

Space And Life Sciences Criticality 3
Experiment Unique Equipment
System Requirements Document

E085/507

Visuomotor and Orientation Investigations in
Long-duration Astronauts (VOILA)

LS-71143

Preface

This experiment specific SRD has been derived from the JSC provided template LS-71143 dated 28 February 2000.

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ACRONYMS AND ABBREVIATIONS

{Add and delete entries as necessary}

AC	Alternating Current
ADP	Acceptance Data Package
APM	Attached Pressurized Module
C&DH	Command and Data Handling
CAM	Centrifuge Accommodation Module
CCB	Configuration Control Board
CFU	Colony Forming Units
CI	Cargo Integration
COTS	Commercial Off-the-Shelf
dB	Decibels
DBA	Acoustic Decibel Level
DC	Direct Current
DGCS	Display and Graphics Commonality Standards
DR	Discrepancy Report
EEE	Electrical, Electronic, and Electromechanical
EMC	Electromagnetic Compatibility
EPCE	Electrical Power Consuming Equipmen
ESD	Electrostatic Discharge
EUE	Experiment Unique Equipment
FIAR	Failure Investigation Analysis Report
FMEA	Failure Modes and Effects Analysis
FPD	Flight Projects Division
GFCI	Ground Fault Circuit Interrupter
GPVP	Generic Payload Verification Plan
GSE	Ground Support Equipment
HR	Hazard Report
HRF	Human Research Facility
Hz	Hertz
ICD	Interface Control Document
IDD	Interface Definition Document
IMS	Inventory Management System
in	inch
ISPR	International Standard Payload Rack

ISS
ITCS

International Space Station
Internal Thermal Control System

ACRONYMS AND ABBREVIATIONS (Cont'd)

JEM	Japanese Experiment Module
JSC	Johnson Space Center
KHz	Kilohertz
lb	pound
lbf	pounds force
MDM	Multiplexer-Demultiplexer Module
mm	millimeter
MPLM	Mini Pressurized Logistics Module
MSFC	Marshall Space Flight Center
N	Newton (metric force measurement)
NASA	National Aeronautics and Space Administration
ORU	Orbital Replacement Unit
P/L	Payload
Pa	Pascal
para.	paragraph
PDA	Pre-Delivery Acceptance
PFE	Portable Fire Extinguisher
PHTR	Packaging, Handling, and Transportation Records
PI	Principal Investigator
PODF	Payload Operations Data File
psi	pounds per square inch
psia	pounds per square inch absolute
PSRP	Payload Safety Review Panel
QAVT	Qualification for Acceptance Vibration Testing
rms	Root Mean Square
RSP	Resupply Stowage Platform
SE&I	Systems Engineering and Integration
sec	second
SPL	Sound Pressure Level
SRD	System Requirements Document
SVT	Science Verification Testing
TBD	To Be Determined

TPS

Task Performance Sheet

ACRONYMS AND ABBREVIATIONS (Cont'd)

UIP	Utility Interface Panel
UOP	Utility Outlet Panel
USL	United States Lab
V	Volts
VDS	Verification Data Sheet
VOILA	Visuomotor and Orientation Investigations in Long-duration Astronauts
°C	Degrees Celsius
°F	Degrees Fahrenheit

1.0

SCOPE

This specification defines the Human Research Facility (HRF) program requirements for Visuomotor and Orientation Investigations in Long-duration Astronauts (VOILA)—E085/507. The VOILA consists of Criticality 3 Experiment Unique Equipment (EUE) hardware and software that will be used to support the HRF. The term “Experiment Unique Equipment,” as used in this document, is defined as hardware designed to support an HRF Program experiment and not intended for general use.

The primary governing document for the requirements levied in this document is LS-71000, Program Requirements Document for the Human Research Facility. Other requirements are derived from SSP 57200, Human Research Facility - Rack One Hardware Interface Control Document, and interface requirement documents for the various items of HRF equipment.

The requirements in Sections 3, 4, and 5 of this document consist of a minimum set of constraints for Criticality 3 EUE hardware and software. Criticality 3 items are defined in SSP 30234. Provisions for verification and subsequent use of Criticality 3 equipment as part of the HRF program are delineated in Section 5 of LS-71000.

The VOILA Experiment Unique Equipment shall be reviewed through the International Space Station (ISS) Payload Safety Review Panel (PSRP) for Safety Certification and JSC/NT3 Reliability for designation as Criticality 3 hardware.

The HRF Project Office is the controlling authority for this document. The HRF Configuration Control Board (CCB) or a delegated authority must approve any deviations from the requirements of this document. Any change in functionality that requires equipment designated as Criticality 3 to be used in a manner that is not consistent with the requirements specified herein and in LS-71000 will require that item or items to be reassessed for criticality as well as applicability of this document.

2.0

APPLICABLE DOCUMENTS

The following applicable documents of the exact issue shown herein form a part of this specification to the extent specified herein. If a revision level or date is not cited, the latest version of the document should be used, as of the date the contract is issued.

All specifications, standards, exhibits, drawings or other documents referenced in this specification are hereby incorporated as cited in the text of this document.

2.1

DOCUMENTS

<u>Document Number</u>	<u>Revision</u>	<u>Document Title</u>
TBD	TBD	HRF Workstation 2 ICD
FED-STD-595	<i>Rev. B 12/89</i>	Colors Used in Government Procurement
JSC-SN-C-0005	<i>Rev. C 2/89</i>	National Space Transportation System Contamination Control Requirements
LS-71000	<i>Rev. A 1/00</i>	Program Requirements Document for the Human Research Facility
MIL-STD-1686	<i>Rev. C 10/95</i>	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies And Equipment (Excluding Electrically Initiated Explosive Devices)
MSFC-STD-250	<i>Rev. A 10/77</i>	Protective Finishes for Space Vehicle Structures and Associated Flight Equipment, General Specification for
NASA TM 102179	<i>6/91</i>	Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits
NSTS/ISS 13830	<i>Rev. C, Ch. 1 7/99</i>	Implementation Procedure for NSTS Payloads System Safety Requirements for Payloads Using the Space Transportation System
NSTS-1700.7	<i>Rev. B, Ch. 4 3/97</i>	Safety Policy and Requirements For Payloads Using the Space Transportation System
NSTS-1700.7B ISS ADDENDUM	<i>12/95</i>	Safety Policy and Requirements For Payloads Using the International Space Station
NSTS/ISS 18798	<i>Rev. B, Ch. 3 9/97</i>	Interpretations of NSTS/ISS Payload Safety Requirements
SSP 30233	<i>Rev. E 11/95</i>	Space Station Requirements for Materials and Processes
SSP 30237	<i>Rev. D 7/98</i>	Space Station Electromagnetic Emission and Susceptibility Requirements

<u>Document Number</u>	<u>Revision</u>	<u>Document Title</u>
SSP 30240	<i>Rev. C</i> 6/99	Space Station Grounding Requirements
SSP 30242	<i>Rev. D,</i> <i>Ch. 2</i> 6/99	Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility
SSP 30243	<i>Rev. E,</i> <i>Ch. 3</i> 6/99	Space Station Requirements for Electromagnetic Compatibility
SSP 30245	<i>Rev. D,</i> <i>Ch. 6</i> 6/99	Space Station Electrical Bonding Requirements
SSP 30312	<i>Rev. F</i> 11/95	Electrical, Electronic, and Electromechanical (EEE) and Mechanical Parts Management and Implementation Plan International Space Station Program
SSP 30512	<i>Rev. C</i> 9/94	Space Station Ionizing Radiation Design Environment
SSP 30573	<i>Rev. A</i> 10/94	Space Station Program Fluid Procurement and Use Control Specification
SSP 41175-2	<i>Rev. B</i> 6/97	Software Interface Control Document (ICD) Part 1 Station Management and Control to International Space Station Book 2, General Software Interface Requirements
SSP 50005	<i>Rev. B,</i> <i>Ch. 1</i> 9/98	International Space Station Flight Crew Integration Standard (NASA-STD-3000/T)
SSP 50007	<i>Rev. A</i> 11/96	Space Station Inventory Management System Label Specification
SSP 50008	<i>Rev. B</i> 7/98	International Space Station Interior Color Scheme
SSP 52005	<i>Rev. B</i> 3/99	Payload Flight Equipment Requirements and Guidelines for Safety-Critical Structures
SSP 52050	<i>Rev. A</i> 11/98	Software Interface Control Document Part 1, International Standard Payload Rack to International Space Station
SSP 57000	<i>Rev. C</i> 12/98	Pressurized Payloads Interface Requirements Document
SSP 57001	<i>Rev. A</i> 7/99	Pressurized Payloads Hardware Interface Control Document Template

2.2

ORDER OF PRECEDENCE

In the event of a conflict between the text of this specification and references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3.0 SYSTEM REQUIREMENTS

3.1 ITEM DEFINITION

The following items of VOILA EUE will be designed and certified under this requirements document for use on ISS as a part of the HRF program. HRF hardware used with this experiment is certified under separate documentation which is maintained by the appropriate program(s).

Table 3.1-1 lists the equipment items covered by this document.

TABLE 3.1-1. VOILA EXPERIMENT UNIQUE EQUIPMENT

Item Name	Part Number	Quality Flown	Notes
Head Mounted Display	TBD	1	Includes separate interface electronics bo
Optical Tracker	TBD	2	Includes separate interface electronics bo
Inertial Tracker	TBD	3	Includes separate interface electronics bo
Subject Input Device	TBD	1	Joystick input to HRF workstation
Subject Restraint System	TBD	1	Passive

Table 3.1-2 lists the software items covered by this document.

TABLE 3.1-2. VOILA EXPERIMENT UNIQUE EQUIPMENT SOFTWARE

Program Name	Part Number	Notes
Session Manager	TBD	
Experiment Manager	TBD	
Data Manager	TBD	

3.1.1 Experiment Description

3.1.1.1 Experiment Overview

This ISS HRF investigation extends, simplifies, and merges two sensory motor and performance experiments originally developed for the 1998 STS90 Neurolab mission. The two components retain separate numbers (E085/E507) on ISS, but are performed together. The experiments use the HRF Workstation 2 as “science kiosk” to perform short (typically 30 minute long) tests to study the role of visual, vestibular, and haptic cues on spatial orientation and motor behavior. The experiment utilizes virtual environment generation accessories first developed for

the Neurolab as a tool to study these processes during and after long duration (3-6 month) orbital flight. Restrained and free-floating subjects wear a wide field of view, color stereo head mounted display. Tests are based on 1-G paradigms, require little set-up time, and can be selected and performed by an astronaut in an automated fashion using Session Manager software. Three pre-flight, three in flight, and three post-flight performances of each test are planned on each ISS increment.

