STR-81
Revision A
May 21, 1999

HUBBLE SPACE TELESCOPE
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HUBBLE SPACE TELESCOPE THIRD SERVICING MISSION LEVEL III FLIGHT SYSTEMS AND SERVICING PROJECT REQUIREMENTS

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ACRONYMS

AC	Alternating Current
ACS	Advanced Camera for Surveys
AFD	Aft Flight Deck
ASCS	Aft Shroud Cooling System
ASIPE	Axial Science Instrument Protective Enclosure
ASLR	Aft Shroud Latch Repair
BAPS	Berthing and Positioning System
CATS	Crew Aids and Tools
CCTV	Closed Circuit Television
C&DH	Command and Data Handling
CEI	Contract End Item
CG	Center of Gravity
CPC	Center for Power and Communications
DBA2	Second Diode Box Assemblies
dc	Direct Current
DIU	Data Interface Unit
DPC	Direct Power Converter
ECU	Electronics Control Unit
EFMDM	Enhanced FMDM
EMC	Electromagnetic Compatibility
EP/TCE	Electrical Power/Thermal Control Electronics
EOL	End of Life
EPDSU	Electrical Power Distribution and Switching Unit

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ESF	Exterior Simulator Facility
ESM	Electronic Support Module
EVA	ExtraVehicular Activity

SCN 002

SCN 002

ACRONYMS (Continued)

FGS	Fine Guidance Sensor
FMA	Fuse Module Assemblies (OTA)
FMDM	Flexible Multiplexer/Demultiplexer
FOC	Faint Object Camera
FOFE	Fiber Optic Flight Experiment
FPA	Fuse Plug Assemblies (SSM)
FPS	Feet Per Second
FSIPE	FGS Science Instrument Protective Enclosure
FSS	Flight Support System
FS&SP	Flight Systems and Servicing Project
G	Gravity
GDRD	Generic Design Requirements Document
GEVS	GSFC Environmental Verification Specification
GFE	Government-Furnished Equipment
GN_2	Gaseous Nitrogen
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HDOS	Hughes Danbury Optical Systems
HFMS	High Fidelity Mechanical Simulator
HOST	Hubble Space Telescope Orbital Systems Test
HST	Hubble Space Telescope
HST486	HST 486 Computer
ICD	Interface Control Document
	Interface Control Drawing
I&T	Integration & Test

ACRONYMS (Continued)

JSC	Johnson Space Center
KHB	KSC Handbook
km	Kilometer
KSC	Kennedy Space Center
KWH	Kilo Watt Hours
lbs	Pounds
LMSC	Lockheed Missiles & Space Company, Inc.
LOPE	Large ORU Protective Enclosure
MLI	Multi-Layer Insulation
MSB	Mechanism Selection Box
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NBL	Neutral Buoyancy Laboratory
NCS	NICMOS Cooling System
NHB	NASA Handbook
NICMOS	Near Infrared Camera and Multi-Oject Spectrometer
nmi	Nautical Mile
NOBL	New Outer Blanket Layer
NSTS	National Space Transportation System
OCE	Optical Control Electronics
OCE-EK	OCE Enhancement Kit
OPE	ORU Protective Enclosure

ACRONYMS (Continued)

OPF	Orbiter Processing Facility at KSC
ORI	Orbital Replacement Instrument
ORU	Orbital Replacement Unit
ORUC	Orbital Replacement Unit Carrier
OTA	Optical Telescope Assembly
O&GS	Operations and Ground System
PCR	Payload Changeout Room
PCS	Pointing Control System
PCU	Power Control Unit
PDSU	Power Distribution and Switching Unit
PDU	Power Distribution Unit
PE	Protective Enclosure
PFR	Portable Foot Restraint
PIP	Payload Integration Plan
PIP	Push In and Pull (as in PIP Pins)
PPCU	Port Power Control Unit
PRJU	Power Regulator Junction Unit
RAC	Rigid Array Carrier
RIU	Remote Interface Unit
RSU	Rate Sensing Unit
RWA	Reaction Wheel Assembly
SA2	Solar Array II
SA3	Solar Array III
SAA	South Atlantic Anomaly
SAC	Second Axial Carrier
SADA	Solar Array Drive Assembly
SADM	Solar Array Drive Mechanism
SDRD	Specific Design Requirements Document
SEUs	Single Event Upsets

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ACRONYMS (Continued)

SI	Scientific Instrument
SIP	Standard Interface Panel
SIPE	Scientific Instrument Protective Enclosure
SM	Servicing Mission
SMGT	SM Ground Test
SMOV	Servicing Mission Observatory Verification
SM2	Second Servicing Mission
SM3	Third Servicing Mission
SM3A	Servicing Mission 3 Part A
SM3B	Servicing Mission 3 Part B
SM4	Fourth Servicing Mission SCN 002
SPCU	Starboard Power Control Unit SCN 003
SSAT	S-Band Single Access Transmitter
SSE	Space Support Equipment
SSM	Support Systems Module
SSR	Solid State Recorder
SSRF	Shield/Shell Replacement Fabric
ST	Space Telescope
STIS	Space Telescope Imaging Spectrograph
STS	Space Transportation System
TBD	To Be Determined
TBR	To Be Resolved
TBS	To Be Supplied
UARS	Upper Atmosphere Research Satellite
UASE	UARS Airborne Support Equipment
VEST	Vehicle Electrical System Test
VIK	Voltage/Temperature Improvement Kit
VPF	Vertical Processing Facility at KSC
VRCS	Vernier Reaction Control System

TBD/TBR/TBS List

Item No.	Section	Description	Resp. Party	Date

SCN 002

1. SCOPE

This document establishes the Flight Systems and Servicing Project (FS&SP) Level III requirements for the Hubble Space Telescope (HST) Third Servicing Mission (SM3) as allocated by STR-80, HST SM3 Level II Requirements. The SM3 mission consists of two parts designated as SM3A and SM3B involving two STS launches and two separate rendezvous with HST. This core segment of STR-81 specifies the combined overall objectives and requirements for the SM3 mission. Mission specific objectives and requirements for SM3A and SM3B are detailed in Appendices A and B respectively.

This document contains the FS&SP System Level requirements on SM Hardware and servicing needed to successfully service HST. SM Hardware consists of Orbital Replacement Instrument (ORI), Orbital Replacement Units (ORU), and Space Support Equipment (SSE). ORUs and ORIs, henceforth referred to as ORUs, include all hardware taken to orbit and all replaceable hardware, currently installed on the HST, which will be returned to Earth. SSE includes all remaining hardware required to meet SM objectives, including Carrier Systems and Crew Aids and Tools (CATs). SM hardware shall refer to SSE and ORUs.

In addition, this document contains the FS&SP system Level III requirements on SM Support and Verification.

Figure 1-1 describes the SM3 Requirements Documentation Flowdown and is provided for information only.

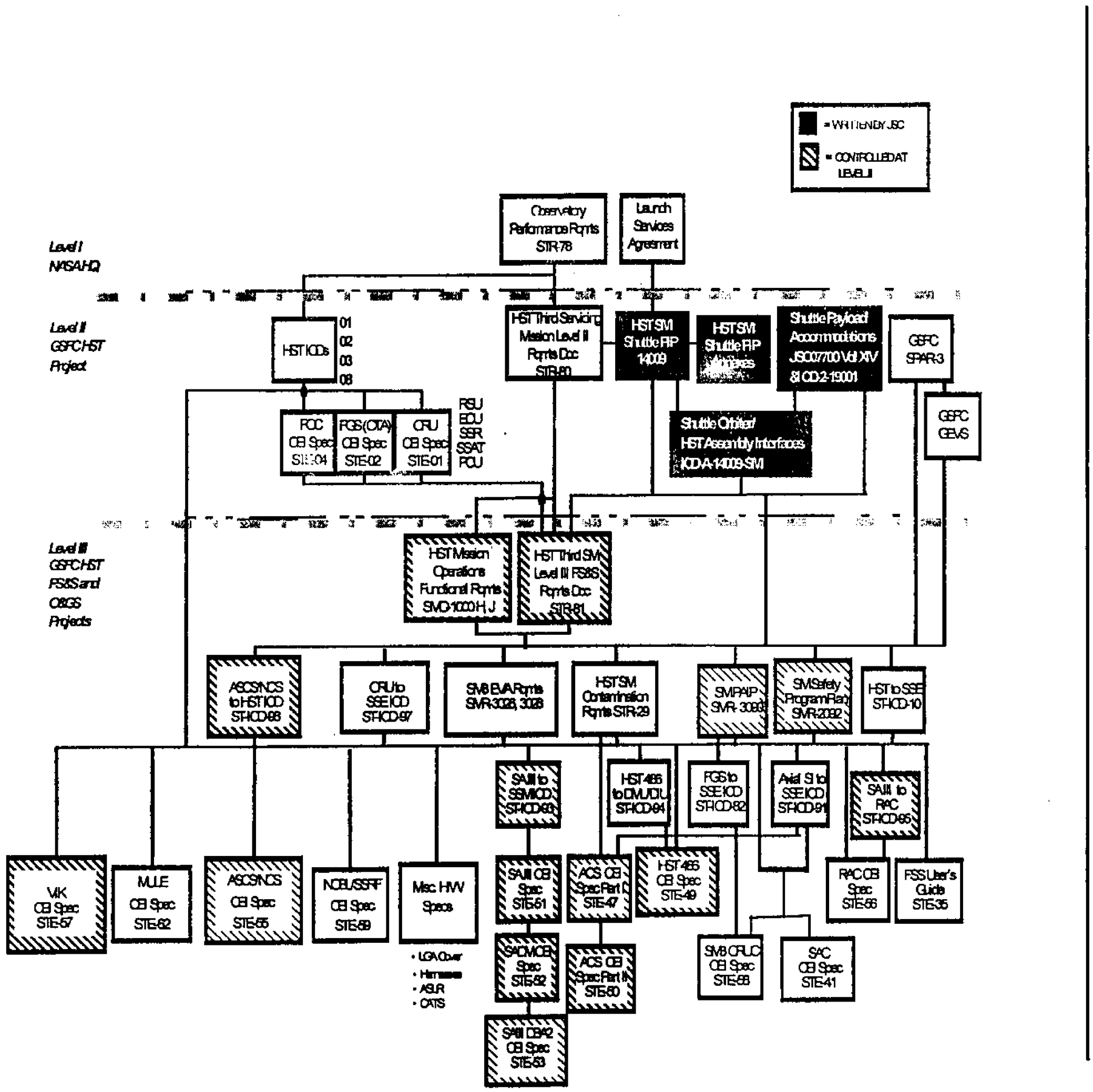

Figure 1-1 HST Third Servicing Mission Requirements Flowdown

1.1 CONTENT STATUS

The requirements specified in this document have a status in one of the following categories (reference TBD/TBR/TBS list).

a. Requirements which are established: these requirements have no special notation.

b. Requirements which are unknown or not agreed upon: these requirements are noted as TBD (to be determined).

c. Requirements which are subject to change but are the most current known at the time of document release: these requirements are noted as TBR (to be resolved).

d. Requirements which are passed down from Level II: these requirements are noted as TBS (to be supplied).

2. APPLICABLE DOCUMENTS

The following documents form a part of this specification as related to design characteristics, performance characteristics, and/or verification. Within the text of this document, the applicable documents are referenced by basic number only. In the event of conflict between the following referenced documents and this Requirement Document, STR-81, the following precedence is followed:

1. Hubble Space Telescope Level 1 Requirements for the Operational Phase of the Hubble Space Telescope Program; Office of Space Science, Astrophysics Division, NASA Headquarters, February 29, 1996.

2. STR-80, Hubble Space Telescope Third Servicing Mission, Level II Requirements.

3. NSTS 14009, SM3 Payload Integration Plan (PIP), Space Transportation System and Space Telescope.

4. ICD 2-19001, Shuttle Standard Interfaces, Revision K (NSTS 07700, Vol. XIV, Attachment 1).

5. STR-81, Hubble Space Telescope Third Servicing Mission (SM3) Flight Systems and Servicing Project (FS&SP) Level III Requirements (this document).

