuvering/mobility unit
ESD	Electrostatic Discharge
EVA	Extra Vehicular Activity
EVR	Extra Vehicular Robotics
EXT	External
F	Fahrenheit
FDIR	Failure Detection Isolation and Recovery
FEU	Flight Equivalent Unit
FMEA	Failure Mode and Effects Analysis
FSRP	Flight Safety Review Panel
GFE	Government Furnished Equipment
GFM	Government Furnished Material
GNC	Guidance, Navigation and Control
GOTS	Government Off-The-Shelf
GUI	Graphical User Interface
IBM	International Business Machines
ICD	Interface Control Document
IDD	Interface Definitions Document
IEEE	Institute of Electrical and Electronic Engineers
I/F	Interface
I/O	Input/Output

IOL	ISS On-board LAN
IPT	Integrated Product Team
IMS	Inventory Management System
IRD	Interface Requirements Document
ISL	ISS Integrated Station LAN
ISS	International Space Station
IUCF	Indiana University Cyclotron Facility
IVA	Internal Vehicular Activity
JEM	Japanese Experiment Module
JSC	Johnson Space Center
LAN	Local Area Network
LED	Light Emitting Diode
MB	Megabytes
MDM	Multiplexer/demultiplexer
MHz	Megahertz
MIL	Military
MIP	Mission Integration Plan
MMCH/Y	Mean Maintenance Crew Hours Per Year
MPLM	Multi-Purpose Logistics Module
MPV	Manual Procedures Viewer
MSS	Mobile Servicing System
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
NDI	Non-Deliverable Item
NSTS	National Space Transportation System
NTSC	National Television Standards Committee
OCA	Orbiter Communications Adapter
ODF	Operations Data File
OOCI	ODF/OSTP Crew Interface
ORU	Orbital Replaceable Unit
OSTP	On-board Short Term Plan
PC	Portable Computer
PCI	Peripheral Component Interconnect
PCMCIA	Personal Computer Memory Card International Association
PCS	Portable Computer System
PFM	Program Furnished Material
PGSC	Payload General Support Computer
PIDS	Prime Item Development Specification
PIP	Payload Integration Plan
PL	Payload
psi	pounds per square inch
psia	pounds per square inch absolute
PSRP	Payload Safety Review Panel

PTRS	Project Technical Requirements Specification
QA	Quality Assurance
R&M	Reliability & Maintainability
R & MIPT	Reliability & Maintainability Integrated Product Team
RAESR	Risk Assessment Executive Summary Report
RAM	Random Access Memory
SAR	Safety Assessment Report
SCSI	Small Computer System Interface
SEE	Single Event Effects
SM	Service Module
SMC	Station Management and Control
SSC	Space Station Support Computer
SSCDB	Space Station Control Board Directive
SSP	Space Station Program
STD	Standard
SDTO	Station Development Test Objective
STS	Space Transportation System
SVGA	Super Video Graphics Array
TBD	To Be Determined
TID	Total Ionizing Dose
UIRD	User Interface Requirements Document
UOP	Utility Output Panel
US	United States
USB	Universal Serial Bus
VDC	Volts Direct Current
VM	Verification Matrix

APPENDIX B - Definitions

Catastrophic hazard - Any condition, which may cause a disabling or fatal personnel injury, or loss of one of the following: Orbiter or ISS. For safety failure tolerance considerations, loss of the ISS is to be limited to those conditions resulting from failures or damage to elements of the ISS that render the ISS unusable for further operations, even with contingency repair or replacement of hardware, or which render the ISS in a condition which prevents further rendezvous and docking operations with ISS launch elements.

Control loop: The automated control of a function, where the item controlling the function is making decisions based on data received.

Critical hazard - Any condition which may cause a non-disabling personnel injury, severe occupational illness; loss of a major ISS element, loss of an ISS on-orbit life sustaining function or emergency system, or involves damage to the Orbiter. For safety failure tolerance considerations, critical hazards include loss of ISS elements that are not in the critical path for station survival or which can be restored through contingency repair.