The Specific Objectives are

To determine the effects of microgravity on:

(1) The influence of scene symmetry, rotation, haptic cues, and expected orientation on static and dynamic self tilt (Virtual Tilting and Tumbling Room Tests); (2) the onset of x-axis illusory linear self-motion without haptic cues (Linear Vection Test); (3) the effect of perceived orientation on visual object recognition and shape recognition (Object Recognition Tests); (4) whether information used in grasping remembered objects is stored in head fixed, body fixed, or exocentric reference frames (Virtual Grasping Test); and (5) how the timing of catching movements depends on anticipation of downward acceleration (Virtual Catching Test).

3.1.1.2 Operational Overview

In each session, based on the amount of crewtime available, the Workstation Session Manager program suggests one or more of 5 different visual perception tests and one or more of 4 different visuomotor tasks. Inflight tests are performed in up to 3 possible conditions: quasi-free floating, lightly restrained and/or with constant-force springs (simulated gravity). Pre-and post-flight tests will be conducted in one of three conditions: erect, supine, or with a tilted seat.

Visual Perception

Test 1: Tilted Room. Subject indicates perceived vertical while viewing a series of tilted scenes.

Test 2: Tumbling Room. Subject indicates vection magnitude and surface identity while viewing rotating scenes.

Test 3: Linear Vection. Subject indicates vection onset and magnitude while viewing a moving corridor scene.

Test 4: Figures. Subject indicates which complex 2D figure seems most familiar.

Test 5: Shading. Subject indicates which shaded circle seems most convex.

Visuomotor Coordination

Test 6: Grasping. Upright. Subjects align the hand with a object oriented in 3D space.

Test 7: Grasping. Head Tilt. Subjects repeat Test 6 with 30 head tilt.

Test 8: Pointing. Subjects perform rapid point-to-point movements with the dominant hand.

Test 9: Interception. Subjects intercept a flying ball with the dominant hand.

Three inflight performances of each test. The first should be during Week 2 (FD8 to FD14), the second during Week 5 (FD29 to FD35), and the third during Week 11 (FD71 to FD77). Depending on crew schedules, it would be highly desirable to schedule one additional performance during Week 1 (FD1 to FD7) and another about 3-4 weeks before the end of the increment (R-21 to R-28). If possible, additional performances every six weeks after Week 11 until as late as possible would also be desirable.

3.2 CHARACTERISTICS

3.2.1 Performance Characteristics

3.2.1.1 Functional Performance Characteristics

- A. Note: Functional requirements for the VOILA EUE are described in Visuomotor and Orientation Investigations in Long-duration Astronauts—E085/507 Experiment Document (ED), LS-20427. Functional requirements for HRF subrack payloads, stowed equipment, and deployed equipment that may be used in conjunction with this EUE are described in the individual equipment hardware requirements documents.
- B. Equipment provided under this document should, as a minimum, be verified to be functionally acceptable for its intended operational lifetime.
- C. Upon arrival at Johnson Space Center (JSC), the VOILA shall undergo full experiment protocol test and checkout.
- D. This testing shall be documented on a Task Performance Sheet (TPS) (JSC Form 1225) per JSC Work Instruction NT1-CWI-001.
- E. This testing shall be of sufficient level to demonstrate end-to-end functionality of the VOILA EUE.

3.2.1.2 Equipment Performance Characteristics

{Specific equipment performance characteristics necessary for the successful completion of the intended experiment should be detailed in this section. As an example, if an item of measuring equipment associated with the experiment were required to measure parameters over a certain range (i.e., 400 millivolts, or 0.2 - 100 ml/min, etc.) and have a certain accuracy (i.e., $\pm 0.5\%$ Full Scale, or $\pm 2\%$ of reading, etc.), these items would be regarded as equipment performance characteristics.}

3.2.2 Physical Characteristics

3.2.2.1 Mass Properties

{Weight requirements for the VOILA are as negotiated with the developer and are documented in the ED.}

3.2.2.2 Envelope

{Stowed and deployed envelope requirements for the hardware are as negotiated with the developer and are documented in the ED.}

3.2.2.2.1 Stowed Envelope

{If stowed envelope dimensions are critical features of the hardware or if there is a dimensional value which must be met within a given tolerance or which cannot be exceeded (e.g., for stowage), that dimensional requirement should be specified in this section. Otherwise, the requirement for hardware to be measured and its dimensions documented on a TPS (JSC Form 1225) should be stated in this section. The tolerance of the measuring system should also be recorded on this form. As an alternative, the hardware provider may provide the item dimensions and the measuring system tolerance as part of the data package. Estimated stowed envelope dimensions should be provided as early in the design process as possible. Note: This data is to be provided for flight integration purposes.}}

{Table 3.2.2.2.1-1 is provided as a guide.}

TABLE 3.2.2.2.1-1. STOWAGE UNIT VOLUME ALLOWANCE

Stowage Unit	Volume Allowance (1)	Reference
Middeck Modular Stowage Locker	2 ft ³ 17.3 in (W) 20.3 in (D) x 10.0 in (H)	NSTS-21000-IDD-MDK, Section 3.4.1
Middeck Standard Stowage Tray	1.8 ft ³ 17.0 in (W) x 20.0 in (D) x 9.5 in (H) (Top Opening is 14.5 in x 18.6 in)	NSTS-21000-IDD-MDK, Section 3.4.1.1
4 PU Drawer	1.3 ft ³ 16.2 in (W) x 23.7 in (D) x 5.9 in (H)	SSP 52000-PAH-ERP Section 4.1.2 SSP 52000-IDD-ERP Section 3.4.4
Resupply Stowage Platform 1 - Stowage System (RSP1-SS) M1 Bag (6 CTBE) M2 Bag (4 CTBE) M1 Bag (6 CTBE) M2 Bag (4 CTBE)	13 ft ³ 35.3 in (W) x 21.0 in (D) x 32.2 in (H) 8 ft ³ 35.3 in (W) x 21.0 in (D) x 20.0 in (H)	TBD

(1) The volume allowances and dimensions shown are only approximate. The payloads must meet the height, width, and depth limitations of the Stowage unit as well as the interface requirements for the individual Stowage Unit.

3.2.2.2.2 Deployed Envelope

3.2.2.2.2.1 Hardware Protrusion Limits

3.2.2.2.2.1.1 Permanent Protrusions

Integrated rack payload hardware shall only extend beyond the National Aeronautics and Space Administration (NASA) International Standard Payload Rack (ISPR) front face Ground Support Equipment (GSE) attachment points as defined in SSP 41017 and agreed to by ISS in the unique payload ICDs. Payload hardware extended or attached on-orbit may protrude beyond the face of the NASA ISPR front face GSE attachment points only on an intermittent or temporary basis. Payload work corridor will be 50 inches x 72 inches, (50 inches Y axis, 72 inches Z axis). (LS-71000, Section 6.4.4.1.1)

3.2.2.2.2.1.2 Intermittent Protrusions

A. Intermittent protrusions are defined as equipment which remains setup in the aisle over a period of days, during which time crew attendance is repeatedly required. Intermittent protrusions shall be limited to 17 inches beyond the plane of the NASA ISPR front face GSE attachment points (except for payloads manifested in the floor or ceiling locations which are limited to 6 inches). (LS-71000, Section 6.4.4.1.2A)

B. Intermittent protrusions shall be easily stowable. (LS-71000, Section 6.4.4.1.2B)

3.2.2.2.2.1.3 Temporary Protrusions

Temporary protrusions are defined as equipment which remains set up in the aisle for a period of less than eight hours, during which time crew attendance will be nearly continuous. Temporary protrusions shall be limited to 26 inches beyond the plane of the NASA ISPR front face GSE attachment points. (LS-71000, Section 6.4.4.1.3)

3.2.2.2.2.1.4 Clearance for Crew Restraints and Mobility Aids

Protrusions, intermittent or temporary shall not interfere with crew mobility and translation restraints. Any temporary or intermittent protrusions will create additional rack placement constraints and risks to the microgravity environment of the payload. (LS-71000, Section 6.4.4.1.4)

3.2.2.2.2 Deployed Envelope Dimensions

{The deployed hardware dimensions must conform to the limitations stated in 3.2.2.2.1. If other deployed envelope dimensions are critical features of the hardware or if there is a dimensional value which must be met within a given tolerance or which cannot be exceeded, that dimensional requirement should be specified in this section. Otherwise, hardware should be measured and its dimensions documented on a TPS (JSC Form 1225). The tolerance of the measuring system should also be recorded on this form. As an alternative, the hardware provider may provide the item dimensions and the measuring system tolerance as part of the data package. Estimated deployed envelope dimensions should be provided as early in the design process as possible. Note: This data is to be provided for flight integration purposes.}

{If the stowed and deployed envelope dimensions are the same, state that they are the same in this section and reference Section 3.2.2.2.1 of this document.}

3.2.3 Reliability

This specification applies only to equipment designated as Criticality 3 in accordance with the criteria stated in LS-71000, Section 3.2.

3.2.3.1 Failure Propagation

The design shall preclude propagation of failures from the payload to the environment outside the payload. (NSTS 1700.7B, Section 206)

3.2.4 Maintainability

- A. Payload provided unique tools shall meet the requirements of SSP 50005, paragraph 11.2.3. (LS-71000, Section 6.4.4.2.6.3)
- B. All Orbital Replacement Units (ORUs) connectors, whether operated by hand or tool, shall be designed and placed so they can be mated/demated using either hand. (LS-71000, Section 6.4.4.3.1)
- C. It shall be possible to mate/demate individual connectors without having to remove or mate/demate connectors on other ORUs or payloads during maintenance operations. (LS-71000, Section 6.4.4.3.2B)
- D. Electrical connectors and cable installations shall permit disconnection and reconnection without damage to wiring connectors. (LS-71000, Section 6.4.4.3.2C)
- E. Access to inspect or replace a hardware item (e.g., an ORU) which is planned to be accessed on a daily or weekly basis shall not require removal of another hardware item or more than one access cover. (LS-71000, Section 6.4.4.2.6)

F. Payload containers of liquids or particulate matter shall have built-in equipment/methods for control of vaporization, material overflow, or spills. (LS-71000, Section 6.4.3.1.2A)

G. The capture elements, including grids, screens, or filter surfaces shall be accessible for replacement or cleaning without dispersion of the trapped materials. (LS-71000, Section 6.4.3.1.2B)

3.2.4.1 Logistics and Maintenance

{Describe all ORUs for the VOILA. EUE.} TBD

3.2.4.1.1 Payload In-Flight Maintenance

Payloads shall be designed to be maintainable using Space Station provided on-board tools. Available tools on-orbit are defined in the Payloads Accommodations Handbook. (LS-71000, Section 6.4.10)

3.2.4.1.2 Maintenance Functions

None

3.2.5 Environmental Conditions

3.2.5.1 On-Orbit Environmental Conditions

3.2.5.1.1 On-Orbit Internal Environments

3.2.5.1.1.1 Pressure

The VOILA EUE shall be safe when exposed to pressures of 0 to 104.8 kPa (0 to 15.2 psia). (LS-71000, Section 6.3.6.1.1)

3.2.5.1.1.2 Temperature

The VOILA EUE shall be safe when exposed to temperatures of 10° to 46° C (50 to 115° F). (LS-71000, Section 6.3.6.1.2)

3.2.5.1.1.3 Humidity

The VOILA EUE shall be designed to not cause condensation when exposed to a dewpoint of 4.5° to 15.6° C (40° to 60° F) and a relative humidity of 25% to 75%. (LS-71000, Section 6.3.6.1.3)

3.2.5.1.2 Use of Cabin Atmosphere

3.2.5.1.2.1 Active Air Exchange

Active air exchange with the cabin atmosphere by the VOILA EUE shall be limited to air exchange for specimen metabolic purposes and for mass conservation purposes. (LS-71000, Section 6.3.6.2.1)

3.2.5.1.2.2 Oxygen Consumption

Not applicable to VOILA.