6. STE-01, Support Systems Module Prime Equipment Contract End Item Detail Specification, Part 1.

7. STR-76, Hubble Space Telescope Solid State Recorder Requirements Document.

8. STE-48, Hubble Space Telescope Solid State Recorder CEI Specification.

9. LMSC 4171761, Rate Gyro Assembly Specification.

10. All other referenced documents.

The documents referenced herein are listed according to source:

DOD/NASA/Other	Document Title
Annex 1	Payload Data Package Annex, Hubble Space Telescope Servicing Mission, NSTS 14009, Volume B, Revision D
Interface Control Annex	Interface Control Annex, Hubble Space Telescope Third Servicing Mission, NSTS 14009, Volume B, Revision C
Annex 11	Extravehicular Activity Annex, Hubble Space Telescope Third Servicing Mission, NSTS 14009, Volume B, Revision E
GSFC-GEVS-SE Rev A	General Environmental Verification Specification for STS and ELV Payloads, Subsystems, and Components
HDOS ST-SE-5375	ORU Fuse Module Assembly Tether Loop
ICD-A-14009-SM	Shuttle Orbiter/HST Servicing Mission-(HST-SM) Assembly Interfaces

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NASA GDRD JSC-26626A	EVA Hardware Generic Design Requirement Document (GDRD)
KHB 1700.7, Rev B	Space Shuttle Payload Ground Safety Handbook
LMMS/P505023	Requirements Specification for HST Aft Shroud Latch Repair (ASLR) Mechanism
LMSC 4171463, Rev F	Reaction Wheel Assembly Specification
LMSC 4171761, Rev C	Rate Gyro Assembly Specification
LMSC 4171868, Rev B	Specification Command/Control Computer Assembly (DF-224)
LMSC 4171870,	Space Telescope S-Band Single Access Transmitter Specification
LMSC 4171871, Rev A	Hardware Interface Document
LMSC 4172016	Engineering Critical Component Specification Power Control Unit SCN 002
LMSC 4174331	Fuse Plug Assembly Drawing
LMSC P422948	ORU Harness Extension Requirements
MIL-HDBK-5G	Metallic Materials and Elements for Flight Vehicle Structures
MIL-STD-461, Rev. C	Electromagnetic Emission and Susceptibility Requirements for Control of Electromagnetic Interference
MIL-STD-462, Notice 6	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-1246B	Military Standard Product Cleanliness Levels and Contamination Control Plan
NASA Form 1426	Form from NHB 6000.1
NASA-STD-3000	Man-Systems Integration Standards

NASA TM 78119

Space and Planetary Environment Criteria Guidelines for use in Space Vehicle Development

NHB 6000.1C	Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems Equipment and Associated Components
NHB 8071.1	Fracture Control Requirements for Payloads Using the National Space Transportation System (NSTS)
NSTS 07700, Vol XIV APP 7	System Description and Design Data - Extravehicular Activity
NSTS 14046	Payload Interface Verification Requirements
NSTS 1700.7B	Safety Policy and Requirements for Payloads Using the Space Transportation System
NSTS 37330	Space Shuttle Bonding, Electrical,and Lighting Specifications SCN 002
NSTS/ISS 18798B	Interpretations of NSTS/ISS Payload Safety Requirements
MA2-97-093	Crew Mating/Demating of Powered Connectors, second letter to NSTS/ISS 18798B
P-442-0173	HST Ground Operations Safety Plan for GSFC
P-442-1285	HST Second Servicing Mission Contamination Monitor End Item Specification
RS-SA-B019, Rev B	Requirement Specification for the Diode Box Assembly

RS-SA-B203

Requirement Specification for the SA2 Primary Deployment Mechanism and the Solar Array Drive Adapter

SDM-1030	Hubble Space Telescope HST486 Computer Functional Interface Document
SMO-1020 Rev. J	HST Constraints and Restrictions Document
SMR-1035 Baseline Issue	Hubble Space Telescope First Servicing Mission Fuse Plug Assembly Integration and Test Plan
SMR-3091	HST Third Servicing Mission Weight Control Plan
SMR-3022	HST Third Servicing Mission EVA Verification Plan
SMR-3026	HST SM3A EVA Requirements
SMR-3028	HST SM3B EVA Requirements
SMR-3040 (Baseline Issue)	HST Third Servicing Mission Integration and Test (I&T) Plan
ST-ICD-01, Rev. F	Support Systems Module (SSM) to Optical Telescope Assembly (OTA) Interface Control Document (ICD)
ST-ICD-02, Rev. E	Axial Scientific Instrument (SI) to OTA and SSM ICD
ST-ICD-03, Rev. F	Radial Scientific Instrument (SI) to OTA and SSM ICD
ST-ICD-08, Rev. D	SI to SI Control and Data Handling (SI C&DH) ICD
ST-ICD-10 Rev. G	Hubble Space Telescope Level II Interface Control Document Space Telescope to Space Support Equipment (ST to SSE)

SCN 004

ST-ICD-82

Fine Guidance Sensor to Space Support Equipment Interface Control Document (FGS to SSE ICD)

ST-ICD-91	Axial Scientific Instrument to Space Support Equipment (SSE) Interface Control Document
ST-ICD-93	Level II Interface Control Document Third Solar Array to Support Systems Module
ST-ICD-94	Hubble Space Telescope HST486 Computer to Data Management Unit and Data Interface Units Interface Control Document
ST-ICD-95	Third Solar Array to Space Support Equipment (SSE) Interface Control Document
ST-ICD-97	Orbital Replacement Units to Space Support Equipment (SSE) Interface Control Document
ST-ICD-98	Aft Shroud Cooling System to Axial Scientific Instrument and Support Systems Module (SSM) Interface Control Document
STE-02, Rev. D	Optical Telescope Assembly (OTA) Prime Equipment Contract End Item Detail Specification, Part 1
STE-04, Rev A	Prime Equipment Contract End Item Detail Specification Performance, Design, and Verification Requirements Part I for the Faint Object Camera for Space Telescope
STE-41	HST Second Axial Carrier (SAC) Contract End Item Specification SCN 002
STE-47	Hubble Space Telescope Advanced Camera Contract End Item (Part I).
STE-48	Solid State Recorder Contract End Item.

STE-49	Hubble Space Telescope HST486 Contract End Item (CEI) Specification.
STE-51	HST Third Solar Array Contract End Item Specification Part I
STE-52	Third Solar Array Drive Mechanism (SADM) Contract End Item Specification
STE-53	Solar Array 3 Diode Box Assembly Contract End Item (CEI) Specification
STE-55	Hubble Space Telescope Aft Shroud Cooling System Contract End Item Specification
STE-56	Rigid Array Carrier Contract End Item Specification
STE-57	Voltage/Temperature Improvement Kit CEI Specification
STE-58	SM3 ORU Carrier CEI Specification
STE-59	HST New Outer Blanket Layer (NOBL) Shield/Shell Replacement Fabric (SSRF) Contract End Item Specification
STE-62	MULE Contract End Item Specification
STE-65	HST SM Harness Extension Assemblies Requirements Specification
STE-68	HST Flight Support System CEI Specification SCN 004
STR-01	Support Systems Module (SSM) to Optical Telescope Assembly (OTA) Interface Requirements Document
STR-29, Rev A	HST SM Contamination Control Requirements
STR-76	Solid State Recorder Requirements Document,

STR-82	SM3 CATS Specific Design Requirements Document
ST/SE-04	Space Telescope Mass Properties Report

DRAWINGS

GSFC GE-1497033	ASCS/NCS External Envelope Drawing
GSFC GE-1497034	ASCS/NCS Internal Envelope Drawing
GSFC GE-1525372	ASCS/NCS Mechanical Interface Control Drawing - Axial SIs
GSFC GE-1525373	ASCS/NCS Mechanical Interface Control Drawing - SSM
CAN 610	SADA General Arrangement
CPL 040	SADA Interface Diagram

3. REQUIREMENTS

3.1 SERVICING MISSION REQUIREMENTS

The planning and operation of the mission, as specified herein, shall ensure to the maximum possible extent that no degradation to flight hardware occurs, including cases with HST appendages deployed.

3.1.1 Mission Description

The SM Hardware shall support the HST SM3A and SM3B parts of the mission at the maximum retrieval orbital altitudes specified in Appendices A and B respectively with a 28.5 degree inclination. Reboost to a higher orbit is not required during SM3A or SM3B, but is desired during SM3B. There is no requirement for re-rendezvous after deployment. There is no requirement to return the HST to the ground during SM3. The objectives of the SM3 are stated in Paragraph 1.2 of the Hubble Space Telescope Third Servicing Mission Level II Requirements, STR-80. The SM3 Carriers, Flight Support System (FSS), Orbital Replacement Unit Carrier (ORUC), Rigid Array Carrier (RAC), Second Axial Carrier (SAC), and Multi-Use Light-weight Equipment (MULE) Carrier, composed of a Upper Atmosphere Research Satellite (UARS) Avionics and Support Electronics (UASE) cradle, shall carry a complement of ORUs and other designated HST equipment to the HST for on-orbit servicing. During ExtraVehicular Activity (EVA), new ORUs will be installed into HST and the change-out ORUs will be re-moved from the HST and stowed for Earth return by EVA crew members. EVA activities will also include installation of the NICMOS Cooling System (NCS) including the Electronic Support Module (ESM), and the New Outer Blanket Layer (NOBL). SCN 002 SCN 002

3.1.2 SM Objectives

SM3 has four Level II objectives which must be satisfied. The first objective is to provide an enhanced Orbital Replacement Instrument (ORI) that will satisfy the HST Level I Requirements. The servicing element which satisfies this objective is the Advanced Camera for Surveys (ACS).

ACS shall replace the Faint Object Camera (FOC) in the (-V2, -V3) axial bay of the HST aft shroud.

The second objective is to replace certain failed or malfunctioning ORUs and upgrade other ORUs with new technology units to enhance the reliability and ensure the long term scientific productivity of the HST. These replacement units shall maintain the operational capability and redundancy required by Level I. For ORUs where parts are no longer available or if the state of the art technologies make improvements cost effective and technically feasible, those enhancements may be made. The spacecraft elements which satisfy this objective are Fine Guidance Sensor-2 replacement (FGS-2R), Advanced Computer (HST486) and Y harness, Third Solar Array (SA3) including the SA3 Diode Boxes (DBA2), Rate Sensor Units (RSU-1R), (RSU-2R) and (RSU-3R), Solid State Recorder (SSR-3), Voltage/Temperature Improvement Kit (VIK), the Power Control Unit (PCU), the New Outer Blanket Layer and Shield/Shell Replacement Fabric (NOBL/SSRF), the S-Band Single Access Transmitter (SSAT), the Reaction Wheel Assembly-1 (RWA-1R), the PDU-2 P16R Fuse Plug Assembly (FPA), which will replace the existing FPA as part of the PCU change-out, and nominally 6 handrail contamination covers and three door knob contamination covers. SCN 002, 004

The third objective of SM3 is to restore the scientific capability of the HST at near-infrared wavelengths. The servicing

element which satisfies this objective is the Near Infrared Camera and Multi-Object Spectrometer (NICMOS) Cooling System (NCS) which will be installed during SM3B. The ESM which houses the electronics for the NCS (and the Aft Shroud Cooling System intended for SM4) and a sensor to monitor and trend the aft shroud pressure environment will also be installed during SM3B. In preparation for NCS installation, the NICMOS cooling line valves will be opened during SM3A. SCN 002

The fourth objective of SM3 is to increase the orbit altitude of HST as much as Space Transportation System (STS) propellant reserves permit, so that orbit decay will not constrain science operations or shorten mission life below Level I requirements. The goal (to be achieved during SM3B) is a post-deployment HST orbit that is energy equivalent to a circular orbit with a mean altitude as specified in Appendix B.

A subset of the following elements as specified in Appendices A and B respectively for SM3A and SM3B shall be carried to support unplanned activities during each mission: two each of contingency Power Distribution Unit (PDU) P15, P16, and P17 Fuse Plug Assemblies (FPAs); contingency P25, P26, P27A and P28A Optical Telescope Assembly (OTA) Fuse Module Assemblies (FMAs); one spare/contingency RSU, one contingency ECU, one spare 486 and Y harness, one spare DBA2, two spare SADA manacle clamps and two spare VIKs. Additionally, contingency hardware and tooling shall be identified and carried to ensure mission success; this shall include eight solar array bistem brace kits and Aft Shroud Latch Repair (ASLR) mechanism assemblies as defined in Appendices A and B. SCN 002

The requirements for the above Spacecraft Hardware are found in Section 3.2. The changeout priority of the hardware is defined in STR-80 (HST SM3 Level II Requirements), Table 1-2 Servicing Mission 3A Priorities and Table 1-3 Servicing Mission 3B Priorities.