Manual command loop: The flow of a crew-initiated command from the ISS & SSP laptop through the C&DH architecture to the effector. Data received from the effector is displayed to the crew in order for the crew member to determine if the command was carried out successfully, and if any further action is required.

APPENDIX C - JPR 8080.5 Traceability Matrix for NGL

Reqm't No.	A: Applicable N: Not Applicable E: Exception	Title of Standard	Rationale for Not Applicable
G–1	A	Equipment Accessibility for Maintenance	----------
G–2	N	Separation of Redundant Equipment	NGL are inherently separate from each other.
G–3	E	Systems Checkout Provisions	NGL does not have provisions to permit check out tests without disconnecting flight connectors. The maintenance of the NLG on orbit is limited to removal and replace of ISS laptop ORU's, cables, drives and internal batteries.
G–4	A	Protection of Spacecraft Electrical and Mechanical Systems from Debris	----------
G–5	N	Interior Design of Spacecraft for Cleanliness	Vehicle requirement.
G–6	N	Redundancy Requirements	Requirement has been cancelled.
G–7	N	Time Displays	Requirement has been cancelled.
G–8	A	Redundant Paths – Verification of Operation	----------
G–9	A	Shatterable Material – Exclusion from Habitable Compartment	----------
G–10	A	Control of Limited Life Components	----------
G–11	A	Procurement Document Identification for Manned Spaceflight Vehicle Items	----------
G–12	A	Application of Previous Qualification Tests	----------
G–13	A	Shipping and Handling Protection for Spaceflight Hardware	Requirement has been cancelled.
G–14	A	Identification and Classification of Flight and Non–flight Equipment	----------
G–15	A	Equipment Failure–Verification of Flight Readiness	----------
G–16	N	Operating Limits on Temperature–Controlled Equipment	The NGL is not temperature controlled equipment.
G–17	A	Separate Stock for Spaceflight Parts and Materials	----------
G–18	A	Safety Precautions – Test and Operating Procedures	----------
G–19	A	Special Processes – Identification of Drawings	----------
G–20	N	Spacecraft Equipment – Protection from System Liquids	NGL is not located in an area near liquids.
G–21	A	Spacecraft Equipment – Moisture Protection	----------
G–22	A	Parts Identification	----------
G–23	A	Pressure Garment Wiring – Ignition of Materials by Electrical Current	----------
G–24	N	Ground Support Equipment and Airborne Support Equipment Protective Devices	NGL has no ground support equipment or airborne support equipment.
G–25	A	Thermal Design and Analysis – Thermal Parameters	----------
G–26	A	Internally Generated Radiation	----------
G–27	A	Fire Control	----------

Reqm't No.	A: Applicable N: Not Applicable E: Exception	Title of Standard	Rationale for Not Applicable
G–28	N	Sealing – Solid Propellant Rocket Motors	NGL does not contain solid propellant rocket motors.
G–29	N	Reentry Propulsion Subsystem In–flight Test	Vehicle requirement.
G–30	N	Switch Protection Devices	Requirement has been cancelled.
G–31	N	Detachable Crew–Operated Tools – Restriction in Spacecraft	Detachable tools are not used for NGL.
G–32	N	Measurement Systems That Display Flight Information to the Crew – Indication of Failure	Requirement has been cancelled.
G–33	N	Surface Temperatures	Requirement has been cancelled.
G–34	N	Extravehicular Activity Electronic Connectors	Requirement has been cancelled.
G–35	N	Enclosure Panels External to the Habitable Modules	Requirement has been cancelled.
G–36	N	Thermal Blankets – Extravehicular Activity	Requirement has been cancelled.
G–37	N	Verification of Adequate External Visibility	Vehicle requirement.
G–38	N	Pressurization or Repressurization – Precluding Ingress of Undesirable Elements	Vehicle requirement.
G–39	N	Lightning Protection Design	Vehicle requirement.
G–40	N	Radioactive Luminescent Devices	NGL contains no radioactive luminescent devices.
G–41	N	Acoustic Noise Criteria	Requirement has been cancelled.
G–42	N	Solar Wind Environment	Requirement has been cancelled.
G–43	N	Centralized Subsystem Controls	Requirement has been cancelled.
G–44	N	Attitude Control Authority	NGL does not contain attitude control authority.
G–45	N	Solid Propellant Rocket Motors – Ignition Capability with Unsealed Nozzle	Solid Rocket Motor requirement.
G–46	N	Separation Sensing System – Structural Deformation	Vehicle requirement.
G–47	N	Gyroscopes – Verification of Rotational Speed or Drift Rate	NGL is not a guidance, navigation, or control system.
G–48	A	Onboard Experiments – Required Preinstallation Checklist	----------
G–49	N	Temperature and Pressure Monitoring Requirements of Hydrogen Peroxide Systems	Requirement has been cancelled.
G–50	A	Direct Procurement of Parts	----------
G–51	A	Flight Hardware – Restriction on Use for Training	----------
G–52	A	Reuse of Flight Hardware	----------
G-53	A	Reverification	----------