3.2.5.1.2.3 Chemical Releases

Chemical releases to the cabin air shall be in accordance with paragraphs 209.1a and 209.1b in NSTS 1700.7, ISS Addendum. (LS-71000, Section 6.3.6.2.3)

3.2.5.1.2.4 Cabin Air Heat Leak

Cabin air heat rejection is defined by the ISS program in terms of ISS modules only. No sub-allocation has been made for integrated racks or EUE. VOILA EUE maximum cabin air heat rejection must be documented in the VOILA EUE ICD. (LS-71000, Section 6.3.4.2)

3.2.5.1.2.5 Cabin Air Cooling

The VOILA EUE air heat load absorption shall be no greater than the maximum values listed in Table 3.2.5.1.2.5-1, with linear interpolation to ambient temperatures between the specified values. (LS-71000, Section 6.3.4.3)

TABLE 3.2.5.1.2.5-1. AIR HEAT LOAD

Ambient Temperature	Max Heat Load
15.5° C (60° F)	68 W
49° C (120° F)	140 W

3.2.5.1.3 Ionizing Radiation Requirements

3.2.5.1.3.1 Instrument Contained or Generated Ionizing Radiation

Not applicable to VOILA

3.2.5.1.3.2 Ionizing Radiation Dose

EUE should expect a total dose (including trapped protons and electrons) of 30 Rads (Si) per year of ionizing radiation. A review of the dose estimates in the ISS (SAIC-TN-9550) may show ionizing radiation exposure to be different than 30 Rads (Si) per year, if the intended location of the rack in the ISS is known. (LS-71000, Section 6.3.6.3.2)

3.2.5.1.3.3 Single Event Effect (SEE) Ionizing Radiation

The VOILA EUE shall be designed not to produce an unsafe condition or one that could cause damage to equipment external to the VOILA EUE as a result of exposure to SEE ionizing radiation assuming exposure levels specified in SSP 30512, paragraph 3.2.1, with a shielding thickness of 25.4 mm (1000 mils). (LS-71000, Section 6.3.6.3.3)

3.2.5.1.4 Additional Environmental Conditions

TABLE 3.2.5.1.4-1. ENVIRONMENTAL CONDITIONS ON ISS

Environmental Condition	Value
Atmospheric Conditions	
Pressure Extremes	0 to 104.8 kPa (0 to 15.2 psia)
Normal operating pressure	See Figure 3.2.5.1.4-1
Oxygen partial pressure	See Figure 3.2.5.1.4-1
Nitrogen partial pressure	See Figure 3.2.5.1.4-1
Dewpoint	4.4 to 15.6 °C (40 to 60 °F)
Percent relative humidity	25 to 75
Carbon dioxide partial pressure during normal operations with 6 crewmembers plus animals	24-hr average exposure 5.3 mm Hg Peak exposure 7.6 mm Hg
Carbon dioxide partial pressure during crew changeout with 11 crewmembers plus animals	24-hr average exposure 7.6 mm Hg Peak exposure 10 mm Hg
Cabin air temperature in United States Lab (USL), Japanese Experiment Module (JEM), Attached Pressurized Module (APM), and Centrifuge Accommodation Module (CAM)	17 to 28 °C (63 to 82 °F)
Cabin air temperature in Node 1	17 to 31 °C (63 to 87 °F)
Air velocity	0.051 to 2.03 m/s (10 to 40 ft/min)
Airborne microbes	Less than 1000 Colony Forming Units (CFU)/m ³
Atmosphere particulate level	Average less than 1000,000 particles/ft ³ for particles less than 0.5 microns in size
MPLM Air Temperatures	
Active and Passive Flights	
Extremes for all phases of flight	10 to 46 °C (50 to 114.8 °F)
Thermal Conditions	
Module wall temperature	13 °C to 43 °C (55 °F to 109 °F)
Other integrated payload racks	Front surface less than 37 °C (97 °F)
Microgravity	
General Illumination	TBD
	108 Lux (10 fc) measured 30 inches from the floor in the center of the aisle

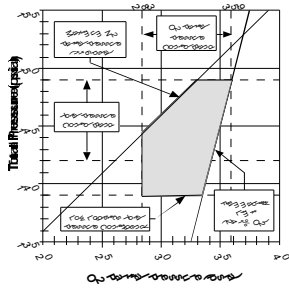


Figure 3.2.5.1.4-1. Operating Limits of the ISS Atmospheric Total Pressure, Nitrogen, and Oxygen Partial Pressures

3.2.5.1.5 Pressure Rate of Change

- A. The VOILA EUE shall maintain positive margins of safety for the on-orbit depress/repress rates in Table 3.2.5.1.5-1. (LS-71000, Section 6.3.1.2B)

TABLE 3.2.5.1.5-1. ISS PRESSURE RATE OF CHANGE

Depressurization	878 Pa/sec (7.64 psi/minute)
Repressurization	230 Pa/sec (2.0 psi/minute)

- B. Not applicable to VOILA EUE.

C. EUE shall maintain positive margins of safety for maximum depressurization and repressurization rates for the carrier(s) in which it will be transported. (LS-71000, Section 6.3.1.2A)

D. EUE that have Portable Fire Extinguisher (PFE) access ports shall maintain positive margins of safety when exposed to the PFE discharge rate given in Figure 3.2.5.1.5-1. (LS-71000, Section 6.3.1.2C)

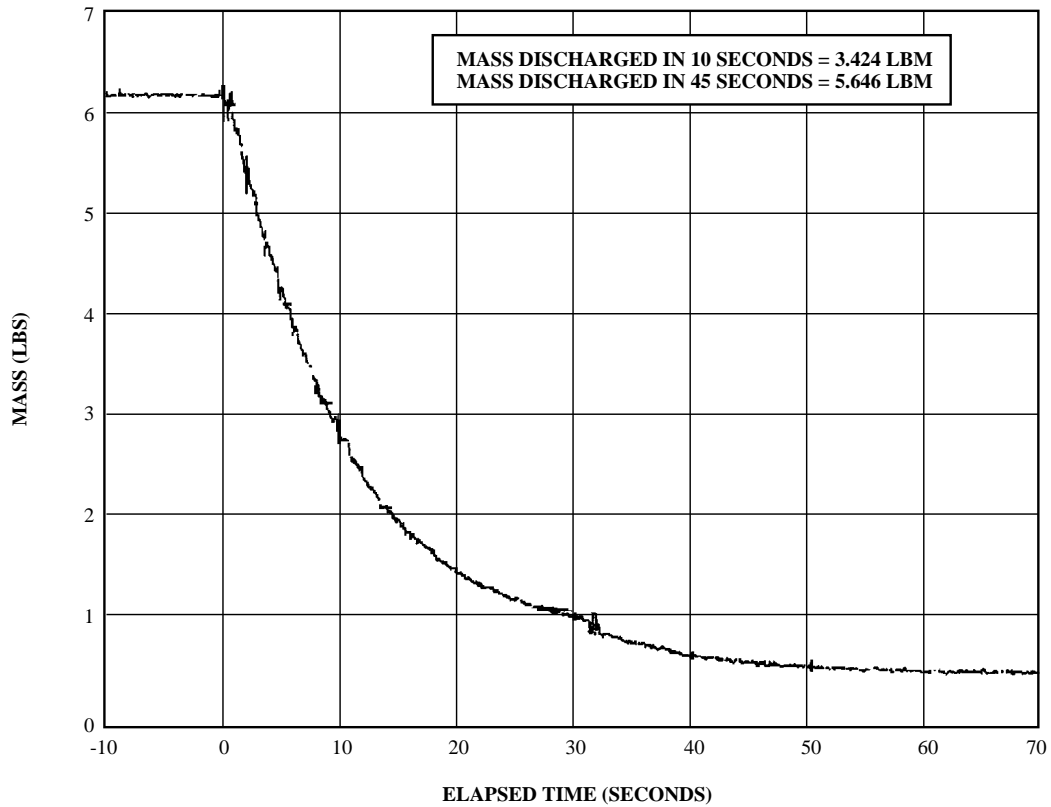


Figure 3.2.5.1.5-1. Manual Fire Suppression System Performance Characteristics

3.2.5.2 Acoustic Emission Limits

3.2.5.2.1 Continuous Noise Limits

VOILA EUE continuous acoustical emissions shall individually comply with the acoustic requirements (NC-40 equivalent) in Table 3.2.5.2-1. (LS-71000, Section 6.4.3.3.1C)

TABLE 3.2.5.2-1. CONTINUOUS NOISE LIMITS

Rack Noise Limits Measured at 0.6 Meters Distance From the Test Article	
Frequency Band (Hz)	Integrated Rack Sound Pressure Level (SPL)
63	64
125	56
250	50
500	45
1000	41
2000	39
4000	38
8000	37

3.2.5.2.2 Intermittent Noise Limits

A. The Integrated rack (including any supporting adjunct active portable equipment operated outside the integrated rack that is within or interfacing with the crew habitable volume) Intermittent Noise Source (See Glossary of Terms) shall not exceed the Total Rack A-weighted SPL Limits during the Maximum Rack Noise Duration as specified in Table 3.2.5.2.2-1 when the equipment is operating in the loudest expected configuration and mode of operation that can occur on orbit under any planned operations. (LS-71000, Section 6.4.3.3.2A)

Note: These acoustic requirements do not apply during failure or maintenance operations.