The SSE consists of those hardware items that are mounted on, stowed on, and transported by the Orbiter for on-orbit servicing of the HST with ORUs. The SSE will provide environmental protection for ORUs during pre-launch, launch, on-orbit servicing, return, and post-landing. SSE that services HST includes: the Flight Support System (FSS); the Orbital Replacement Unit Carrier (ORUC), which includes two (one radial and one axial) Scientific Instrument Protective Enclosures (SIPEs) and ORU Protective Enclosure(s) (OPEs); the Rigid Array Carrier (RAC); the Second Axial Carrier (SAC) which includes one axial SIPE and OPEs; and the MULE. Crew Aids and Tools will aid the crew in the removal, temporary storage (parking), translation, and installation activities associated with HST servicing. The requirements for the SSE and CATS are found in Section 3.4. SCN 002

Section 3.5 contains design and construction requirements for SM hardware.

3.2 SERVICED SPACECRAFT HARDWARE PERFORMANCE REQUIREMENTS

The performance specifications for the ACS shall be met assuming the following image stability while under Fine Guidance System (FGS) control and guiding in fine lock:

a. Line of sight instrument image motion delivered by the OTA due to all causes shall be less than 0.007 arc sec root mean square (r.m.s.) over a period of 24 hours.

b. A time average of 60 seconds focal plane line-of-sight r.m.s jitter shall be: less than or equal to 0.007 arc sec for no less than 95 percent of any given orbit and less than or equal to 0.012 arc sec for no less than 100 percent of any given orbit.

c. A loss of fine lock shall occur, on average, no more often than one out of 15 orbits.

ORUs to be installed in the HST shall meet or exceed the performance requirements of the hardware to be replaced. When possible, replacement hardware shall include upgrades necessary to provide protection against failure modes/degraded performance realized on-orbit. All replacement hardware connectors shall be compatible with the orientation and configuration of the connectors on the existing hardware. Provisions shall be made to protect connectors to ensure that ORUs are not damaged during launch, on-orbit operations, and landing.

3.2.1 Baseline Component Requirements

3.2.1.1 Advanced Camera for Surveys Requirements. The Advanced Camera for Surveys (ACS) is an advanced science instrument camera with greater capability than the first or second generation HST scientific instruments. It will take full advantage of the available HST image quality with improved throughput, field of view, sampling, and red rejection in the far ultraviolet. The ACS replaces the HST's first generation FOC.

The ACS shall meet the requirements stated in the "Hubble Space Telescope Advanced Camera Contract End Item (Part I)", STE-47.

3.2.1.2 HST486 Requirements. The HST486 incorporates advance semiconductor technology to support the additional computational requirements of STIS, NICMOS, and the growth which will occur because of ACS and Vision 2000. Vision 2000 is a development project intended to automate HST operations. The HST486 replaces and extends the capabilities of HST's DF-224 and Coprocessor computer.

The HST486 shall meet the interface controls defined in the "Hubble Space Telescope HST486 Computer to Data Management Unit and Data Interface Units Interface Control Document," ST-ICD-94 and "Hubble Space Telescope HST486 Computer Functional Interface Document," SDM-1030. The HST486 shall meet the requirements stated in the "Hubble Space Telescope HST486 Contract End Item (CEI) Specification," STE-49. In addition, a Y harness which provides HST heater power as backup volatile memory power shall meet the requirements stated in STE-65, "HST SM Harness Extension Assemblies Requirements Specification".

3.2.1.3 Fine Guidance Sensor Requirements. The replacement FGS shall meet the requirements stated in ST-ICD-01, STE-02, and STR-01. This FGS shall replace FGS-2 in the +V3 radial bay. The refurbishment of the FGS and its compatibility with the HST PCS shall not prevent the HST from meeting the image motion requirements stated in paragraphs a and b of section 3.2. The Optical Control Electronics (OCE) Enhancement Kit (OCE-EK) installed during SM2 in the OTA Equipment Section Bay C shall be reconfigured by connecting the OCE-EK cables identified as P11A/J11A in line with the OCE P11 to HST J11 connectors.

3.2.1.4 Third Solar Array, Diode Box, and SADM Requirements. The SA3 shall meet the interface controls defined in the "Level II Interface Control Document Third Solar Array to Support Systems Module," ST-ICD-93 and "HST Third Solar Array Contract End Item Specification, Part 1," STE-51. The design of the SA3 and its compatibility with the HST PCS shall not prevent the HST from meeting the image motion requirements stated in paragraphs a, b, and c of section 3.2. The DBA2 shall meet the requirements stated in the "Solar Array 3 Diode Box Assembly Contract End Item (CEI) Specification," STE-53. The Solar Array Drive Mechanism

shall meet the requirements stated in the "Third Solar Array Drive Mechanism (SADM) Contract End Item Specification," STE-52.

3.2.1.5 Rate Sensing Unit Requirements. The RSU shall meet the requirements stated in "Rate Gyro Assembly Specification", LMSC 4171761 and ST-ICD-01.

3.2.1.6 NICMOS Cooling System (NCS) Requirements. The NICMOS Cooling System shall meet the interface controls defined in "Aft Shroud Cooling System to Axial Scientific Instrument and Support Systems Module (SSM) Interface Control Document," ST-ICD-98. The NCS shall meet the requirements stated in "Hubble Space Telescope Aft Shroud Cooling System Contract End Item Specification," STE-55. The design of the NCS and its compatibility with the HST PCS shall not prevent the HST from meeting the image motion requirements stated in paragraphs a, b, and c of Section 3.2.

3.2.1.7 Aft Shroud Cooling System (ASCS) Requirements SCN 002
(Deleted)

3.2.1.8 New Outer Blanket Layer (NOBL) and Shield/Shell Replacement Fabric (SSRF) Requirements. The NOBL/SSRF shall meet the requirements stated in the "Hubble Space Telescope (HST) New Outer Blanket Layer (NOBL) Shield/Shell Replacement Fabric (SSRF) Contract End Item Specification," STE-59.

The Bay #1 NOBL shall be added to maintain the Data Management Unit, without additional heater support, at temperatures within ±5 degrees C of the on-orbit operating temperature extremes experienced during normal and software safemode operations between launch and SM3A. The Bay #1 NOBL shall only be installed in conjunction with the HST 486 Computer.

3.2.1.9 Solid State Recorder (SSR) Requirements. The replacement SSR shall meet the requirements stated in "Solid State Recorder Contract End Item Specification" STE-48" and the system performance requirements specified in "Solid State Recorder Requirements Document, STR-76.

3.2.1.10 S-Band Single Access Transmitter. The SSAT-2R shall meet the requirements specified in LMSC 4171870, Space Telescope S-band Single Access Transmitter Specification.

3.2.1.11 V/T Improvement Kit. The VIK shall meet the requirements of STE-57 Voltage/Temperature Improvement Kit CEI Specification.

3.2.1.12 Power Control Unit. The PCU shall meet the requirement of LMSC 4172016, Engineering Critical Component Specification, Power Control Unit and ST-ICD-01. SCN 002

3.2.1.13 PDU-2 P16 Fuse Plug Assembly Requirements. Fuses to be used in the PDU power distribution circuits shall meet the circuit protection requirements of ST-ICD-01, ST-ICD-02, ST-ICD-03, and ST-ICD-93 and LMSC drawing 4174331. The replacement P16 FPA shall meet the -511 assemblies requirements.

SCN 004

The fuses shall be tested individually to the requirements specified in SMR-1035, HST First SM Fuse Plug Assembly Integration and Test Plan.

3.2.1.14 Reaction Wheel Assembly (RWA) Requirements. The RWA shall meet the requirements of LMSC 4171463, Reaction Wheel Assembly Specification and ST-ICD-01.

3.2.2 Contingency Component Requirements. The HST hardware manifest for SM3 shall include contingency and spare hardware deemed essential for recovery from credible single and common-mode failures which may occur during servicing operations.

SCN 002

3.2.2.1 Rate Sensing Unit Requirements. The spare/contingency RSU shall meet the requirements stated in "Rate Gyro Assembly Specification", LMSC 4171761 and ST-ICD-01. SCN 002

3.2.2.2 Electronics Control Unit Requirements. The spare/contingency ECU shall meet the requirements stated in "Rate Gyro Assembly Specification", LMSC 4171761 and ST-ICD-01. SCN 002

3.2.2.3 HST486 Requirements. The spare HST486 shall meet the interface controls defined in the ST-ICD-94 and SDM-1030. The spare HST486 shall meet the requirements stated in the STE-49. In addition, the spare Y harness shall meet the requirements stated in STE-65.

3.2.2.4 Fuse Plug Assemblies (FPAs) Requirements. Fuses to be used in the PDU power distribution circuits shall meet the circuit protection requirements of ST-ICD-01, ST-ICD-02, ST-ICD-03, and ST-ICD-93 and LMSC drawing 4174331. The replacement P15, P16 & P17 FPAs shall meet the -509, -511 and -513 assemblies respectively. Fuses to be used in the OTA Electrical Power/Thermal Control Electronics (EP/TCE) power distribution circuits shall meet the circuit protection requirements of Hughes Danbury Optical System (HDOS) SD-679-1807 and ST-SE-5375.

The fuses shall be tested individually to the requirements specified in SMR-1035, Hubble Space Telescope First Servicing Mission Fuse Plug Assembly Integration and Test Plan.

3.2.2.5 DBA2 Requirements. The spare DBA2 shall meet the requirements of STE-53.

3.2.2.6 VIK Requirements. The spare VIKs shall meet the requirements of STE-57.

3.2.2.7 Aft Shroud Latch Repair Mechanism Requirements. The ASLR Mechanism shall meet the requirements of LMMS/P505023, Requirements Specification for HST Aft Shroud Latch Repair Mechanism.

3.2.3 ORU Harnesses/Extensions/Converters Requirements

The ORU harnessess/extensions/converters manifested for SM3 shall meet the requirements specified in STE-65 HST SM Harness Extension Assemblies Requirements Specification.

3.3 SERVICING MISSION SUPPORT REQUIREMENTS

3.3.1 Mission Planning

3.3.1.1 Operations Planning. On-orbit operations timeline information shall be developed to support mission planning including detailed scenarios for EVA activities and servicing hardware operations. This timeline information shall be suitable to support the Shuttle requirements for HST payload operations timeline development and the HST project requirements for flight operations development. The timeline information shall be incorporated into the integrated timeline to be developed by the HST O&GS project. Detailed timeline supporting information shall be provided for the ORUs. Operational constraints and restrictions documentation for ORUs, operations scenarios for SSE, and EVA test support and contingency procedures for EVA training, testing, and familiarization activities shall be developed and incorporated for use in servicing mission execution.

All relevant hardware operational sensitivities shall be identified, including mechanical, electrical, thermal, and contamina-

tion, and appropriate hardware and/or operational controls shall be implemented to ensure the integrity of sensitive equipment for its intended usage. These sensitivities shall be documented in either Annex 2 Part 2, HST SM3 EVA Requirements (SMR-3026/3028) HST Constraints and Restrictions Document, SMO-1020. SCN 004

3.3.1.2 SM Returned Hardware. Mission planning shall support the return from orbit of the replaced hardware. During this servicing mission (SM) there is no requirement for a return mission (i.e. to return the HST to the ground). It is not a requirement for the replaced hardware to be maintained in an operational state once the successful installation of replacement hardware into the HST has been verified. Prior to this verification, functional hardware which has been removed from the HST shall be protected against environmental conditions which would preclude its reinstallation or create a contamination risk to hardware remaining in orbit.

3.3.1.3 Uninstalled Replacement Hardware. Mission planning shall support the return of uninstalled replacement hardware from orbit. SM planning shall provide conditions which protect such hardware from thermal environments which violate the non-operate temperature limits of the hardware. Structural loads experienced by uninstalled hardware during nominal landings shall not preclude its re-flight. SM planning shall permit this hardware to be cleaned to a flightworthy condition after a nominal landing.