Reqm't No.	A: Applicable N: Not Applicable E: Exception	Title of Standard	Rationale for Not Applicable
G-54	N	Automatic Shutdown of Launch Vehicle	NGL does not interface to the automatic shutdown of a launch vehicle.
E–1	A	Mating Provisions for Electrical Connectors	----------
E–2	N	Protection of Severed Electrical Circuits	NGL electrical connections are not severed.
E–3	A	Electrical and Electronic Devices – Protection from Reverse Polarity and/or Other Improper Electrical Inputs	----------
E–4	A	Electrical Connectors – Moisture Protection	----------
E–5	A	Electrical Connectors – Pin Assignment	----------
E–6	A	Corona Suppression	----------
E–7	A	Tantalum Wet Slug Capacitors – Restriction on Use	----------
E–8	N	Electrical and Electronic Supplies and Loads – Verification Tests	GSE requirement.
E–9	A	Electrical Circuits – Deenergizing Requirement	----------
E–10	A	Cleaning of Electrical and Electronic Equipment	----------
E–11	A	Protective Covers or Caps for Electrical Receptacles and Plugs	----------
E–12	A	Electrical Connectors – Disconnection for Trouble–Shooting and Bench Testing	----------
E–13	A	Bioinstrumentation Systems – Crew Electrical Shock Protection	----------
E–14	A	Electrical Wire Harnesses – Dielectric Tests	----------
E–15	A	Electrical Power Distribution Circuits – Overload Protection	----------
E–16	A	Testing Protective Devices for Solid–State Circuits	----------
E–17	N	Electrical and Electronic Piece Parts – Closure Construction	Hermetic packaging is not needed for the NGL.
E–18	N	Circuitry for Automatic Shutdown of Launch Vehicle Engine(s)	Requirement has been reclassified as G54.
E–19	A	Equipment Design – Power Transients	----------
E–20	A	Control of Electrostatic Discharge for Electronic Parts and Assemblies	----------
E–21	A	Electrical Connectors	Requirement has been cancelled.
E–22	A	Ionizing Radiation Effects	----------
E–23	N	Transistors – Selection of Types	Requirement has been cancelled.
E–24	A	Electrical Wire and Cable Acceptance Tests	----------
E-25	A	Protecting Electrical Wire, Cables, Bundles, and Harnesses.	----------
F–1	A	Flow Restriction Requirements –	----------