TABLE 3.2.5.2.2-1. INTERMITTENT NOISE LIMITS

Rack Noise Limits Measured At 0.6 Meters Distance From The Test Article	
Maximum Rack Noise Duration	Total Rack A - Weighted SPL (DBA)
8 Hours	49
7 Hours	50
6 Hours	51
5 Hours	52
4 Hours	54
3 Hours	57
2 Hours	60
1 Hour	65
30 Minutes	69
15 Minutes	72
5 Minutes	76
2 Minutes	78
1 Minute	79
Not Allowed	80

B. The Rack Noise Duration is the total time that the rack produces intermittent noise above the NC-40 limit during a 24 hour time period. This duration is the governing factor in determining the allowable Intermittent Noise Limits. Regardless of the number of separate sources and varying durations within a rack, this cumulative duration shall be used to determine the A-weighted SPL limit in column B. (LS-71000, Section 6.4.3.3.2B)

3.2.5.3 Instrument Surface Temperature

The VOILA EUE shall be designed such that the average surface temperature is less than 37° C (98.6° F) with a maximum temperature limit not to exceed 45° C (113° F). (LS-71000, Section 6.3.4.1)

3.2.6 Transportability

3.2.6.1 Launch and Landing

The VOILA EUE shall be transportable to and from orbit. Equipment carried in the Shuttle mid-deck lockers shall be transportable in the Shuttle mid-deck locker to and from orbit, as specified in NSTS-21000-IDD-MDK.

3.2.7 Operational Interface Requirements

{Provide a block diagram and describe all interfaces with the HRF Rack and/or ISS and/or Shuttle in these sections.}

3.2.7.1 Mechanical Interface Requirements

3.2.7.1.1 Connector Physical Mate

Where required, the VOILA EUE shall physically mate with the Utility Interface Panel (UIP), Utility Outlet Panel (UOP), and Fluid Services connectors intended to be used by the payload as listed in Table 3.1.1.6.1-1 of SSP 57000.

{Describe the [name of equipment] mechanical interface requirements with the HRF Rack, HRF Rack Equipment, ISS and/or Shuttle in this section. Reference SSP 57000, SSP 57001, Shuttle interface documentation, and HRF equipment ICDs for specific interface data.}

3.2.7.2 Electrical Interface Requirements

{Describe the EUE electrical interface requirements with the HRF Rack, HRF Rack Equipment, ISS and/or Shuttle in this section. Reference SSP 57000, SSP 57001, Shuttle interface documentation, and HRF equipment ICDs for specific interface data.}

3.2.7.2.1 Electromagnetic Radiation

3.2.7.2.1.1 Electromagnetic Compatibility (EMC)

The VOILA EUE shall meet the payload provider applicable requirements of SSP 30243, paragraphs 3.1, 3.5, and 3.6.2. (LS-71000, Section 6.3.2.4)

3.2.7.2.1.1.1 Electrical Grounding

The VOILA EUE shall meet all requirements specified in Section 3 of SSP 30240. (LS-71000, Section 6.3.2.4.1)

3.2.7.2.1.1.2 Electrical Bonding

Electrical bonding of the VOILA EUE shall be in accordance with Class [*bonding class*] SSP 30245 and NSTS 1700.7, ISS Addendum, Sections 213 and 220. (LS-71000, Section 6.3.2.4.2) *{The hardware provider in conjunction with HRF SE&I will analyze the hardware application and determine the applicable bonding class per Section 3.2.1 of SSP 30245.}*

3.2.7.2.1.2 Electromagnetic Interference

{The need to perform susceptibility tests is determined upon initiation of the VOILA project. If susceptibility tests are performed, the levels in B and C below may be applied to Criticality 3 equipment for radiated susceptibility.}

- A. The VOILA shall meet all EMI requirements of SSP 30237. (LS-71000, Section 6.3.2.4.4)
- B. Note: The alternative use of RS03 stated below applies to radiated susceptibility requirements only. (LS-71000, Section 6.3.2.4.4)
- C. Alternately, the payload Electrical Power Consuming Equipment (EPCE) may choose to accept a minimal increase of EMI risk with a somewhat less stringent Electric Field Radiated Susceptibility (RS03) requirement on equipment considered to be non-safety critical to the vehicle and crew. The tailored RS03 requirement, shown below, will hereafter be denoted RS03PL. (LS-71000, Section 6.3.2.4.4)

TABLE 3.3.2.2-1. RS03PL

FREQUENCY	RS03PL LIMIT (V/m)
14 kHz - 400 MHz	5
400 MHz - 450 MHz	30
450 MHz - 1 GHz	5
1 GHz - 5 GHz	25
5 GHz - 6 GHz	60
6 GHz - 10 GHz	20
13.7 GHz - 15.2 GHz	25

- D. Comments: The less stringent RS03PL limit was developed to envelope the electric fields generated by ISS transmitters and ground-based radars tasked to perform space surveillance and tracking. Ground-based radars that are not tasked to track the ISS and search radars that could momentarily sweep over the ISS are not enveloped by the relaxed RS03PL. For most scientific payloads, the minimal increase of EMI risk for the reduced limits is acceptable. The RS03PL limit does not account for module electric field shielding effectiveness that could theoretically reduce the limits even more. Although shielding effectiveness exists, it is highly dependent on the EPCE location within the module with respect to ISS windows.

3.2.7.2.2 Electrostatic Discharge

- A. Unpowered VOILA EUE EPCE shall not be damaged by Electrostatic Discharge (ESD) equal to or less than 4000 V to the case or any pin on external connectors. (LS-71000, Section 6.3.2.5)
- B. VOILA EUE EPCE that may be damaged by ESD between 4000 V and 15,000 V shall have a label affixed to the case in a location clearly visible in the installed position. (LS-71000, Section 6.3.2.5)
- C. Labeling of VOILA EUE EPCE susceptible to ESD up to 15,000 V shall be in accordance with MIL-STD-1686. (LS-71000, Section 6.3.2.5)
- D. Note: These voltages are the result of charges that may be accumulated and discharged from ground personnel or crewmembers during equipment installation or removal. (LS-71000, Section 6.3.2.5)

3.2.7.2.3 Corona

The VOILA EUE shall be designed to preclude damaging or destructive corona in its operating environment. Guidance for meeting the corona requirement is found in MSFC-STD-531, High Voltage Design Criteria. (LS-71000, Section 6.3.2.8)

3.2.7.2.4 Cable/Wire Design and Control Requirements

The VOILA EUE shall meet all Cable and Wire requirements of SSP 30242. (LS-71000, Section 6.3.2.4.3)

3.2.7.2.4.1 Wire Derating

- A. Wire derating for wire/cable between EUE and the UOP shall be in accordance with SSP 30312. (LS-71000, Section 6.3.2.1A)
- B. Derating criteria for EUE connected to payload rack power outlets shall be per NASA Technical Memo (TM) 102179 as interpreted by NSTS 18798, TA-92-038. (LS-71000, Section 6.3.2.1B)

3.2.7.2.4.2 Exclusive Power Feeds

Cabling shall not occur between Interface C connected EPCE with Interface B; and/or Interface B with Interface C. (LS-71000, Section 6.3.2.2)

3.2.7.2.5 Loss of Power

The VOILA EUE shall fail safe in the event of a total or partial loss of power, regardless of the availability of Auxiliary power in accordance with NSTS 1700.7, ISS Addendum. (LS-71000, Section 6.3.2.3)

3.2.7.2.6 Alternating Current Magnetic Fields

The generated Alternating Current (AC) magnetic fields, measured at a distance of 7 centimeters (cm) from the generating equipment, shall not exceed 140 dB above 1 picotesla for frequencies ranging from 30 Hz to 2 KHz, then falling 40 dB per decade to 50 KHz. (LS-71000, Section 6.3.2.6)

3.2.7.2.7 Direct Current Magnetic Fields

The generated Direct Current (DC) magnetic fields shall not exceed 170 dB picotesla at a distance of 7 cm from the generating equipment. This applies to electromagnetic and permanent magnetic devices. (LS-71000, Section 6.3.2.7)

3.2.7.3 Command and Data Handling Interface Requirements

The following requirements are defined for compatibility with HRF Common Software on the HRF portable computer.

3.2.7.3.1 Word/Byte Notations, Types and Data Transmissions

3.2.7.3.1.1 Word/Byte Notations

HRF rack independent instruments shall use the word/byte notations as specified in paragraph 3.1.1, Notations in SSP 52050. (LS-71000, Section 6.3.3.1.1)

3.2.7.3.1.2 Data Types

HRF rack independent instruments shall use the data types as specified in paragraph 3.2.1 and subsections, Data Formats in SSP 52050. (LS-71000, Section 6.3.3.1.2)

3.2.7.3.2 HRF Software Requirements

- A. File pathnames required for proper execution of the software shall be read from a configuration file rather than “hard coded” in the software. (LS-71000, Section 6.3.3.2A)
- B. The rack independent instrument software shall execute in the environment described in the host system IDD. (Workstation, Laptop, Common Software) (LS-71000, Section 6.3.3.2B)
- C. The Rack independent instruments software executable shall generate consistent results given the same initialization data. (LS-71000, Section 6.3.3.2C)

- D. User interface software shall comply with the Display and Graphics Commonality Standards (DGCS) (<http://139.169.159.8/idags/dgcs.html>) and the International Space Station Operations United States Payload Operations Data File Payload Display Implementation Plan. (LS-71000, Section 6.3.3.2D)
- E. Real-time data shall be formatted in accordance with the Life Sciences Data System (LSDS) Format. (LS-71000, Section 6.3.3.2E)

3.2.7.3.3 ISS Command and Data Handling Services Through HRF Common Software Interface

Rack independent instruments obtaining HRF rack and Payload Multiplexer-Demultiplexer Module (MDM) services (e.g., ancillary data requests, file transfer, report health and status, etc.) through the HRF Common Software shall request services in accordance with LS-71062-8, Interface Definition Document for the Human Research Facility Common Software. (LS-71000, Section 6.3.3.3)

3.2.7.4 Fire Protection Interface Requirements

Fire detection requirements for instruments operated outside of rack volumes have not been defined by ISS. Fire detection methodology for instruments operated outside of rack volumes must be approved by the PSRP. Fire protection requirements in this section apply to all instruments. Fire suppression requirements in this section apply for instruments operated outside of the rack volume that have forced air flow. (LS-71000, Section 6.3.7)

3.2.7.4.1 Fire Prevention

The VOILA EUE shall meet the fire prevention requirements specified in NSTS 1700.7B, ISS Addendum, paragraph 220.10a. (LS-71000, Section 6.3.7.1)

3.2.7.4.2 Fire Suppression

3.2.7.4.2.1 Portable Fire Extinguisher

- A. VOILA EUE instruments with forced air flow that have a panel thickness less than or equal to 3.175 mm (0.125 inch) and contain a potential fire source shall provide a PFE access port that is between 12.7 mm (0.5 inch) and 25.4 mm (1.0 inch) in diameter. PFE discharge characteristics are specified in Figure 3.2.5.1.5-1. (LS-71000, Section 6.3.7.2.1A)
- B. VOILA EUE instruments with forced air flow that have a panel thickness greater than 3.175 mm (0.125 inch) and contain a potential fire source shall provide a PFE access port that is 25.4 mm (1.0 inch) in diameter. PFE discharge characteristics are specified in Figure 3.2.5.1.5-1. (LS-71000, Section 6.3.7.2.1B)