3.3.1.4 Contingency Plans. Alternative operations shall be planned and developed for use in the event of failure of on-orbit servicing operations and supporting operations which are safety critical or mission critical. Procedures shall be developed for

reaching decisions on use of the alternative options. The ability to rapidly replan the remaining mission timeline shall be provided.

3.3.1.5 Orbital Predictions. Predictions of HST orbital altitude decay shall be generated for use in mission planning and HST altitude reboost requirement determination.

3.3.1.6 Solar Array Configuration. Nominal SM reboost planning shall assume the successful installation of the HST Third Solar Array (SA3), reference ST-ICD-93. SM hardware changeout operations planning shall minimize the time the HST is exposed to the retraction and stowage of the HST Solar Array II, reference ST-ICD-49.

3.3.1.7 Servicing Mission Duration. The planned duration (nominal plus reserved contingency) of shuttle-based servicing shall be sufficiently long to accomplish the replacements listed in STR-80 Table 1-2 and 1-3 and to ensure that the HST is left in an operational state.

3.3.1.8 Power Control Unit Changeout. Nominal PCU changeout shall require interruption of power to S/C loads (including heaters and mechanisms). All spacecraft hardware shall be maintained above their minimum survival temperatures during this power interruption period. Contingencies shall be identified, for each case plans and contingency hardware to assure HST health and safety shall be in place. SCN 002

3.3.2 EVA Procedures and Hardware Development

The SM3 EVA operations and the associated timeline shall be planned for successful accomplishment within the time allocated by the Payload Integration Plan (PIP). Procedures and timelines for on-orbit servicing of HST by Shuttle EVA crew shall be developed and exercised using simulators of HST, SIs, ORUs, interface hardware, crew aids, tools, Shuttle equipment, and the zero-gravity space environment. The procedures and timeline are to be developed in detail suitable for supporting Shuttle training and documentation requirements. The procedure development is to be

interactive with design and development of hardware, interfaces, crew aids, and tools, including: expected environments; contamination; constraints and restrictions.

All servicing operations shall be conducted without damaging the HST, FSS, ORUC, RAC, SAC, MULE, ORUs, and CATs including cases when the HST appendages are deployed. SCN 002

The EVA procedures and crew interfaces, and the hardware simulators used in their development shall be adequate for use by the Shuttle program for crew training. High Fidelity Mechanical Simulator (HFMS) ORU simulator requirements shall be documented in the HFMS ORU simulator CEI Specifications. Differences between the flight hardware and the HFMS simulators, Neutral Buoyancy Laboratory (NBL) hardware, and Vehicle Electrical System Test (VEST) shall be documented.

Crew familiarization and Form, Fit, and Function Test exercises shall be conducted using high fidelity one-gravity simulators and flight hardware.

Proper engagement of all fasteners and mechanisms shall be confirmed by torque limiting and/or visual inspection and telemetry monitoring.

3.4 SERVICING SUPPORT EQUIPMENT REQUIREMENTS

3.4.1 Shuttle Support

Planning and execution of the servicing mission shall meet the requirements of the "Payload Integration Plan, Hubble Space Telescope, NSTS 14009." The entire complement of payload (including

the Shuttle attached HST), carriers, tools, and crew aids shall meet the requirements of "NSTS 07700, Vol. XIV Space Shuttle System Payload Accommodations." The HST payload shall meet the requirements of "Space Shuttle/HST Interface Control Document", ICD-A-14009-SM.

3.4.2 Space Support Equipment

The SSE hardware shall be operationally compatible with the Orbiter, HST, applicable crew systems, ORU hardware, crew aids, and tools.

The SSE design shall permit the accommodation of ORUs designated for the SM3 in accordance with ST-ICD-97. The SSE shall provide environmental protection for the ORUs to ensure delivery of undamaged and uncontaminated hardware for on-orbit servicing and return of SM hardware to Earth.

The Axial SIPE shall be configurable to support an axial SI with Optical Telescope Assembly (OTA) Axial bay 1 and 3 latch provisions. Axial SI interfaces with the SSE shall be as defined in ST-ICD-91 and the FGS interfaces with the SSE shall be as defined in ST-ICD-82.

The SSE shall satisfy the following list of requirements:

1. The SSE shall meet the interface requirements of ICD-A-14009-SM.

2. The SSE shall be operationally compatible with all phases of the servicing mission and shall support replacement of designated equipment by EVA.

3. The carriers shall serve as a transportation and stowage platform from which the EVA crew can remove, stow, and replace various crew aids, tools, and ORUs.

4. The design of the RAC, ORUC, FSS, SAC, and MULE as an integrated payload shall incorporate translation and access routes required for EVA crew members to perform HST servicing tasks. SCN 002

5. The carriers and associated Protective Enclosures (PE) in conjunction with the nominal mission attitude as defined in the PIP and ICD-A-14009-SM shall provide thermal conditioning as specified in paragraph 3.5.6.2.1.3.

6. For liftoff, landing, and transportation the SSE shall maintain the structural loads for the ORUs in accordance with ST-ICD-97 and for the latches in accordance with their structural limits. The SIPEs shall be compatible with the latch capabilities.

7. The SSE design shall permit direct line-of-sight visibility of the FSS berthing latch mechanisms and pivoter/rotator visual aid from the Orbiter Aft Flight Deck (AFD) viewing ports during HST berthing operations.

8. The SSE shall meet the rapid safing requirements of NSTS 1700.7B.

9. The SSE shall provide the resources necessary to support both passive and active on-orbit contamination monitoring.

3.4.3 SSE Functional Requirements

3.4.3.1 Flight Support System (FSS). The FSS will provide a service platform for the HST during the on-orbit servicing mission. This hardware has flown on other Orbiter missions, but shall be modified, as required, to meet requirements defined for the SM3.

The FSS shall meet the interface requirements of ST-ICD-10 and ICD-A-14009-SM.

The FSS shall provide:

1. A remotely operated Berthing and Positioning System (BAPS) for HST servicing. The BAPS shall be capable of rotating the HST about the HST V_1 axis and pivot about an axis parallel to the Orbiter Y axis.

2. A remotely operated main umbilical mechanism which mates to and demates from the HST main umbilical.

3. Manual override of all FSS mechanisms with the exception of: the translator; berthing latch closing; main umbilical mating; and down lock mating.

4. A backup (deploy/return) umbilical mechanism which demates from the HST via AFD command.

5. The mounting of an Orbiter supplied Closed Circuit Television (CCTV) camera.

6. Crew aids attachments (tether attach points, handrails, portable foot restraint (PFR) attachments, Auxiliary Axial SI Handle, Low Gain Antenna Protective Cover and ancillary items defined by NBL simulations).

7. BAPS post mounting.

8. Operations of the BAPS mechanisms shall be conducted without damaging the HST and FSS, including cases when the HST appendages are deployed.

9. Visual indication of pivoter and rotator positions.

10. Support to maintain the HST, throughout the servicing mission, in a condition which permits the resumption of its science mission.

11. Resources necessary to support an active contamination monitor - a footprint location that provides contamination monitor instrumentation viewing angles in all required directions, mounting interface from the contamination monitor to the FSS structure, and power.

12. ORU mounting provisions. The FSS shall include provisions for structural isolation and thermal control of ORUs as specified in ST-ICD-97. SCN 002

13. Thermal Control. Provisions for MLI, heater power, and temperature monitoring)

14. Contamination mitigation. Contamination protection shall be provided for items that are intended for installation or extended use (over one EVA day) in the AS as specified in ST-ICD-97. SCN 002

SCN 002

3.4.3.1.1 FSS General Spacecraft Servicing. Modifications to the FSS shall not preclude its ability to support other-class spacecraft servicing.

3.4.3.2 Orbital Replacement Unit Carrier (ORUC). The ORUC shall provide for the following as specified in ST-ICD-97:

1. Thermal Control. (Provisions for MLI, heater power and temperature monitoring).

2. Contamination. (Provisions for GN_2 purge up to T-0).

3. Structural load isolation.

4. ORU mounting provisions.

In addition, the ORUC shall provide:

1. Crew aids (tether attach points, handles, handrails, PFR attachments, etc.).

2. Visual indication and telemetry monitoring of active SI latch engagement.

The ORUC design shall meet the mission requirements and support the SM3 carrying any and all parts of the ORUC ORU complement.

Detailed design and performance requirements for the ORUC are defined in the "ORU Carrier Contract End Item Specification," STE-58.

3.4.3.3 Rigid Array Carrier (RAC). The RAC shall provide for the following as specified in ST-ICD-97:

1. Thermal Control. (Provisions for MLI).

2. ORU mounting provisions.

In addition, the RAC shall provide:

1. Crew aids (tether attach points, handrails, PFR attachments, etc.).

2. Visual indications for SA latch engagement/ disengagement.

The RAC design shall be able to support the SM3 carrying any part of the RAC ORU complement.

Detailed design and performance requirements for the RAC are defined in the "Rigid Array Carrier Contract End Item Specification, STE-56".

3.4.3.4 Multi-Use Lightweight Equipment (MULE) Carrier. The MULE shall provide for the following as specified in ST-ICD-97:

1. Thermal Control. (Provisions for MLI, heater power, and temperature monitoring).

2. ORU mounting provisions.

3. Contamination mitigation. (Provisions for GN2 purge up to T-0). Contamination protection shall be provided for non-purged items that are intended for installation or extended use (over one EVA day) in the AS. SCN 002

In addition, the MULE shall provide:

1. Crew aids (tether attach points, handrails, PFR attachments, etc.).

The MULE design shall be able to support the SM3 carrying any part of the MULE ORU complement.

Detailed design and performance requirements for the MULE are defined in the " Multi-Use Lightweight Equipment (MULE) Contract End Item Specification," STE-62.

3.4.3.5 GSFC Crew Aids and Tools.

Crew aids and tools are those items necessary to efficiently accomplish on-orbit servicing. The design and interface requirements for generic crew aids and tools (CATs) provided by HST, but which could be used on other Space Shuttle missions shall be based on the JSC Generic Design Requirements Document (GDRD), JSC 26626, Revision A, dated May 1995. Applicability of these requirements, and additional design requirements derived from STR-81 shall be documented in individual Specific Design Requirements Documents (SDRDs). The design and interface requirements for HST-unique CATs shall be documented in a CEI specification. Crew aids shall include protective covers that provide, as required, physical, cleanliness, illumination, anti-static and anti-arching protection.

3.4.3.5.1 Rotational and Translational Mass Stability. ORU attachments shall be located for restraints, tethers, and guides to prevent contributions to handling forces that could magnify element tumbling, misalignment, or binding during on-orbit servicing operations.

SCN 002

3.4.3.6 Second Axial Carrier (SAC). The SAC shall provide for the following as specified in ST-ICD-97: SCN 002

1. Thermal Control. (Provisions for MLI, heater power and temperature monitoring).

2. Contamination mitigation. (Provisions for GN2 purge up to T-0). Contamination protection shall be provided for non-purged items that are intended for installation or extended use (over one EVA day) in the AS.

3. Structural load isolation.

4. ORU mounting provision.

In addition, the SAC shall provide:

1. Crew aids (tether attach points, handrails, PFR attachments, etc).
2. Visual indication and telemetry monitoring of active SI latch engagement.
3. Temporary parking for ORUs not provided by other carriers.

The SAC design shall be able to support the SM3B carrying any part of the SAC ORU complement.

Detailed design and performance requirements for the SAC are defined in the "Second Axial Carrier Contract End Item Specification, STE-41".

3.4.4 SSE Electrical Requirements

The SM3 payload power, command and data allocations shall comply with the applicable sections of the ICD-A-14009-SM and the PIP.

a. SSE Power Margins. The SSE shall provide power margins for ORU payload growth.

3.4.4.1 Total FSS Electrical Load. The total load served through the FSS shall not exceed the combined power allocation at the FSS Umbilical and the Orbiter-to-FSS Standard Interface Panel (SIP), as identified in Appendices A and B respectively for the SM3A and SM3B parts of the mission.