Reqm't No.	A: Applicable N: Not Applicable E: Exception	Title of Standard	Rationale for Not Applicable
		Pressurized Sources	
F–2	N	Moisture Separators in a Zero–Gravity Environment	NGL does not use moisture separators.
F–3	N	Service Points – Positive Protection From Inter–Changeability of Fluid Service Lines	Vehicle requirement.
F–4	N	Ground Service Points – Fluid Systems	Vehicle requirement.
F–5	N	Fluid Lines – Separation Provisions	Vehicle requirement.
F–6	N	Temperature and Pressure Monitoring Requirements for Potentially Hazardous Reactive Fluids	Vehicle requirement.
F–7	N	Capping of Servicing and Test Ports	NGL does not contain fluid servicing and test ports.
F–8	N	Fluid System Components Whose Function is Dependent on Direction of Flow – Protection Against Incorrect Installation	NGL does not contain fluid system components.
F–9	N	Spacecraft Venting – Induced Perturbing Forces	Vehicle requirement and EVA requirement.
F–10	N	Nozzles and Vents – Protection Prior to Launch	Vehicle requirement.
F–11	N	Fluid Supplies – Verification Tests	GSE requirement.
F–12	N	Protection of Pressurized Systems from Damage Due to Pressurant Depletion – Ground Support Equipment and Airborne Support Equipment	NGL does not require fluid pressure.
F–13	N	Crew Cabin Module Pressure – Venting Restriction	Vehicle Requirement.
F–14	N	Crew Cabin Module Ventilating Fans – Protection From Debris	Requirement has been cancelled.
F–15	N	Separation of Hypergolic Reactants	NGL does not contain hypergolic reactants.
F–16	N	Fluid Line Installation	Vehicle requirement.
F–17	N	Cleanliness of Flowing Fluids and Associated Systems	NGL does not contain the cleanliness of flowing fluids.
F–18	N	Pressure Relief Valves – Standardization of Functional Testing	NGL does not contain pressure relief valves.
F–19	A	Protection for Tubing, Fittings, and Fluid System Components – Flight Hardware and Associated Equipment	----------
F–20	N	Fluid Systems – Cleanliness	NGL does not contain fluid systems.
F–21	N	Purge Gases – Temperature and Humidity Requirements	Vehicle requirement.
F–22	N	Pressure Garments – Protection Against Failure Propagation	NGL does not use pressure garments..
F–23	N	Qualification Fluid	Requirement has been reclassified as G53.
F–24	N	Fluid Systems – Design for Flushing and Draining	NGL does not contain fluid systems.
F–25	A	Toxicity – Fluids Contained in Systems in the Crew Compartment	----------
F–26	N	Atmospheric Pressure and Composition	Vehicle requirement.

Reqm't No.	A: Applicable N: Not Applicable E: Exception	Title of Standard	Rationale for Not Applicable
		Control	
F–27	N	Liquid or Gas Containers – Verification of Contents	NGL does not contain liquid or gas containers.
F–28	N	Use of Halogen Method for Coolant System Leak Detection	Requirement has been cancelled.
F–29	N	Filter Protection of Active Fluid Components	NGL does not contain fluid systems.
F–30	N	Pressure Relief for Pressure Vessels	NGL does not contain pressure relief for vessels.
M/P–1	A	Material Selection, Review, and Drawing Sign–Off	----------
M/P–2	A	Flammability of Wiring Material	Requirement has been cancelled.
M/P–3	A	Toxicity of Materials Used in Crew Compartments – Wire Insulation, Ties, Identification Marks, and Protective Covering	Requirement has been cancelled.
M/P–4	N	Metals and Metal Couples – Restriction on Use	Requirement has been cancelled.
M/P–5	N	Solutions Which Contain Ethylene Glycol – Requirements for Silver Chelating Agent	Requirement has been cancelled.
M/P–6	N	Toxicity – Requirements for Nonmetallic Materials Proposed for Use within Crew Compartment	Requirement has been cancelled.
M/P–7	N	Material Detrimental to Electrical Connectors	Requirement has been cancelled.
M/P–8	N	Leak Detectors – Wetting Agents	Requirement has been cancelled.
M/P–9	A	Breathing Systems – Requirement to Test for Mercury Contamination	----------
M/P–10	N	Liquid Locking Compounds – Restrictions and Controls	Requirement has been cancelled.
M/P–11	N	Pressure Vessel Documentation	NGL does not contain any pressure vessel systems.
M/P–12	N	Multilayer Blanket Bake–Out	Requirement has been cancelled.
M/P–13	N	Pressure Vessel Design	NGL does not contain any pressure vessel systems.
M/P–14	N	Silicate Ester Coolant System Design	Requirement has been cancelled.
M/P–15	N	Mercury – Restriction on Use	Requirement has been cancelled.
M/P–16	N	Restriction on Coatings for Areas Subject to Abrasion	Requirement has been cancelled.
M/P–17	N	Radiographic Inspection of Brazed and Welded Tubing Joints	Requirement has been cancelled.
M/P–18	N	Etching Fluorocarbon Insulated Electrical Wire	Requirement has been cancelled.
M/P–19	N	Spacecraft Material – Restriction on Use of Polyvinyl Chloride	Requirement has been cancelled.
M/P–20	N	Titanium or Its Alloys – Prohibited Use with Oxygen	Requirement has been cancelled.
M/P–21	N	Beryllium – Restricted Use within Crew Compartment(s)	Requirement has been cancelled.
M/P–22	N	Brazed Joints – Identification Marks	Requirement has been cancelled.