Note 1: The final determination of whether or not a payload volume contains a potential fire source and requires a PFE access port will be presented to and approved by the PSRP during the phased safety reviews. (LS-71000, Section 6.3.7.2.1 Note 1)

Note 2: The ISS PFE has an “open cabin” diffuser nozzle which will be used to surround fire events that are not in an enclosed volume with suppressant. (LS-71000, Section 6.3.7.2.1 Note 2)

Note 3: Internal volumes are volumes which are presented to and approved by the PSRP as sealed containers and do not require PFE access ports. (LS-71000, Section 6.3.7.2.1 Note 3)

3.2.7.4.2.2 Fire Suppression Access Port Accessibility

VOILA EUE requiring an access port shall have a front face designed to accommodate the PFE nozzle and bottle specified in Figures 3.2.7.4.2.2-1 and 3.2.7.4.2.2-2 so the PFE nozzle can interface to the PFE port. (LS-71000, Section 6.3.7.2.2)

3.2.7.4.2.3 Fire Suppressant Distribution

The internal layout of the VOILA EUE shall allow ISS PFE fire suppressant to be distributed to the entire volume that PFE Access Port serves, lowering the Oxygen concentration to or below 10.5% by volume at any point within the enclosure within one minute. (LS-71000, Section 6.3.7.2.3)

Note: The position of VOILA EUE components near the PFE Access Port should not prevent fire suppressant to be discharged into the volume the PFE Access Port serves. PFE discharge characteristics are specified in Figure 3.2.5.1.5-1 and PFE closed volume nozzle dimensions are specified in Figure 3.2.7.4.2.2-2. (LS-71000, Section 6.3.7.2.3 Note)

3.2.7.4.3 Labeling

HRF VOILA EUE items requiring an access port shall label the PFE access port with a SDD32100397-002 “Fire Hole Decal” specified in JSC 27260, “Decal Process Document and Catalog.” (LS-71000, Section 6.3.7.3)

3.2.7.5 Other Interface Requirements

Not applicable to VOILA.

3.3.1.2 Sharp Edges

The VOILA EUE design within a pressurized module shall protect crewmembers from sharp edges and corners during all crew operations in accordance with SSP 50005, Section 6.3.3 as listed in Section 3.3.1.2.1 of this document. (LS-71000, Section 6.4.9.2)

3.3.1.2.1 Edge and Corner Requirements

A. Exposed Edge Requirements for Facilities and Mounted Hardware

- (1) Exposed edges 6.4 mm (0.25 in) thick or greater shall be rounded to minimum radius of 3.0 mm (0.12 in). (SSP 50005, Section 6.3.3.1A)
- (2) Exposed edges 3.0 - 6.4 mm (0.12 to 0.25 in) thick or greater shall be rounded to minimum radius of 1.5 mm (0.06 in). (SSP 50005, Section 6.3.3.1B)
- (3) Exposed edges 0.5 - 3.0 mm (0.02 to 0.12 in) thick or greater shall be rounded to a full radius. (SSP 50005, Section 6.3.3.1C)
- (4) The edges of thin sheets less than 0.5 mm (0.02 in) thick shall be rolled or curled. (SSP 50005, Section 6.3.3.1D)

B. Exposed Corner Requirements for Facilities and Mounted Hardware

- (1) Exposed corners of materials less than 25 mm (1.0 in) thick shall be rounded to a minimum radius of 13 mm (0.5 in). (SSP 50005, Section 6.3.3.2A)
- (2) Exposed corners of materials that exceed 25 mm (1.0 in) thick shall be rounded to a radius of 13 mm (0.5 in). (SSP 50005, Section 6.3.3.2B)

C. Protective Covers for Portable Equipment - Portable equipment which does not meet the corner and edge requirements of A and B above shall be covered or shielded when not in use. (SSP 50005, Section 6.3.3.3)

D. Holes - Holes that are round or slotted in the range of 10.0 to 25.0 mm (0.4 to 1.0 in) shall be covered. (LS-71000, Section 6.4.9.3, SSP 50005, Section 6.3.3.4)

E. Latches - Latches that pivot, retract, or flex so that a gap of less than 35 mm (1.4 in) exists shall be designed to prevent entrapment of a crewmember's appendage. (LS-71000, Section 6.4.9.4, SSP 50005, Section 6.3.3.5)

F. Screws and Bolts - Threaded ends of screws and bolts accessible by the crew and extending more than 3.0 mm (0.12 in) shall be capped to protect against sharp threads. (LS-71000, Section 6.4.9.5, SSP 50005, Section 6.3.3.6)

- G. Securing Pins - Securing pins in handrails shall be designed to prevent their inadvertently backing out above the handhold surface. (LS-71000, Section 6.4.9.6, SSP 50005, Section 6.3.3.7)
- H. Levers, Cranks, Hooks, and Controls - Levers, cranks, hooks, and controls shall not be located where they can pinch, snag, or cut the crewmembers or their clothing. (LS-71000, Section 6.4.9.7, SSP 50005, Section 6.3.3.8)
- I. Burrs - Exposed surfaces shall be free of burrs. (LS-71000, Section 6.4.9.8, SSP 50005, Section 6.3.3.9)
- J. Locking Wires - Safety wires shall not be used on fasteners which must be unfastened for on-orbit removal or replacement. (LS-71000, Section 6.4.9.9A)
- K. Locking Wires - All fracture-critical fasteners as defined in SSP 52005 (paragraph 5.6, Fastener Requirements, and Appendix B, Glossary of Terms), which must be unfastened for on-orbit removal or replacement, shall be safety cabled or cotterpinned. (LS-71000, Section 6.4.9.9B)
- L. Locking - Threaded fasteners shall incorporate features that allow them to be locked so they will not unthread without using a tool. (SSP 50005, Sections 6.3.3.10 and 11.9.3.3I)
- M. Loose Equipment - Loose equipment edge and corner radiusing shall be per Table 3.3.1.2.1-1 (SSP 50005, Section 6.3.3.11)

TABLE 3.3.1.2.1-1. LOOSE EQUIPMENT EDGE AND CORNER RADIUSING REQUIREMENTS

(METRIC)

Mass (Kg)	Edge Radius (mm)	Corner Radius (mm)
0.0 to 0.25	0.3	0.5
0.25 to 0.5	0.8	1.5
0.5 to 3.0	1.5	3.5
3.0 to 15.0	3.5	7.0
15.0 to 50.0	3.5	13.0

(STANDARD)

Mass (lb)	Edge Radius (in)	Corner Radius (in)
0.0 to 0.5	0.01	0.02
0.5 to 1.1	0.03	0.06
1.1 to 6.6	0.06	0.14
6.6 to 33.0	0.14	0.3
33.0 to 110.0	0.14	0.5

3.3.1.3 Electrical, Electronic, and Electromechanical Parts Selection

A. As a guide, parts should be controlled in accordance with:

- (1) NHB 5300.4(1F), "Electrical, Electronic, and Electromechanical (EEE) Parts Management and Control Requirements for NASA Space Flight Programs."
- (2) SSP 30312, "Electrical, Electronic, and Electromechanical (EEE) and Mechanical Parts Management and Implementation Plan for Space Station Program."

B. As a guide, part selection should be in accordance with:

- (1) SSP-30423, "Space Station Approved Electrical, Electronic, and Electromechanical (EEE) Parts List."
- (2) SSQ-25002, "Supplemental List of Qualified Electrical, Electronic, Electromechanical (EEE) Parts, Manufacturers, and Laboratories (QEPM&L)."
- (3) Semiconductors shall be JANTXV in accordance with MIL-S-19500, "General Specifications for Semiconductor Devices." Diodes shall have a metallurgical bond. Passive parts shall be at least the second highest level of appropriate Military Established Reliability (MIL-ER).
- (4) SSP-30512C, "Space Station Ionizing Radiation Design Environment."

C. Where no alternative is available, nonmilitary parts, components, and subassemblies may be used, but screening of these items shall be accomplished through burn-in as described in Section 3.3.1.3.1 of this document. Screening shall be completed (100%) on all flight hardware (units).

3.3.1.3.1 Burn In Screening Tests

A. Burn-In screening shall be performed on all flight units where nonmilitary parts, components, or subassemblies are used. The burn-in test may be accomplished at the component or assembly level, and is specified as:

- _ 72 hrs continuously at room ambient temperature while functioning
- _ 96 hrs continuously at a specified controlled temperature while functioning.

B. Full functional tests shall be performed on the experiment hardware before and after the burn-in test. Controlled temperature is defined as 15 °C below the maximum rating of the device with the lowest temperature rating in the

article under test. (LS-71000, Section 5.4.1.1.10)

3.3.2 Nameplates and Product Marking

3.3.2.1 Equipment Identification

Integrated racks, all (installed in the rack or separately) sub-rack elements, loose equipment, stowage trays, consumables, ORUs, crew accessible connectors and cables, switches, indicators, and controls shall be labeled. Labels are markings of any form [including Inventory Management System (IMS) bar codes] such as decals and placards, which can be adhered, “silk screened,” engraved, or otherwise applied directly onto the hardware. Appendix C of SSP 57000C provides instructions for label and decal design and approval. (LS-71000, Section 6.4.7) *{Labels may be manufactured under the direction or JSC Flight Projects Division (FPD). Labels not manufactured under the direction of JSC FPD, must be inspected and approved as meeting the requirements in Appendix C of SSP 57000C by JSC FPD. The formal approval process takes about 10 days once a complete drawing set is received by FPD. Pre-release drawings should be supplied to FPD as early in the design phase as practical, so that recommended changes can be incorporated into the final design prior to final formal approval.}*

3.3.3 Workmanship

The P/L developer shall use workmanship standards agreed to by NASA (JSC/NT3). The P/L developer may use NASA preferred standards located at <http://standards.nasa.gov>

3.3.4 Interchangeability

Parts with the same part number must be interchangeable for maintenance.