3.4.4.1.1 FSS-to-HST Electrical Interfaces. The FSS-to-HST power and voltage interfaces shall comply with ST-ICD-10, Paragraph 7.14.

3.4.4.1.2 FSS-to-ORUC Electrical Interfaces. The FSS-to ORUC power and voltage interfaces shall comply with ST-ICD-10, Paragraph 7.16.

3.4.4.1.3 FSS Avionics and Heaters. The FSS avionics and heaters power and voltage requirements shall comply with ST-ICD-10, Paragraph 7.15.

3.4.4.2 Orbital Replacement Unit Carrier (ORUC). The ORUC shall be capable of operating from power, command, and interfaces provided by the FSS, as determined by the limiting set of Orbiter cabling allocations between the FSS and ORUC as specified in ICD-A-14009-SM.

The ORUC power and voltage requirements shall comply with ST-ICD-10, Paragraph 7.16.

3.4.4.3 Rigid Array Carrier (RAC). The RAC shall not be powered.

3.4.4.4 Multi-Use Lightweight Equipment (MULE). The MULE power, command and data allocations shall comply with the applicable sections of ICD-A-14009-SM.

3.4.4.5 Power Allocation, Minimum Voltage, and Energy Limits. The servicing mission power allocation and the voltage limits at the interfaces of major payload components, as well as the total energy allocation, including AC power loads, for the SM3A and SM3B parts of the mission are given in Appendices A and B respectively.

3.4.4.6 Second Axial Carrier (SAC). The SAC power, command and data allocations shall comply with the applicable sections of ICD-A-14009-SM. SCN 002

3.5 DESIGN AND CONSTRUCTION

3.5.1 Physical

3.5.5.1 Mass Properties. The mass properties for the Hubble Space Telescope are defined in ST/SE-04.

The weight of all payload-chargeable SSE and ORUs shall not exceed the total weight limits identified in Appendices A and B respectively for SM3A and SM3B. Weight margins shall be maintained in accordance with the "HST SM3 Weight Control Plan," SMR-3091.

3.5.1.1.1 Contract End Item Weight Allocation. Hardware weight allocations for SM3A and SM3B are given in Appendix A and B. These values shall be considered as not-to-exceed weights and shall be used as design criteria for the SSE and ORUs. The ORUC and SAC weight allocations include Government Furnished Equipment (GFE) latch hardware. SCN 002

3.5.1.1.2 Center of Gravity. The placement of all cargo elements, other crew aids and additional mission-related hardware

shall not exceed the Orbiter Payload Bay center of gravity (CG) envelope defined by the Mission Specific Flight Design Assessment.

The CG will be determined for each of the cargo elements and all other SSE manifested for SM3A and SM3B.

3.5.1.2 Coordinate Systems. The FSS, ORUC, RAC, SAC, and MULE shall use the coordinate axes as delineated in ICD-A-14009-SM. | SCN 002

ORUs and SSE shall be marked or referenced on drawings in relation to either the Orbiter or HST coordinate systems, or both, as defined in PIP Annex 1.

3.5.2 Contamination Control

The ACS and FGS life cycle, from build through the integration and test activity at GSFC, delivery to orbit and installation into the HST shall ensure ACS and FGS cleanliness levels that meet or exceed the levels specified in STR-29.

More stringent ORI internal and optical surface contamination requirements have been established by the ACS developers to meet optical performance requirements. These requirements are stated in their Contamination Control and Implementation Plan.

The ASCS/NCS and RSU internal aft shroud components life cycle, from build through the integration and test activity at GSFC, deliveryto orbit and installation into the HST shall ensure cleanliness levels that meet or exceed the levels specified in STR-29.

For the SSE and all other SM hardware (non-aft shroud), contamination requirements are defined in STR-29.

3.5.2.1 Contamination Budget. HST SM contamination budgets shall be allocated according to critical ORU end-of-life performance requirements. These budgets establish incremental and cumulative allocations per significant event.

3.5.2.2 Contamination Monitoring. During the servicing mission, the on-orbit contamination environment shall be monitored. Both particulate and molecular contamination shall be monitored via an active contamination instrumentation (Contamination Environmental Package - CEP). The CEP shall meet the requirements stated in "HST Second Servicing Mission Contamination Monitor End Item Specification", P-442-1285.

3.5.3 Reliability

The FSS, ORUC, RAC, SAC, and MULE shall be single fault tolerant against failure to support the baseline mission. Crew aids and tools provisions shall be sufficient to provide single fault tolerance against failure to support the baseline mission. SCN 002

3.5.4 Safety

The SM hardware and software (including the HST vehicle) shall be designed, maintained and operated to eliminate or control hazards during all phases of SM integration and test activities, transportation, on-orbit SM activities, Shuttle operations and EVA.

3.5.4.1 Flight Safety. Flight hardware and operations shall be designed and controlled per NSTS 1700.7B to ensure Orbiter and crew safety will not be compromised at any time under normal

modes of operation and documented by approved (JSC/GSFC) Flight Safety Hazard Reports. The safety aspects of on-orbit work-arounds will be handled according to the guidelines specified in the flight rules.

The payload hardware shall be designed to comply with the operational safety constraints and safety-critical interfaces as specified in the SM3 PIP and ICD-A-14009-SM.

3.5.4.2 Ground Safety. SM flight hardware and GSE planned for integration and test activities at KSC shall be designed and controlled per KHB 1700.7B to ensure that personnel and facilities safety are not compromised and documented by approved (KSC/GSFC) Ground Safety Hazard Reports. Mission critical hardware/GSE planned for integration and test activities at GSFC shall comply with P-442-0173.

3.5.5 Maintainability

The SM hardware shall be designed to perform without maintenance at any time during flight, with the exception of power tool battery replacement.

All other maintenance, repair, and adjustment of SM Hardware shall be accomplished on the ground prior to and following flight missions.

3.5.5.1 Shelf Life. The design of the SSE shall take into account storage/use cycles. The nominal total protected storage time shall be 20 years with a mission use approximately every 2.5 years (no more than six missions).

3.5.5.2 Orbital Usage Life. SSE shall be designed for a total orbital life of 54 days.

3.5.6 Environment

3.5.6.1 Natural Environments. The SSE shall be designed to withstand the natural environments specified in National Aeronautics and Space Administration (NASA) TM-78119.

3.5.6.1.1 Meteoroid Impact. The SSE shall withstand exposure to orbital meteroid and orbital debris without loss of functional capability.

3.5.6.1.2 Radiation. The SSE shall withstand exposure to the on-orbit ionizing particle radiation environment for at least 54 days without loss of functional capability.

3.5.6.2 Induced Environments. The SM Hardware shall be capable of surviving any environment or combination of environments, consistent with the mission phase (i.e. launch and ascent, on-orbit, descent, or landing), specified herein and in ICD-A-14009-SM.

3.5.6.2.1 Thermal Requirements. Thermal design of the SM hardware shall be consistent with the Orbiter attitudes defined in ICD-A-14009-SM.

3.5.6.2.1.1 SM Hardware Thermal Requirements. Thermal design of the SM hardware shall be consistent with the planned operations of the HST and shall not introduce any constraints to the baseline capabilities of the HST during normal operations or the Servicing Mission.

3.5.6.2.1.2 Orbiter Bay Thermal Requirements. The SM hardware shall survive the Orbiter bay thermal environment defined in ICD-A-14009-SM. Safety related temperature limits and allowable

exposure times for contingency situations shall be determined and maintained for all SM hardware.

3.5.6.2.1.3 ORU Thermal Requirements. The carriers shall provide thermal conditioning of ORUs such that the non-operational limits are not violated while on the carriers or during transport and installation into the HST.

The intent shall be to maintain ORUs above the minimum turn on temperature at HST installation to allow for immediate ORU turn on and checkout (no thermal timeline constraint).

3.5.6.2.2 Loads and Deformations

SM hardware design shall accommodate flight and operational loads.

Crew-imposed loads/forces and work restraints shall be as defined in NSTS 07700, Vol. XIV, Appendix 7 and ICD-A-14009-SM.

3.5.7 Transportability/Transportation

3.5.7.1 Transportation Load Criteria. The SM hardware shall be transportable by ground, air, and surface transportation as individual components, subassemblies, assemblies, or as a unit. All transportation loads shall be enveloped by flight loads.

3.5.7.2 Ground Handling. The design of the FSS, ORUC, RAC, SAC, and MULE shall include 1-G handling points to permit installation and loading as a complete unit into the cargo bay. | SCN 002

3.5.8 Storage of SSE

During storage, the SSE components and assemblies shall be packaged and preserved per NHB 6000.1 and individual Packaging Handling and Transportation Records kept as defined in NASA Form 1426.

3.5.9 Ground Support Equipment

Mechanical and electrical GSE shall be used for the support, testing, transportation, handling, installation, and servicing of SSE and ORU hardware. All test equipment shall be designed with a fail-safe goal such that equipment failure will not degrade flight hardware.

1. Mechanical GSE. Factors of Safety and Proof test Loading shall be:

   a. Factor of Safety for lifting equipment = 5.0 (ult)
   b. Proof load Factor for lifting equipment = 2.0.

2. Electrical GSE. The electrical GSE shall provide the same interface characteristics to the SSE and ORUs as the STS and the HST.

3.5.10 General Mechanical

3.5.10.1 Design Factors of Safety

Two load criteria exist for metallic structures:

1. SM Heritage hardware that was designed and built to Marshall Space Flight Center (MSFC) safety factor guidelines as noted in Table 3-1.

Analysis of SM hardware built to these earlier standards and showing positive margins of safety relative to this earlier criteria are acceptable.

2. The more recent safety factor guidelines defined in specification GSFC-GEVS-SE, shown in Table 3-2, shall be used for any SM specific hardware, hardware design changes or new SM design.

3.5.10.2 Fatigue. The effects of repeated loads and pressure cycles on the design of SSE missions will be evaluated. Fatigue analysis shall be performed using MIL-HDBK-5 as the primary source of fatigue properties. Structural elements fabricated from composite materials shall be verified by test and analysis, in accordance with NSTS 14046.

3.5.10.3 Fracture Control. All items whose structural failure could result in a hazard to the Orbiter or crew shall be subject to fracture control per NHB 8071.1.

3.5.10.4 Pyrotechnic Devices. The SM hardware shall not include pyrotechnic devices.

3.5.10.5 Latching and Attach Mechanisms. All attachment and operating interfaces shall protect against inadvertent actuation. All hardware which can move and interface with crew activities shall, while in the loosened configuration, have integrated restraints which are capabile of withstanding Shuttle Vernier Reaction Control System (VRCS) jet firings without gross motion.

3.5.10.6 Castings. Castings shall not be used in any SM Hardware component designs without prior approval from the Flight Assurance Manager.

Table 3-1 Heritage Hardware

	Earth Return 9.6 FPS Landing	Crash/Emergency Landing
Analysis Only	= 1.25 yield = 2.0 ultimate	--- = 1.0 ultimate
Analysis and Static Test	= 1.1 yield = 1.4 ultimate	--- = 1.0 ultimate

Table 3-2 Current SM Hardware

	Earth Return 9.6 FPS Landing	Crash/Emergency Landing
Analysis Only	= 2.0 yield = 2.6 ultimate	--- = 1.0 ultimate
Analysis and Static Test	= 1.25yield = 1.4 ultimate	--- = 1.0 ultimate

Note:

Loads occurring at the same time shall be combined and the safety factors applied as follows:

Yield Load = F.S. x Load Spectrum*
Ultimate Load = F.S. x Load Spectrum*

* The load spectrum is a representation of the cumulative quasi-static dynamic and thermal loadings anticipated under all expected environments.

3.5.10.7 Markings. All SM Hardware, including crew aids and tools, shall be clearly marked and labeled as to name and function, and any alignment constraint as applicable to facilitate crew interface and functions.

The CG of the loaded RAC, FSS, ORUC, SAC, and MULE shall be determined and documented prior to ground-handling operations. The CG of ORIs shall be identified and clearly marked prior to ground-hand-ling operations and installation into the HST. SCN 002

3.5.11 General Electrical

3.5.11.1 Grounding and Bonding. All SSE hardware shall be designed to ensure a single point ground configuration consistent with the requirements of NSTS 37330. Grounding and bonding shall be in accordance with NSTS 37330. Grounding of multi-layer insulation shall be per ICD-A-14009-SM. SCN 002

3.5.11.2 Electrical Fault Protection. SSE power circuits shall be designed so that faults within the SSE or SSE interfaces to HST will not damage Orbiter circuits as defined in the applicable documents specified in Section 3.5.4, Safety.