Reqm't No.	A: Applicable N: Not Applicable E: Exception	Title of Standard	Rationale for Not Applicable
M/P–23	N	Pressure Vessels – Materials Compatibility and Vessel Qualification Tests	Requirement has been cancelled.
M/P–24	N	Cadmium – Restriction on Use	Requirement has been cancelled.
M/P–25	N	Pressure Vessels – Non–destructive Evaluation Plan	Requirement has been cancelled.
M/P–26	N	Repair of Sandwich – Type Structures	Requirement has been cancelled.
M/S–1	A	Equipment Containers – Design for Rapid Spacecraft Decompression	----------
M/S–2	A	Alignment of Mechanical Systems	----------
M/S–3	A	Wire Bundles – Protective Coating	Requirement has been reclassified as E-25.
M/S–4	N	Hatches – Repeated Use	NGL does not contain hatches.
M/S–5	A	Threaded Fittings – Restrictions on Release of Particles and Foreign Material	----------
M/S–6	A	Exposed Sharp Surfaces or Protrusions	Requirement has been cancelled.
M/S–7	A	Windows and Glass Structure	----------
M/S–8	N	Penetration of Inhabited Spacecraft Compartments	Vehicle requirement.
M/S–9	N	Mechanisms	NGL does not contain any mechanical systems.
M/S–10	N	Functional Doors That Operate in Flight	Requirement has been cancelled.
M/S–11	N	Meteoroid Protection Levels for Structures	Vehicle requirement.
M/S–12	N	Spacecraft Recovery Hoist Loops	Vehicle requirement.
M/S–13	N	Lifting and Hoisting Ground Support Equipment Identification	Requirement has been cancelled.
M/S–14	A	Structural Analysis	----------
M/S–15	A	Stainless Steel Tubing – Method of Joining	NGL does not contain stainless steel tubing.
M/S–16	N	Pressure Vessels – Negative Pressure Damage	NGL does not contain pressure vessels.
P–1	N	Explosive Devices – Arming and Disarming	NGL does not contain pyrotechnic devices.
P–2	N	Pyrotechnic Devices – Preflight Verification Tests at Launch Sites	NGL does not contain pyrotechnic devices.
P–3	N	Wire Splicing	NGL does not contain pyrotechnic circuits.
P–4	N	Explosive Devices – Packaging Material	NGL does not contain pyrotechnic devices.
P–5	N	Explosive Devices – Identification Requirements	NGL does not contain pyrotechnic devices.
P–6	N	Protection of Electrical Circuitry for Explosive Devices Employing Hot Bridgewire Initiators	NGL does not contain pyrotechnic devices.
P–7	N	Explosive Devices – Color Coding	NGL does not contain pyrotechnic devices.

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		Requirements	