3.3.5 Safety Requirements

{The VOILA EUE must meet the applicable requirements of NSTS 1700.7, NSTS 1700.7 ISS Addendum, NSTS/ISS 18798, NSTS/ISS 13830, and KHB 1700.7. Applicability of the requirements is determined by working with the Safety representative assigned to this hardware.}

3.3.5.1 Electrical Safety

EUE shall meet the electrical safety requirements as defined in NSTS 1700.7, ISS Addendum. *{Applicability and closure of these requirements is determined by working with the Safety representative assigned to this hardware.}* (LS-71000, Section 6.3.2.10)

3.3.5.1.1 Mating/Demating of Powered Connectors

- A. The VOILA EUE shall comply with the requirements for mating/demating of powered connectors specified in NSTS 18798, MA2-97-093. (LS-71000, Section 6.3.2.10.1)
- B. Note: The HRF rack or UOP can provide one verifiable upstream inhibit which removes voltage from the UIP and UOP connectors. The module design will provide the verification of the inhibit status at the time the inhibit is inserted. (Derived from LS-71000, Section 6.3.2.10.1)

3.3.5.1.2 Power Switches/Controls

- A. Switches/controls performing on/off power functions for the VOILA EUE shall open (dead-face) all supply circuit conductors except the power return and the equipment grounding conductor while in the power-off position. (LS-71000, Section 6.3.2.10.3A)
- B. Power-off markings and/or indications shall be used only if all parts, with the exception of overcurrent devices and associated EMI filters, are disconnected from the supply circuit. (LS-71000, Section 6.3.2.10.3B)
- C. Standby, charging, or other descriptive nomenclature shall be used to indicate that the supply circuit is not completely disconnected for this power condition. (LS-71000, Section 6.3.2.10.3C)

3.3.5.1.3 Ground Fault Circuit Interrupters/Portable Equipment DC Sourcing Voltage

Not applicable to VOILA.

3.3.5.1.4 Portable Equipment/Power Cords

Not applicable to VOILA.

3.3.6 Human Engineering

3.3.6.1 Closures or Covers Design Requirements

- A. Closures or covers shall be provided for any area of the payload that is not designed for routine cleaning. (LS-71000, Section 6.4.3.1.1)
- B. Note: As a goal, SSP 50005, Section 11.4.3 may be used as guidelines for the design of closures and covers on equipment housing.

3.3.6.2 Interior Color

3.3.6.2.1 Rack Mounted Equipment

Not applicable to VOILA.

3.3.6.2.2 Stowed/Deployable Equipment

The colors and finishes for stowed and deployable equipment, even if it is normally attached to the rack during use shall be as specified below:

- A. COTS equipment that is not repackaged by HRF engineers shall be finished as delivered by the manufacturer. (LS-71000, Section 6.4.3.5.2A)
- B. Items that are repackaged by HRF engineers shall be finished using anodic film per MIL-A-8625, Type II, Class 2, Dyed Turquoise. Reference FED-STD-595, Color Specification 15187. (LS-71000, Section 6.4.3.5.2B)

3.3.6.2.3 Colors for Soft Goods

Human factors engineering will provide guidance in the appropriate colors for soft goods, in cooperation with the lead engineers, who will provide data on the available color choices for the specified materials. (LS-71000, Section 6.4.3.5.3)

3.3.7 Anthropometry

3.3.7.1 Full Size Range Accommodation

- A. All payload workstations and hardware having crew nominal operations and planned maintenance shall be sized to meet the functional reach limits for the 5th percentile Japanese female and yet shall not constrict or confine the body envelope for the 95th percentile American male as specified in SSP 50005, Section 3. (LS-71000, Section 6.4.2.3)
- B. COTS equipment shall be as delivered by the manufacturer and is exempted from this requirement.
- C. *{Include any special anthropometric requirements for this hardware}* - TBD

3.3.8 System Security

Not applicable to VOILA.

3.3.9 Design Requirements

3.3.9.1 Structural Design Requirements

- A. EUE shall maintain positive margins of safety for launch and landing loading conditions for the carrier(s) in which it will be transported. (Reference Section 3.2.6.2, this document) (LS-71000, Section 6.3.1.3A)
- B. EUE shall provide positive margins of safety for on-orbit loads of 0.2 Gs acting in any direction. (LS-71000, Section 6.3.1.3B)

3.3.9.1.1 Crew Induced Load Requirements

EUE shall provide positive margins of safety when exposed to the crew induced loads defined in Table 3.3.9.1.1-1, Crew-Induced Loads. (LS-71000, Section 6.3.1.3C)

TABLE 3.3.9.1.1-1. CREW-INDUCED LOADS

Crew System Or Structure	Type Of Load	Load	Direction Of Load
Levers, Handles, Operating Wheels, Controls	Push or Pull concentrated on most extreme edge	222.6 N (50 lbf), limit	Any direction
Small Knobs	Twist (torsion)	14.9 N-M (11 ft-lbf), limit	Either direction
Exposed Utility Lines (Gas, Fluid, and Vacuum)	Push or Pull	222.6 N (50 lbf), limit	Any direction
Cabinets and any normally exposed equipment	Concentrated load applied by flat round surface with an area of (0.093 m ²) (1 ft ²)	556.4 N (125 lbf), limit	Any direction
Legend: ft = feet, m = meter, N = Newton, lbf = pounds force			

3.3.9.1.2 Safety Critical Structures Requirements

The VOILA EUE shall be designed in accordance with the requirements specified in SSP 52005. (LS-71000, Section 6.3.1.1)

3.3.9.2 Electrical Power Consuming Equipment Design

3.3.9.2.1 Batteries

All battery systems shall meet the requirements of NSTS 1700.7, ISS addendum, Section 213.2. (Derived from LS-71000, Section 6.3.2.10, NSTS 1700.7, ISS Addendum, Section 213.2)

4.0

VERIFICATION PROVISIONS

This section contains the minimum/mandatory requirements for qualification and acceptance test requirements and establishes guidelines for additional testing associated with hazard and reliability screening of non-critical HRF EUE. The methodology associated with qualification and acceptance testing will be consistent with paragraph 4.1 of this document

- A. Qualification and Acceptance Test requirements are based on Section 5.4.1 of LS-71000.
- B. Integration testing and checkout can 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.
- C. Formal verification of performance characteristics occurs for the full range of performance requirements during qualification and for nominal operational and critical physical requirements during acceptance. The determination of whether or not qualification testing is required for a particular hardware item must be coordinated with JSC/NT3 and HRF SE&I. Factors such as the availability of hardware and the severity of the operational environment must be considered and a Combined Acceptance Plan (CAP) generated.

4.1

GENERAL

Equipment verification methods are defined as follows:

- A. 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.
- B. Analysis is a process used in lieu of, or in addition to, other methods to ensure compliance to specification requirements. The selected techniques may include, but not be limited to, engineering analysis, statistics and qualitative analysis, computer and hardware simulations, and analog modeling. Analysis may also include assessing the results of lower level qualification activity. Analysis may be used when it can be determined that (1) rigorous and accurate analysis is possible, (2) test is not cost effective, and (3) verification by inspection is not adequate.

Verification by similarity is the process of analyzing the specification criteria for 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 previously 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.

- C. 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 procedure.
- D. 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 operation, 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.

4.1.1 Responsibility for Verifications

The responsibility for the performance of all verification activities is as specified in Appendix B. Except as otherwise specified in the contract, the provider may use their own or any other facility suitable for the performance of the verification requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the verifications set forth in this specification.

The Verification Compliance Matrix in Appendix B will be completed in coordination with HRF SE&I.

4.2 ACCEPTANCE AND QUALIFICATION TEST REQUIREMENTS

Sections 4.2 through 4.3 shall be used for the acceptance and qualification testing of VOILA. These sections are based on the Criticality III qualification and acceptance testing requirements in LS-71000.

TABLE 4.2-1. NON-CRITICAL HARDWARE QUALIFICATION TEST REQUIREMENTS

Component Type Test	Electronic or Electrical Equipment (ALL)								
Functional (1)	X								
Thermal Cycling 7.5 Cycles (4)	X								
Depress/ Repress	X								
Random Vibration (6)	X								
Acoustic Vibration									
Shock	X								
EMC	R(2) X X								
LEGEND: R=Required; H= Hazard Screen; G= Reliability Screening									
<p>Note: Tests listed as Reliability Screening Guidelines (G) do not alleviate the responsibility to verify that the criticality 3 equipment will meet the requirements for its intended use on the ISS.</p> <p>(1) Functional tests shall be conducted prior to and following each environmental test.</p> <p>(2) Emissions only.</p> <p>(3) Conducted and Radiated Susceptibility only.</p> <p>(4) Minimum 110 degrees F sweep required.</p> <p>(5) For sealed or pressurized equipment.</p> <p>(6) Vibration testing shall be in accordance with Section 4.2.1.2 of this document.</p>									

TABLE 4.2-2. NON-CRITICAL HARDWARE ACCEPTANCE TEST REQUIREMENTS

Component Type Test	Electronic or Electrical Equipment (ALL)								
Functional (1)	X								
Thermal Cycling 1_ Cycles (3)	X								
Random Vibration (4)	X								
Acoustic Vibration									
Burn-in	X								
Integrated Functional	X								
LEGEND: R= Required; H= Hazard Screen; G= Reliability Screening									
<p>Note: Tests listed as Reliability Screening Guidelines (G) do not alleviate the responsibility to verify that the criticality 3 equipment will meet the requirements for its intended use on the ISS.</p> <p>(1.) Functional tests shall be conducted prior to and following each environmental test.</p> <p>(2.) 72 and Accelerated 96 hour burn in shall be performed as per Section 3.3.1.2.1 of this document.</p> <p>(3.) Minimum 100 degrees F sweep required.</p> <p>(4.) Vibration testing shall be in accordance with Section 4.2.1.2 of this document.</p> <p>(5.) For sealed or pressurized equipment.</p> <p>(6.) Performed for integrated experiment system.</p>									