The SSE shall be designed so that faults within SSE shall not damage the HST. Faults within one SSE subsystem shall not propagate to other SSE subsystems.

3.5.11.3 ElectroStatic Discharge Protection. SSE items requiring bonding to prevent static charge buildup shall be bonded per NSTS 37330, Class S, except for multi-layer insulation (MLI) blankets. MLI, including the PE foam shall meet the surface property requirements of ICD-A-14009-SM, SCN 002

Paragraph 10.7.4.2.3.5.1. SSE shall not be susceptible to damage by static discharge.

3.5.11.4 Corona Suppression. SSE electrical hardware shall be designed to eliminate corona discharges in the on-orbit environment.

3.5.11.5 Connector Protection. All connectors with potential exposure to inadvertent contact or debris shall be protected as follows:

1. Test/unused connectors on new hardware shall be capped at all times.

2. As required by safety mandates per MA2-97-093 "Crew Mating/Demating of Powered Connectors", second letter to NSTS/ISS 18798B.

3. All connectors with 22 AWG or smaller pins, and all non-scoop-proof connectors with pin contacts that are exposed to risk of damage due to inadvertent contact during EVA, shall be capped. Such connectors on replaced hardware shall be protected from inadvertent contact until the installed hardware is verified.

4. All connectors on new hardware, and hardware that may be reinstalled, shall be protected from debris during launch and/or SSE stowage.

5. The EVA crew shall inspect all connectors, except those that have been capped since launch, immediately prior to mating.

3.5.12 Electromagnetic Compatibility (EMC)

The SSE shall be designed for electromagnetic self-compatibility and for electromagnetic compatibility with the HST and with the Orbiter in accordance with Electro-magnetic Compatibility Requirements Systems, MIL-E-6051, and ICD-A-14009-SM.

The SSE electrical and electronic components shall not be a source of, nor be susceptible to, electromagnetic interference as required by GSFC-GEVS-SE, Section 2.5, EMC.

3.5.13 Human Engineering

The SM hardware shall be designed in accordance with the human engineering guidelines in NSTS 07700, Vol. XIV, Appendix 7. Generic CATS shall also be subject to the requirements in JSC-26626A.

3.5.14 Previously Certified Hardware

All hardware items that were developed, built, verified and certified for flight in support of the previous HST Servicing Missions shall be re-certified using the following criteria:

1. All safety critical age or wear sensitive equipment (i.e lubricants, vespel inserts, etc.) shall be refurbished or replaced to meet the SM3 requirements.

2. If there are design changes, function changes, or hardware modifications, then the hardware shall be refurbished or replaced in accordance with the SM3 requirements.

3. If there are no hardware changes, based on the above criteria, then no reverification shall be required.

4. VERIFICATION OF REQUIREMENTS

A verification program shall be conducted with requirements verified by test and/or assessment as defined in Section 4.4. The verification program shall be conducted and scheduled to meet the timely flow of SM hardware.

The verification program shall include prelaunch verification at the developer's facility; GSFC; KSC; EVA task requirements verification at GSFC and JSC; and post-launch, on-orbit verification. The verification program at GSFC and the on-orbit program will consist of both subsystem and system level verification.

4.1 PRELAUNCH VERIFICATION

Verification and testing of all flight hardware shall be conducted before launch to verify compliance with the applicable end-item specification by the hardware developer/manufacturer during the final test program. Prelaunch verification shall be conducted in accordance with the Integration and Test (I&T) Plan, SMR-3040. System level verifications will be conducted at GSFC with the flight hardware integrated with the Vehicle Electrical Systems Test (VEST) Facility to verify compliance and the High Fidelity Mechanical Simulator (HFMS) to verify agreement with ICDs. A mechanical fit check of all ORUs, SIPE interfaces, and EVA tool storage and functional interfaces shall be performed. All SSE ground system to shuttle interfaces shall be verified prior to the end-to-end compatibility test. An end-to-end compatibility test shall be performed between the flight systems and the operational ground systems for:

replacement SI
replacement ORUs
new ORUs
SSE.

SCN 002

Verification activities shall also include EVA task requirements verification and related hardware used for EVA. EVA hardware shall be adequate to demonstrate compliance with the shuttle program and HST requirements.

The functionality and mutual compatibility of the new hardware with hardware manifested for SM4 shall also be tested to the maximum extent practical.

SCN 002

4.1.1 ORUs Mechanical Interface Verification

A fit check with a HFMS for all HST Aft Shroud flight ORUs shall be conducted to verify the flight hardware mechanical interfaces and their agreement with the ICDs and the as-built HST vehicle metrology. This fit check will include installing the flight hardware in the appropriate equipment or instrument bay, on the equipment shelf and/or on the Aft Shroud in a flight manner. Interfaces for flight hardware will also be verified at the NBL, the Exterior Simulator Facility (ESF) the Aft Shroud Door Trainer, the PCU Bay Simulator and in the VEST if applicable. This interface verification will include using the appropriate EVA tools and procedures, where applicable.

SCN 002

4.1.2 Structural Loads Verification

Loads and deformations shall be verified in accordance with the requirements of NSTS 14046.

4.1.3 Contamination Verification

Verification procedures for contamination requirements shall be provided in individual flight hardware contamination control and implementation plans. Contamination control and verification shall comply with ICD-A-14009-SM, Section 6 and STR-29.

4.1.4 Crew Systems Verification

Verification of EVA task and hardware requirements shall be in accordance with the HST EVA Verification Plan SMR-3022. Simulators are acceptable if the flight hardware is unavailable for verification.

4.1.5 Mass Property Verification

The HST SM3 Weight Control Plan SMR-3091 provides the format and frequency for reporting, tracking, and verification. This plan includes mass properties activities from weight prediction through actual weight measurement. SCN 002

4.1.6 System Level Compatibility Tests

System level compatibility tests shall be conducted as part of the I&T program with the flight hardware integrated with the VEST.

1. Compatibility tests will be conducted with the SM3 complement of flight hardware integrated with the VEST facility. The rest of the hardware complement in VEST, in order to have a full equivalent HST system, will be a mixture of flight units, breadboards, engineering units, prototypes and simulators.

2. The compatibility tests will include conducting system tests of each of the new SM3 flight hardware items against each other.

a. Each of the HST sub-systems will be put in a known steady state.

b. Each SM3 flight hardware will be operated in its noisiest electrical state while the remaining flight hardware operate in their quietest (most sensitive) state. This sequence will be run until all SM3 hardware have been operated in its noisy electrical state.

4.2 VERIFICATION PLANNING

The verification program shall assure that the SM Hardware and EVA tasks conform to the design and performance requirements as specified in Section 3. Each requirement shall be verified as specified in the matrix and as formatted in Table 4-1. HST SM Performance verification test matrices shall be developed and maintained for all Level 4 systems (see Table 4-1). These systems will include spacecraft replacement hardware, SSE and EVA tasks.

4.3 VERIFICATION PHASES

The verification phases correspond with the master SM schedule and reflect the location or condition of SSE verification. The phases are defined as follows:

A = Development at Supplier Facility
B = Integration and Test at GSFC
C = Preparation and Integration at KSC
D = On-Orbit Servicing
E = Orbital Verification-Servicing Mission Observatory Verification (SMOV)
F = Science verification - SMOV

Table 4-1 HST Servicing Mission Performance Verification Matrix (Sample)

Doc Level II	Doc STR-36 para	Requirement	H/W	Phase	Test Type	Assessment					Compliance			
						Similar	Analysis	Inspect	Demo	Record	Date	Name	Ref Doc	Notes
Example: STR-36	3.2.3	ORUC shall not exceed 6550 lb	ORUC	B	F		X		X	X	x/x/ 199x	xxxx	P-442-XXX	

Notes:

1. Document Level: Level I, Level II, Level III, and Level IV

2. Document paragraph, i.e., 3.3.1

3. Hardware ORUC, FSS, RAC, ACS, SA3, FGS, HST486 , etc.

4. Phase A = Development at Facility, B = Integration and Test at GSFC, C = Preps and Test Integration at KSC, D = On-orbit Servicing, E = Orbital Verification, and F = Science Verification

5. Test Type (F = Functional, E = Environmental, P = Proof)

6. Assessment - Similarity, Analysis, Inspection, Demonstration, and Validation of Records

7. Compliance date, name of responsible engineer, reference documentation, and liens or Data Discrepancy Reports

4.3.1 Development at Supplier's Facility

Verification at the supplier's facility phase covers all test and verification and supporting analysis deemed necessary to meet hardware specifications prior to GSFC delivery.

4.3.2 Integration and Test at GSFC

The integration and test phase at GSFC includes all appropriate hardware, electrical, and optical test and supporting analyses conducted at GSFC to ensure compliance with SM requirements. This test phase includes VEST, HFMS, ESF, and SM Ground Tests (SMGTs). SCN 002

4.3.3 Preparation and Integration at KSC

The SM hardware pre-launch preparation, integration, and test activities performed at KSC are included in this phase.

4.3.4 On-Orbit Servicing

The on-orbit servicing phase includes all hardware integration and check-out during the servicing phase of on-orbit operations. This includes ORU changeout and ground/observatory checks while the HST is berthed in the Orbiter cargo bay.

4.3.5 Servicing Mission Observatory Verification

The SMOV phase reflects all verification activities of the HST following release from the Orbiter.

4.4 VERIFICATION METHODS

Qualification and acceptance shall be accomplished by any one or more of the following methods and defined in this section:

1. Test
   a. Functional Tests
   b. Environmental Tests
   c. Proof and Leak Tests
2. Assessment
   a. Similarity
   b. Analysis
   c. Inspection
   d. Demonstration
   e. Validation of Records

4.4.1 Functional Tests

Functional testing is an individual or series of electrical or mechanical performance test(s) conducted on flight or flight configured hardware at conditions equal to or less than design specifications. The purpose is to establish that the hardware performs satisfactorily in accordance with design specifications.

4.4.2 Environmental Tests

Environmental testing is an individual or series of test(s) conducted on flight or flight-configured hardware to ensure that the flight hardware will perform satisfactorily in its flight environment. Examples are vibration, acoustic, thermal-vacuum, and EMC. Environmental testing may or may not be combined with functional testing depending on the test objectives.

4.4.3 Proof and Leak Tests

Proof tests are performed above the operational limit design loads, pressure, and cycles to show structural integrity of the component, system, or assembly. The proof test should screen out parts with critical flaws and will provide confidence that a part will meet the design service life. Leak tests are performed at the maximum operational limit design pressure to show structural integrity of the component, system, or assembly, prior to and post proof pressure tests. The Leak test should screen out parts with critical flaws and will provide confidence that a part will meet the design service life.

4.4.4 Similarity Assessment

Verification by similarity is the process of assessing by review of prior test data or hardware configuration and application that the article is similar or identical in design and manufacturing process to another article that has previously been qualified to equivalent or more stringent specifications.

4.4.5 Analysis Assessment

Verification by analysis is a process used in lieu of or in addition to testing to verify compliance to specification requirements. The selected techniques may typically include systems engineering analysis, statistics and qualitative analysis, computer simulations, and modeling. Analysis may be used in lieu of test when it can be determined that:

1. Rigorous and accurate analysis is possible
2. Test is not cost-effective

3. Similarity is not applicable
4. Verification by inspection is not adequate.

4.4.6 Inspection Assessment

Verification by inspection (e.g., physical verification of compliance with drawings, wire coding, material compliance, fracture control maximum initial flaw size, etc.) is a process which may be used in lieu of or in conjunction with testing to verify design features.

4.4.7 Demonstration Assessment

Validation by demonstration is the process by which demonstration techniques (e.g., service access, transportability, crew-hardware interfaces, replacement provisions) are used in lieu of or in conjunction with tests to verify compliance with the requirements (i.e., neutral buoyancy simulation testing).

4.4.8 Validation of Records Assessment

Verification by validation of records is the process by which manufacturing records are used at end-item acceptance to verify construction features and processes for flight hardware.

4.5 VERIFICATION LEVELS

Verification levels identify discrete verification activities. Acceptance verification will normally be at the highest possible level such as the system or integrated SSE levels.

4.5.1 Component Level

The component level is defined as the hardware level within a subsystem or system where end item verification is first applied. A component is a functional unit such as an electronics box.

4.5.2 Subsystem Level

A subsystem is a functional subdivision of a spacecraft generally composed of two or more components designed to perform an operation such as an electrical system or control system. Both qualification and acceptance verifications may be performed on flight and flight-configured systems.

4.5.3 System Level

The system level is defined as the contracted end item level and includes the FSS, ORUC, RAC, MULE, SAC, ACS, HST486, FGS, SA3, RSU, ECU, PCU, NCS, ASCS, CATS, HST, Orbiter, etc. SCN 002

4.5.4 Integrated System Level

The integrated level includes SSE and ORU systems utilized in the Orbiter cargo bay. Verification at this level ensures the functional capability of the SSE to enable flight personnel to accomplish all the HST mission support functions. Verification at this level also ensures compatibility among the various elements of the SSE, Orbiter GFE, and HST-mounted crew systems hardware as well as the compatibility of SSE and ORUs relative to the HST and the Orbiter. Interface simulators will be utilized when actual mating with flight hardware is not possible or practical.

4.6 VERIFICATION TYPES

Verification types are development, qualification, and acceptance. Development is only required on selected items of hardware (i.e., ORUs) whereas qualification and acceptance will be required on all SM flight hardware. When an item such as the FSS has been previously qualified and flown, a joint qualification and acceptance by similarity is possible. The test types listed chronologically are component, element, and integrated system.

4.6.1 Development Verification

Development verification is the process used to verify the feasibility of the design approach and to provide confidence in the ability of the hardware and EVA tasks to comply with performance criteria.

4.6.2 Qualification Verification

Qualification verification is an individual or series of functional and environmental tests conducted on flight-configured hardware at conditions normally more severe than those expected during ground handling, launch, and mission operations to establish that the hardware will perform satisfactorily in the flight environment with sufficient margin. The flight-configured hardware can consist of prototype, protoflight, or flight hardware. The SSE shall be qualified prior to configuration inspection.

4.6.3 Acceptance Verification

Acceptance verification is an individual or series of functional and environmental tests conducted on flight hardware at

conditions equal to design specification to establish that the hardware is acceptable for flight.

4.6.4 Protoflight Verification

Protoflight verification is an individual or series of functional and environmental tests conducted on flight hardware at qualification levels and at acceptance test durations. Protoflight testing establishes that the flight hardware will perform satisfactorily in the flight environment with sufficient margin.

4.7 REQUIREMENTS ALLOCATION/TRACEABILITY MATRIX

The requirements allocation/traceability matrix for this Level III document is shown in Appendix C. Each design requirement specified in Section 3 is identified in the matrix. The matrix provides a summary of the flowdown of requirements from Level II to Level III, as well as the applicability of the requirement to SM elements (Hardware and technical responsibility). The main body of this document shall take precedence over Appendix C in the resolution of discrepancies.

4.8 VERIFICATION FACILITIES AND EQUIPMENT

Existing facilities and equipment shall be utilized to the maximum extent practicable. Maximize the usage of the same test equipment at multiple locations to ensure uniformity of test results. All test equipment shall be verified prior to interfacing with flight equipment to prevent induced damage or degradation to flight hardware.

Servicing mission test facilities include:

Allied Signal	RSU & ECU
Ball Aerospace Group	ACS
Creare	NCC
European Space Agency	SADM, SA3 Wing
Goddard Space Flight Center	ACS, SA3, DBA2, ASCS, NCS, RWA, SSR, SSE Items, and MLI; Bldgs. 7, 10, 15 and 29
Hughes Danbury Optical Systems	FGS
Jackson & Tull	HST486
Johnson Space Center	Crew familiarization and training
Kennedy Space Center	Hangar AE, Orbiter Processing Facility (OPF), Payload Hazardous Payload Servicing Facility, Vertical Processing Facility (VPF), Payload Changeout Room (PCR)
Lockheed Martin Missiles & Space	SA3 Panels, PCU

SCN 002

SCN 002

Lockheed Martin Center for Power and Communications (CPC)	NCC	SCN 002
Swales and Associates	CATs	

4.9 SM HARDWARE REQUIREMENTS

Government acceptance of the SM Hardware shall be in accordance with the requirements specified in its contract end item specification. Acceptance shall include as applicable, analysis, inspection, test, or a combination of these to verify that the hardware conforms to its design and meets the performance and physical requirements. Acceptance shall be performed at the component, element, or integrated system level. Inspection shall be the preferred method of verification when this method can demonstrate compliance with requirements. Quality assurance inspection shall verify that hardware is built to requirements, physical dimensions and acceptable workmanship standards.

Appendix A
HST Level III Flight Systems
and
Servicing Project SM3A
Specific Requirements

A.1. SCOPE

This appendix to STR-81 is intended to specify the objectives and requirements which are mission specific to the SM3A part of the Third Servicing Mission. All requirements defined in the core segment of this document for SM3 are applicable to SM3A unless otherwise specified here in this appendix.

The outline of this appendix is keyed, by paragraph number, to the core segment. Core topics which do not require SM3A unique delineation are omitted in this appendix.

The SM3A mission is the first of a two part Servicing Mission (SM) to satisfy the requirements as defined by the Level I and II requirements documents and shall be planned and executed to meet the objectives stated in Section 1.2 of STR-80.

Figure A-1 describes the SM3A Requirements Documentation Flowdown and is provided for information only.

A.3 REQUIREMENTS

A.3.1.1 MISSION DESCRIPTION

The SM3A Hardware shall support the HST SM3A up to or below the maximum retrieval orbital altitude of 324 nmi with a 28.5 degree inclination. Reboost is not required during SM3A. There is no requirement for re-rendezvous after deployment. There is no requirement to return the HST to the ground during SM3A. The SM3A Carriers, the Flight Support System (FSS) and Orbital Replacement Unit Carrier (ORUC), shall carry a complement of ORUs and other designated HST equipment to the HST for on-orbit servicing.

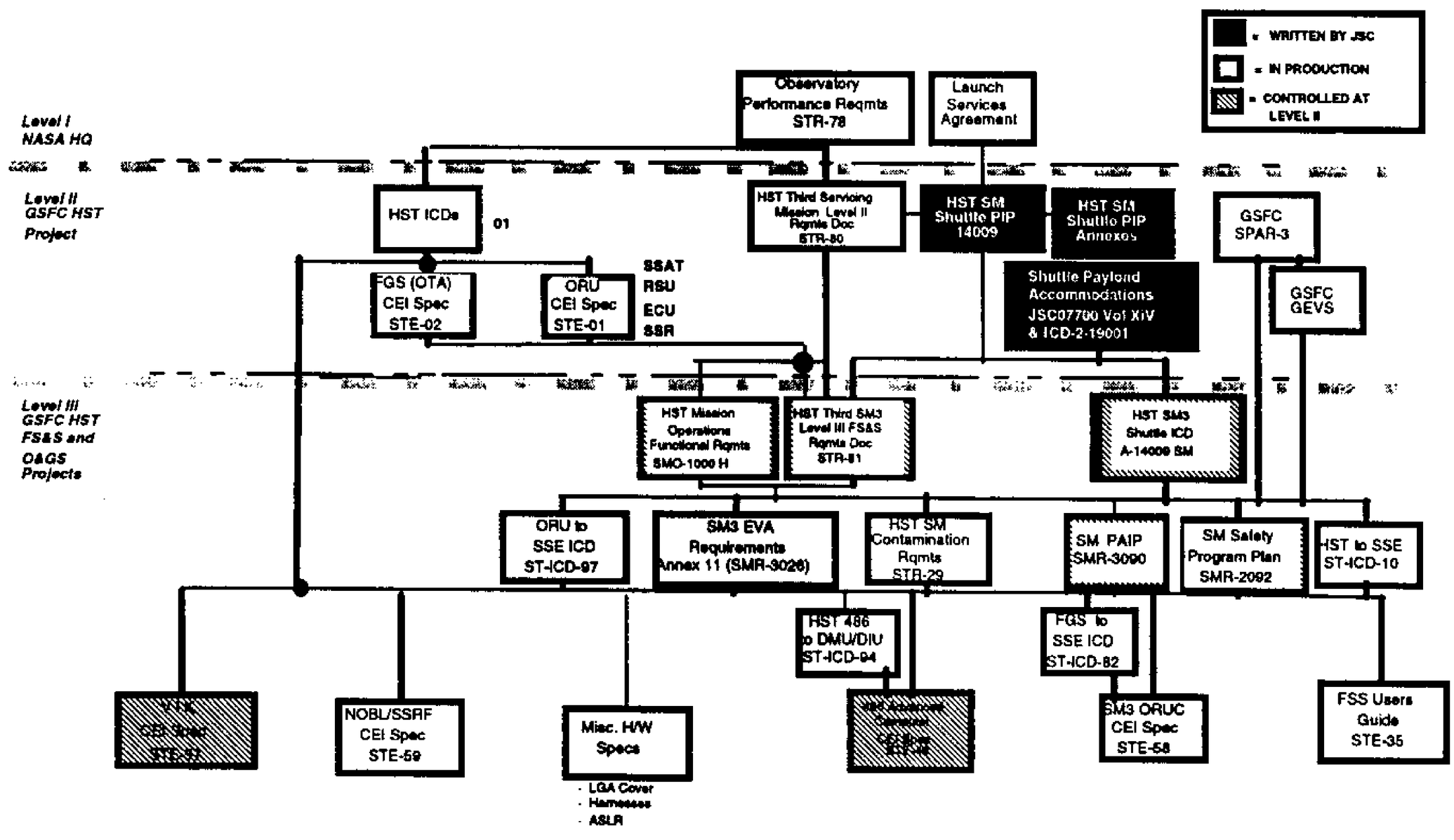

Figure A-1 HST SM3A Mission Requirements Flowdown

During Extra Vehicular Activity (EVA), new ORUs will be installed into HST and the changeout ORUs will be removed from the HST and stowed for Earth return by EVA crew members. EVA activities will also include installation of the New Outer Blanket Layer/Shield Shell Replacement Fabric (NOBL/SSRF).

A.3.1.2 SM3A OBJECTIVES

The first objective is not applicable to SM3A.

The SM3A spacecraft elements which satisfy the second objective are FGS-2R, HST486 and Y harness, RSU-1R, RSU-2R, RSU-3R, SSR-3, VIK, NOBL and the SSAT.

The third objective for SM3A is to vent the NICMOS cooling loop, in preparation for installing the NCS during SM3B, by removing the NICMOS bayonet covers and opening the NICMOS cooling line valves.

The fourth objective is not applicable to SM3A.

The following elements shall be carried to support unplanned activities during the mission: two each of contingency PDU P15, P16, and P17 FPAs; contingency P25, P26, P27A and P28A OTA FMAs; one spare RSU, one contingency ECU, one spare HST486 and Y harness, two spare VIKs, and contingency SSRFs. Additionally, contingency hardware and tooling shall be identified and carried to ensure mission success; this shall include eight solar array bistem brace kits and ten ASLR mechanism assemblies.

The requirements for the above Spacecraft Hardware are found in Section 3.2 of the core document. The changeout priority of the hardware is defined in STR-80 (HST SM3 Level II Requirements), Table 1-2, SM3A Priorities.

SSE that services HST during the SM3A mission includes the FSS, the ORUC, which includes two (one radial and one axial) SIPEs and OPEs.

A.3.3 SERVICING MISSION SUPPORT REQUIREMENTS

A.3.3.1 MISSION PLANNING

A.3.3.1.6 Solar Array Configuration.

Not applicable to SM3A.

A.3.4 SERVICING SUPPORT EQUIPMENT REQUIREMENTS

A.3.4.2 Space Support Equipment

The Axial SIPE requirement to support an axial SI with Optical Telescope Assembly (OTA) Axial bay 1 and 3 latch provisions is not applicable to SM3A. The ASIPE for SM3A shall be configured to provide a shelf to carry contingency hardware for the mission.