4.2.1 Description of Tests

4.2.1.1 Thermal Cycle Tests

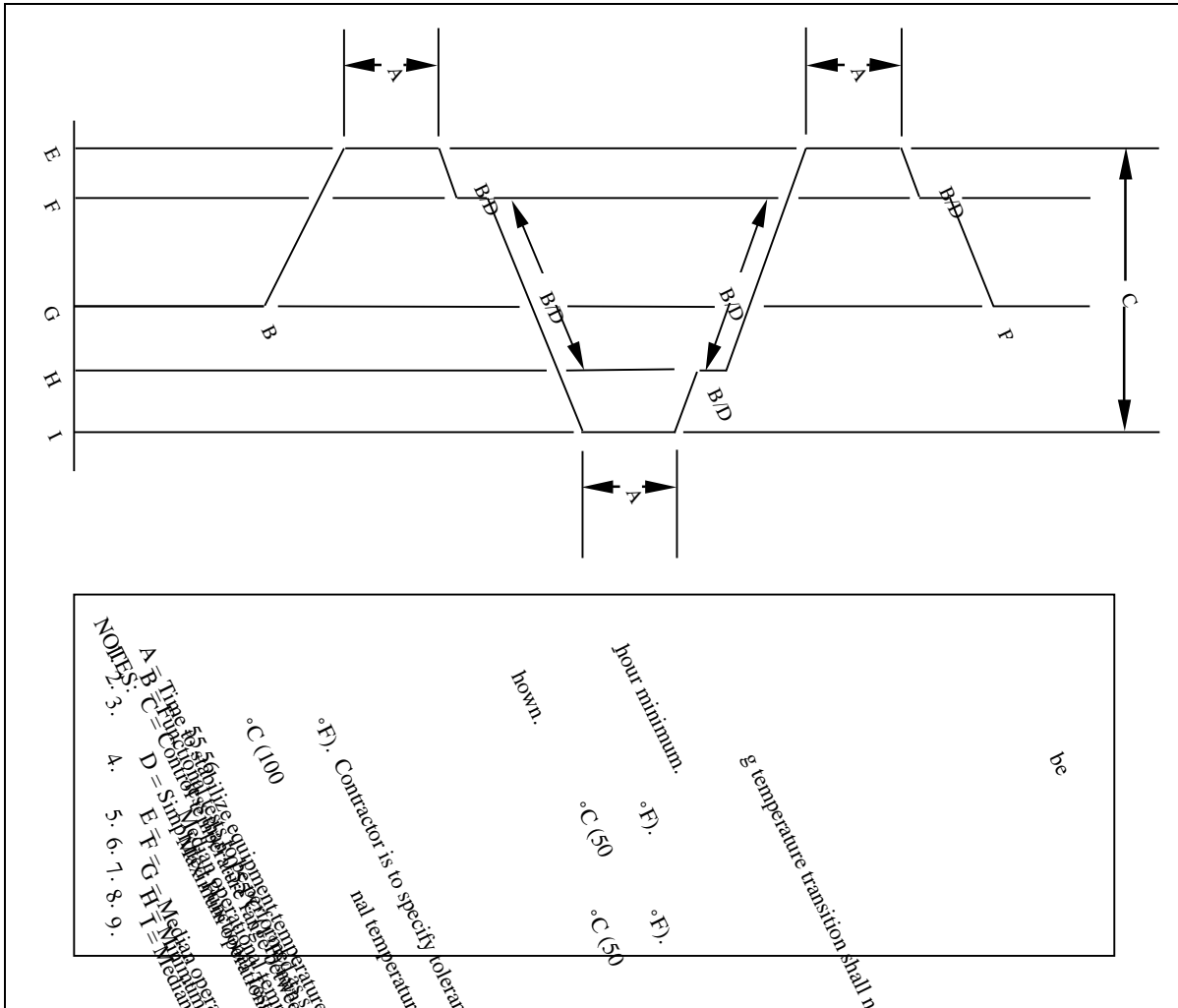
HRF payloads undergoing thermal cycle testing shall be functionally tested at each stable temperature and during transitions. The pass-fail criteria for the functional test and the definition of the functional test will be equipment unique and shall be defined in the test plan and test procedure. Functional tests shall be conducted on end items prior to, during, and after environmental exposure. (LS-71000, Section 5.4.1.1.6)

4.2.1.1.1 Qualification Thermal Cycling

The Qualification Thermal Cycle Test shall be over a range of 110°F (61.1°C) centered about the normal operating temperature as defined in the individual test

plans. The Qualification thermal test shall consist of 7_ cycles. One cycle is defined as starting from normal operating temperature, increasing to the maximum high temperature, decreasing to the minimum low temperature and then returning to the normal operating temperature as depicted in Figure 4.2.1.1.1-1. The complete test is seven and one-half (7_) cycles with one-hour soaks at each extreme. The hardware will be functionally tested during transitions and at the highest and lowest temperature extremes, consistent with the defined operating temperature range. The hardware shall not be functionally tested at temperatures in excess of the defined operating temperature range. (Hardware shall be unpowered when outside the manufacturer's operating limits.) The specific profile shall be defined in the individual test plans. (LS-71000, Section 5.4.1.1.6.1)

the hardware shall dwell at the temperature extremes for a minimum of 1 hour.
(LS-71000, Section 5.4.1.1.6.2)



4.2.1.1.2 Acceptance Thermal Cycling

4.2.1.2 Vibration Test

Qualification for Acceptance Random Vibration Test levels are as described in Section 4.2.1.2.1. Acceptance Random Vibration Test levels are as described in Section 4.2.1.2.2

4.2.1.2.1 Qualification for Acceptance Random Vibration Test

Qualification for Acceptance Vibration Testing (QAVT) determines the number of Acceptance Vibration Tests that may be run on flight units. QAVT shall be run on dedicated qualification test hardware only. The QAVT for HRF equipment shall be performed at a 7.93 g rms composite level over the frequency range and

spectral density defined in Table 4.2.1.2.1-1. QAVT shall be conducted at 1.69 times the Acceptance Random Vibration Test levels. QAVT duration shall be the Acceptance Vibration Testing (AVT) duration multiplied by the number of AVTs for which the hardware is to be qualified. (LS-71000, Section 5.4.1.1.3.2)

TABLE 4.2.1.2.1-1. QUALIFICATION ACCEPTANCE RANDOM VIBRATION TEST LEVELS

Frequency Range (Hz)	Minimum Power Spectral Density (g ² /Hz)
20	0.017
20 - 80	3 dB/Octave Slope
80 - 350	0.067
350 - 2000	-3 dB/Octave Slope
2000	0.0118
Composite	7.93 g rms

4.2.1.2.2 Acceptance Random Vibration Test

AVT is used to screen defects in workmanship that cannot be detected by inspection. AVT for VOILA EUE shall be performed at a 6.1 g rms composite level over the frequency range and minimum AVT levels defined in Table 4.2.1.2.2-1. Vibration duration shall be a minimum of 60 seconds in each of three axes. Functional/continuity tests shall be conducted on components before, during, and after the AVT. LS-71000 Section 5.4.1.1.3.3)

**TABLE 4.2.1.2.2-1. ACCEPTANCE RANDOM VIBRATION
WORKMANSHIP TEST LEVELS**

Frequency Range (Hz)	Minimum Power Spectral Density (g²/Hz)
20	0.01
20 - 80	+3 dB/Octave - Slope
80 - 350	0.04
350 - 2000	-3 dB/Octave - Slope
2000	0.007
Composite	6.1 g rms

4.2.1.3 Electromagnetic Compatibility Testing

One flight assembly shall undergo radiated emission testing and conducted emissions testing. The need to perform susceptibility tests is determined upon initiation of the VOILA EUE project. If susceptibility tests are performed, the levels specified in Section 3.2.7.2.1.2 shall be used. Acceptance criteria are specified in Section 3.2.7.2.1. (LS-71000, Section 5.4.1.2.1)

4.2.1.4 Functional Testing

Abbreviated and full functional test procedures shall be as specified in a TPS or a released procedure.

Functional tests are performed to validate the operation of the VOILA EUE flight hardware. Functionals make up the core of certain tests and can be performed before and after environmental testing. The functional test done prior to testing establishes the functional state (or baseline) of the hardware while the functional done after testing evaluates its ability to withstand the test levels.

An abbreviated functional will be used to test the functional state of the hardware during some environmental testing (i.e., thermal, vibration, bench handling, etc.). The intended use of an abbreviated functional is to verify nominal hardware function between test stages.

4.2.1.5 Burn-In

To the extent practical, COTS and modified COTS must meet the EEE requirements to assure the hardware/design compliance to the EEE part selection criteria for the proposed application and corresponding criticality. This includes a risk assessment, electrical stress analysis, and data delivery on information such as designed/as-built EEE parts, list, construction history, Government and Industry Data Exchange Program (GIDEP) Alerts, part obsolescence, radiation susceptibility, and/or prior history.

All flight assemblies utilizing non-military parts (as specified in Section 3.3.1.2) shall undergo burn-in testing. The test description can be found in Section 3.3.1.2.1. (LS-71000, Section 5.4.1.1.10)

4.2.1.6 Flammability

Payload materials shall be non-flammable or self-extinguishing per the test criteria of NASA-STD-6001, Test 1, Flammability, Odor, offgassing, and compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion. The material shall be evaluated in the worst-case use environment at the worst-case use configuration. When the use of a nonflammable material is not possible, a Material Usage Agreement (MUA) or equivalent shall be submitted to the cognizant NASA center for disposition. If test data does not exist for a material, the experimenter may be asked to provide samples (see NASA-STD-6001, Chapter 4) to a NASA certified test facility Marshall Space Flight Center (MSFC) or White Sands Test Facility (WSTF) for flammability testing).

Materials transported or operated in the orbiter cabin, or operated in the ISS air lock during Extravehicular Activity (EVA) preparations, shall be tested and evaluated for flammability in the worst-case use environment of 30% oxygen and 10.2 psia. Materials used in all other habitable areas shall be tested and evaluated in the worst-case use environment of 24.1% oxygen and 15.2 psia. (LS-71000, Section 5.4.1.1.8)

4.2.1.7 Offgassing (Toxicity)

All flight hardware located in habitable areas shall be subjected to test and meet the toxicity offgassing acceptance requirements of NASA-STD-6001, Test 7. (LS-71000, Section 5.4.1.1.9)

4.2.1.8 Bench Handling Test

A bench handling test shall be performed on the qualification unit for all stowed hardware. The bench handling test shall be conducted in accordance with MIL-STD-810, Section 516.4, I3.6, Procedure 4 or 6 with the following modifications: Test conditions of 26 drops altered to two (2) drops. Surfaces, corners, edges shall be identified in the test procedure. (LS-71000, Section 5.4.1.1.5)

4.2.1.9 Other Tests

Depending upon the payload characteristics and how it is mounted, additional testing may be required. As an example, this additional testing may include Acoustic Noise Surveys and Tests, Pressure Tests, Shock Tests, and/or Sinusoidal Resonance Tests as described in Section 5 of LS-71000. These tests will be coordinated with JSC/NT3 and HRF SE&I.

4.2.1.10 Pre-Delivery Acceptance Test

The responsible manufacturing parties shall perform a Pre-Delivery Acceptance (PDA) after the complete fabrication and assembly has been conducted for all Class I deliverable assemblies. This test shall include verification of software interface and operation. The PDA must be completed before hardware certification testing begins. It is a full functional test and inspection that validates that the hardware operates per the design requirements and that it is constructed per released engineering drawings. All PDA tests shall be approved by the hardware's JSC technical monitor and JSC/NT3, as well as the contractor quality engineering (if applicable). The following are standard steps that each PDA test shall contain:

1. Conformance to Drawing. Verify that the hardware conforms to released engineering drawings.
2. No Sharp Edges. Inspect the hardware to verify that there are no sharp edges or corners present.
3. Proper Identifying Markings. Verify that the hardware has the proper part number and serial number (if applicable) on it.
4. Cleanliness. All PDA tests shall include verification that all surfaces (external, internal, etc.) are to the cleanliness level of Section 3.3.1.1C of this document.

4.2.1.11 Science Verification Testing

A Science Verification Testing (SVT) shall be required of the VOILA flight hardware. This is a full end-to-end functional test of the experiment system that is conducted after environmental testing has been completed. The Principal Investigator (PI) will evaluate the data resulting from the SVT for confirmation of proper function.

4.3 DOCUMENTATION OF VERIFICATION AND CERTIFICATION TESTING

The Verification Matrix (Appendix B) indicates the acceptance/qualification compliance plan for each applicable requirement. Once all procedures (inspection, test, analysis, or demonstration) have been completed, Appendix B will be filled out with the appropriate document references (e.g., TPS, waivers, reports, analysis) and used as a certification compliance matrix.

5.0 PREPARATION FOR SHIPMENT

{HRF ORUs will be launched and returned in a pressurized carrier such as the MPLM, the orbiter middeck or any international transfer vehicle such as the Progress, Automated Transfer Vehicle (ATV), or other transfer vehicles. They will be integrated into SIR drawers, middeck/EXPRESS lockers, or Resupply Stowage Rack (RSR) trays. Large items may require soft stowage accommodations such as the Resupply Stowage Platform (RSP) or the Aisle Stowage Container (ASC). Biological samples will require cold stowage in a freezer.

Analytical and physical integration of HRF ORUs will be performed by the ISS Cargo Integration (CI) organization. CI has the tools and expertise necessary to perform drawer/tray/rack layout, etc. CI will also perform the actual physical integration of HRF stowage items in preparation for launch. Science samples that require late stowage may be integrated by the Utilization organization at Kennedy Space Center (KSC). HRF will provide to CI all necessary data to perform these tasks such as engineering drawings of individual stowage items, weight, dimensions, hardware configuration, etc. Detailed process description and data requirements will be documented in Station Program Implementation Plan (SPIP) Volumes 3, 4, and the PIA. }

5.1 GENERAL

- A. The methods of preservation, packaging, and packing used for shipment, together with necessary special control during transportation, shall adequately protect the article(s) from damage or degradation in reliability or performance as a result of the natural and induced environments encountered during transportation and subsequent indoor storage. (LS-71000, Section 9.1A)
- B. To reduce program cost, prior to developing a newly designed container, every effort will be made by project participants to use container designs and/or containers available commercially or from Government inventories. If reusable containers are not available, a screening process should be initiated for container availability in the following priority: existing containers, commercial off-the-shelf containers, and modified commercial off-the shelf containers. Shipping containers and protective devices will be designed for effective and economical manufacture, procurement, and transportability. (LS-71000, Section 9.1B)

5.2 PACKING, HANDLING, AND TRANSPORTATION

- A. Packaging, handling, and transportation shall be in accordance with applicable requirements of NHB 6000.1C, and referenced documents therein. (LS-71000, Section 9.2A)

- B. Documented procedures and physical controls shall be established to ensure that the HRF rack and individual items of equipment will not be subjected to temperature, shock, and humidity outside the non-operational limits during shipment. LS-71000, Section 9.2C)
- C. The VOILA EUE shall be cleaned to the “Visibly Clean Level 1 (Sensitive)” as determined in JSC-SN-C-0005, Specification Contamination Control Requirements for the Shuttle Program. LS-71000, Section 9.2D)

5.3 PRESERVATION AND PACKING

Preservation and packing shall be in accordance with approved Packaging, Handling, and Transportation Records (PHTRs). (LS-71000, Section 9.3)

5.4 MARKING FOR SHIPMENT

Interior and exterior containers shall be marked and labeled in accordance with NHB 6000.1C including precautionary markings necessary to ensure safety of personnel and facilities, and to ensure safe handling, transport, and storage. Should the individual items of equipment contain any hazardous materials, markings shall also comply with applicable requirements governing packaging and labeling of hazard materials. Packages with reuse capability shall be identified with the words “Reusable Container - Do Not Destroy - Retain for Reuse.” NASA Critical Item Labels (Form 1368 series) shall be applied in accordance with NHB 6000.1C. (LS-71000, Section 9.4)

5.5 NASA CRITICAL SPACE ITEM LABEL

The NASA Critical Space Item Labels Form 1368 shall be affixed to exterior and interior shipping containers in accordance with NHB 6000.1C. (LS-71000, Section 9.5A)

6.0 NOTES

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

6.1 DEFINITIONS

Qualification Test Test conducted as part of the verification program to demonstrate that the design and performance requirements can be realized under specified conditions.

Acceptance Test Formal tests conducted to assure that the end item meets specified requirements. Acceptance tests include performance demonstrations and environmental exposures to screen out manufacturing defects, workmanship errors, incipient failures, and other performance anomalies not readily detectable by normal inspection techniques or through ambient functional tests.

Active Air Exchange Forced convection between two volumes. For example, forced convection between a subrack payload and the internal volume of an integrated rack, or forced convection between a subrack payload and cabin air.

Continuous Noise Source A significant noise source which exists for a cumulative total of eight hours or more in any 24-hour period is considered to be a continuous noise source.

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

APPENDIX A
CRITICALITY 3 EQUIPMENT PROGRAM REQUIREMENTS

CRITICALITY 3 EQUIPMENT PROGRAM REQUIREMENTS

A1.0 HRF PROGRAM REQUIREMENTS

The following sections detail Criticality 3 HRF program requirements that are applicable to all HRF Criticality 3 Projects.

A1.1 EXPERIMENT DOCUMENT

Reference: LS-20427

All EUE projects will have an Experiment Document (ED). The ED should briefly explain the technical need for the project and summarize how the project will meet that need. The overall project objective and justification should be provided. The ED will also document agreements between the HRF Program and the EUE provider.

A1.2 DOCUMENTATION REQUIREMENTS

Documentation requirements for VOILA EUE shall be as specified in Appendix A of the PRD for HRF, LS-71000. Required items for submittal to NASA are summarized below for convenience.

A1.2.1 Acceptance Data Package Requirements List

All flight hardware being provided under contract to NASA shall have an Acceptance Data Package (ADP) upon final delivery. The ADP will be reviewed by NASA and discussed at the pre-delivery acceptance review. The acceptance of any equipment item will be contingent upon NASA's approval of the ADP for that item. *{The table below provides a typical listing of required documentation that must be included in the ADP; not all of these requirements will be applicable for a given piece of equipment. Actual ADP content will be as agreed upon between the HRF project and the EUE developer. The table should be filled out to indicate which items are applicable with any appropriate clarifying words noted in the comments column. A description of each product is provided after the table.}*

#	Document	Required for Project		Comments
		Yes	No	
1	Shipping Documentation (DD250/1149)			
2	Quality Log			
3	Index or Table of Contents			
4	Engineering Drawings			

#	Document	Required for Project		Comments
		Yes	No	
5	Inventory of Serialized Components			
6	Operating, Maintenance, and Handling Procedures			
7	Limited Life/Time and Cycle Requirements			
8	“As run” Test Procedures, Data, and Reports			
9	Waiver requests			Waiver requests are coordinated through HRF SE&I
10	Safety Data			
11	Structural Analyses			
12	Pressure Vessel Data			
13	Radioactive Material Data			
14	Calibration Data			

- (1) Shipping Documentation: A DD250/1149 (or other Government recognized “shipper” document such as JSC Form 290), with quality control validation, will be required for all shipments. The shipper document will indicate nomenclature, part number, serial number, and quantity of hardware shipped. The ADP shall also be listed as an item on the shipping document. The shipping document shall identify any end item shortages, i.e., all items missing from the shipment that are required to make a complete flight set and which are required by the contract. The shipper shall contain a list of all “open work” on the equipment being shipped, i.e., all work, required by the contract, that must be done before the equipment is ready for flight.
- (2) Quality Log: A chronological log of configuration and quality status of each item of equipment must accompany any shipment of functional hardware. A JSC Form 772, System and Component Historical Records, or equivalent, will be used for this purpose. See the Hardware Development Handbook for more information.
- (3) Index or Table of Contents: An index or inventory of the ADP contents. A negative statement at the beginning of a section is required if no entry is applicable. For example, if one of the data requirements in the table above is agreed to not be required, the section should be so noted.
- (4) Engineering Drawings: As-built engineering drawings shall be provided. The drawings shall include the top assembly drawing for each major component and any other drawings necessary to perform receiving inspection and any test or operation to be performed at the destination.
- (5) Inventory of Serialized Components: A list of “field replaceable” serialized components will be included in the ADP. The list will contain the component

part number, component name, and component serial number.

- (6) Operating, Maintenance, and Handling Procedures: Each delivered functional end item shall have a separate manual covering its maintenance, repair, and operation. The manual shall include, but not be limited to, the following (as applicable):
- a. Operational instructions suitable to support operator training and containing a system description and general instructions for operating the equipment.
 - b. Any special handling, packing, transportation or storage procedures (i.e., must be stored/transported in a specific orientation, specific environmental conditions, etc.)
 - c. A list of special tools, support and facilities equipment, and all other materials necessary to perform maintenance.
 - d. A schedule chart listing the time at which all maintenance is to be performed. This shall also include inspection for required repair, maintenance, or replacement of parts.
 - e. Conditions of environment in which maintenance is to be performed.
 - f. Detailed maintenance procedures that describe removal, disassembly, type of maintenance or repair, cleaning, reassemble, and reinstallation of all parts or subassemblies. Also included shall be points of inspection and notes of caution.
 - g. Illustrated part breakdowns showing the details of the part being worked upon.
 - h. Schematic and interconnecting wiring diagrams in sufficient detail to enable troubleshooting to be performed down to the replaceable subassembly or printed circuit board level.
 - i. Fault analysis will be provided to facilitate maintenance. The repair procedures shall be adequate for testing, checkout, disassembly, cleaning, inspection, repair, reassemble, adjustment, calibration, and servicing of the equipment as applicable.
- (7) Limited Life/Time and Cycle Requirements: A Limited Life Items List shall be included which lists all items included in the shipment that have a limited life and what the appropriate expiration date is for each item. In addition, a list of the critical time/cycle items, including the total time or cycles allowed and a record of the time or cycle used. Such time/cycle usages will be recorded on the JSC Form 772, or equivalent.
- (8) "As Run" Test Procedures and Reports: The original "as run" test procedures used for any of the testing required in this HRD, along with any associated data and test reports shall be included in the ADP. These procedures shall include quality buy-off if applicable as documented in the Quality Plan.
- (9) Waiver Requests: Any waiver requested prior to delivery against any of the requirements documented as applicable in this HRD shall be included in the ADP along with any approvals granted. (Waiver requests must be coordinated

through HRF SE&I.)

- (10) Safety Data: Copies of hazard reports and other safety data prepared or collected as a result of ground and/or flight safety requirements.
- (11) Structural Analyses: Copies of any structural analyses performed as specified in this HRD or required in the contract with NASA.
- (12) Pressure Vessel Data: If the hardware contains pressure vessels, this section shall include the appropriate documentation showing the certification, DOT rating and/or any test data.
- (13) Radioactive Material Data: If the shipment contains any radioactive material, this section shall include copies of all required data on radioactive material.
- (14) Calibration Data: This section shall include any calibration or scaling data required to interpret the output signals from or measurements made using the equipment being shipped.

APPENDIX B

VERIFICATION AND CERTIFICATION COMPLIANCE MATRIX