A.3.4.4.1 Total FSS Electrical Load. The total load served through the FSS shall not exceed the com-bined power allocation at the FSS Umbilical and the Orbiter-to-FSS Standard Interface Panel (SIP), as identified in Table A-1.

Table A-1 Power Allocation Limits

HST SM3A POWER ALLOCATIONS		
Payload Component	Interface Location(s)	Power Allocation (Watts)
Total P/L: HST Attached: Peak Max. Cont. HST Not Attached: Peak Max. Cont.	Orbiter SIPs (P/L Pri Bus)	 6400 6100 2400 1800
HST: HST Attached: Peak HST Not Attached: Peak	FSS Umbilical	 2900 0
FSS: HST Attached: Peak HST Not Attached: Peak	Orbiter-to-FSS SIP (FSS Heaters + Avionics + DPC Overhead)	 370[1] 1170[1]
ORUC: Peak	FSS-to ORUC SIP	 1840[2]

Notes:

1. 32.0 volts at interface location.
2. 32.0 volts at Orbiter-to-FSS SIP

A.3.4.4.5 Power Allocation, Minimum Voltage, and Energy Limits. Tables A-1 and A-2 summarize the servicing mission power allocation and the voltage limits, respectively, at the interface of major payload components. The total energy allocation, including AC power loads, for the SM3A is shown in Table A-3.

A.3.5 DESIGN AND CONSTRUCTION

A.3.5.1.1 Mass Properties. The mass properties for the Hubble Space Telescope are defined in ST/SE-04.

The weight of all payload-chargeable SSE and ORUs shall not exceed the total weight limit in Table A-4, and margins shall be maintained in accordance with the "SM3 Weight Control Plan," SMR-3091.

A.3.5.1.1.1 Contract End Item Weight Allocation. Hardware weight allocations are shown in Table A-4. These values shall be considered as not-to-exceed weights and shall be used as design criteria for the SSE and ORUs. The ORUC weights allocations include Government Furnished Equipment (GFE) latch hardware.

Table A-2 Voltage Limits

HST SERVICING MISSION 3A VOLTAGE LIMITS			
Payload Component	Interface Location	Volts- Minimum	Volts- Maximum
HST:	FSS Umbilical		
Main Bus:		32.1[1]/31.0[2]	35.0[3]/33.8[4]
Ess Bus:		29.0[2]	32.3[5]
FSS:	Orbiter-to-FSS SIP		
HST Attached:		24.9[6]	32.0
HST Not Attached:		24.7[6]	32.0
FSS DPC:	DPC Input	24.0	32.0
FSS FMDM:	FMDM Input	24.0	32.0
ORUC:	ORUC Htrs Input	26.0/21.8[7]	32.0 @ Orbiter-to-FSS SIP

Notes:

1. Protects Battery Discharge Limit with 85 amps on Main Bus (requires DPC regulation voltage of 34.7 volts).
2. Ensures sufficient DPC rollover margin with 118 amp (maximum DPC capability) load on Main Bus and 40 watt load on Essential Bus.
3. Protects Main Bus Survival Limit with no load on Main Bus.
4. Protects Main Bus Operating Limit with 25 amp (minimum) load on Main Bus.
5. Protects Essential Bus Operating Limit with no load on Main Bus (requires 3 series diodes on Essential Bus service).
6. Based on End-of-Life (EOL) Fuel Cell performance at the peak power allocation.
7. 26.0 volts is the nominal orbital average minimum voltage. Worst-case minimum transient voltage at peak load is 21.8 volts.

Table A-3 Electrical Energy Limits

HST SERVICING MISSION 3A TOTAL ENERGY		
Item	Control Authority	Total Energy
Total Energy	PIP 14009	600 kWH

Table A-4 Weight Allocation for SM3A Hardware

SM3A HARDWARE	ALLOCATION (lbs)
ORUC	
ORUC Structure + Anc.	6350
FGS[1] + Handhold	510
ORUs	605
ORUC Total	7465
FSS	
FSS Structure + Anc.	4625
FSS Total	4625
Misc (Middeck and Tool Stowage Assembly)	185
PROJECT RESERVE	1725
SM3A MISSION TOTAL	14000

Notes:

1. The capability to carry an ASIPE shelf or equivalent mass simulator, due to load isolation system design, is required.

A.4.7 REQUIREMENTS ALLOCATION/TRACEABILITY MATRIX

The requirements allocation/traceability for SM3A shall be derived from the requirement allocation/traceability matrix for the core document provided in Appendix C. This derivation shall be based on the SM3A unique hardware and system requirements identified in this appendix and the applicable requirements of the core document.

Appendix B
HST Level III Flight Systems
and
Servicing Project SM3B
Specific Requirements

SCN 002

B.1. SCOPE

This appendix to STR-81 is intended to specify the objectives and requirements which are mission specific to the SM3B part of the Third Servicing Mission. All requirements defined in the core segment of this document for SM3 are applicable to SM3B unless otherwise specified here in this appendix.

The outline of this appendix is keyed, by paragraph number, to the core segment. Core topics which do not require SM3B unique delineation are omitted in this appendix.

The SM3B mission is the second of a two part Servicing Mission to satisfy the requirements as defined by the Level I and II requirements documents and shall be planned and executed to meet the objectives stated in Section 1.2 of STR-80.

Figure B-1 describes the SM3B Requirements Documentation Flow-down and is provided for information only.

B.3 REQUIREMENTS

B.3.1.1 MISSION DESCRIPTION.

The SM3B Hardware shall support the HST SM3B up to or below the maximum retrieval orbital altitude defined in STR-80 with a 28.5 degree inclination. Reboost is not required but is highly de- SCN 004
sired during SM3B. There is no requirement for re-rendezvous after deployment. There is no requirement to return the HST to the ground during SM3B. The SM3B Carriers, the FSS, the RAC, the

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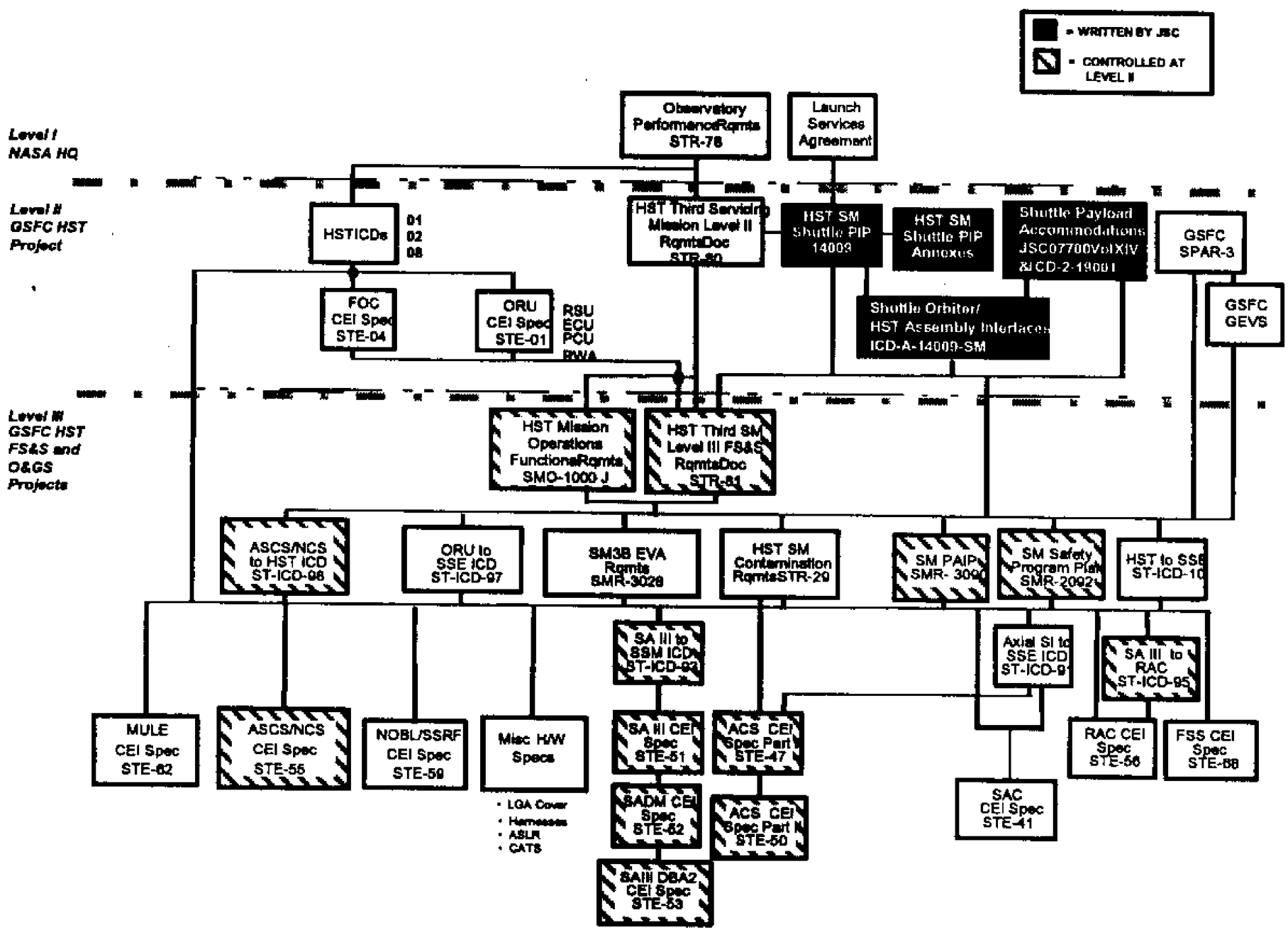

SCN 004

SCN 004

Figure B-1 HST SM3B Mission Requirements Flowdown

SCN 002, 004

SAC and the MULE shall carry a complement of ORUs and other designated HST equipment to the HST for on-orbit servicing.

During EVA, new ORUs will be installed into HST and the changeout ORUs will be removed and stowed for Earth return by EVA crew members. EVA activities will also include installation of the remaining segments of the NOBL originally intended for installation during SM3A.

B.3.1.2 SM3B OBJECTIVES

The first objective for SM3B will be met by the replacement of the FOC with the ACS in HST axial bay #3.

The second objective for SM3B will be satisfied by the replacement of the RWA-1R, PCU, SA3 and DBA2, and the PDU-2 P16R FPA, the installation of the remaining NOBLs, and on a time-available basis the replacement of RSU-3R (in orbit since SM3A). SCN 004

The third objective for SM3B will be fulfilled by the installation of the NCS including the ESM.

The fourth objective for SM3B, to increase the orbit altitude, is a goal as indicated in section B3.1.1 above.

The following elements shall be carried to support unplanned activities during the mission: two each of contingency PDU P15, P16, and P17 FPAs; contingency P25, P26, P27A and P28A OTA FMAs; one each contingency RSU and ECU; and one spare DBA2 and two

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spare SADA manacle clamps. Additionally, contingency hardware and tooling shall be identified and carried to ensure mission success; this shall include four solar array bistem brace kits,

eight ASLR mechanism assemblies, and hand rail covers, harnesses and MLI patches as needed.

The requirements for the above Spacecraft Hardware are found in Section 3.2 of the core document. The changeout priority of the hardware is defined in STR-80 (HST SM3 Level II Requirements), Table 1-3, SM3B Priorities.

SSE that services HST during the SM3B mission includes the FSS, the SAC with one axial SIPE, the RAC, the MULE and OPEs.

B.3.3 SERVICING MISSION SUPPORT REQUIREMENTS

B.3.3.1 MISSION PLANNING

B.3.3.1.6 Solar Array Configuration.
Planning for SA changeout shall take into consideration hardware conditions observed during previous missions.

B.3.4 SERVICING SUPPORT EQUIPMENT REQUIREMENTS

B.3.4.4.1 Total FSS Electrical Load. The total load served through the FSS shall not exceed the combined power allocation at the FSS Umbilical and the orbiter-to-FSS SIP as identified in Table B-1.

B.3.4.4.5 Power Allocation, Minimum Voltage, and Energy Limits. Tables B-1 and B-2 summarize the servicing mission power allocation and the voltage limits, respectively, at the interface of major payload components. The total energy allocation, including AC power loads, for the SM3B is shown in Table B-3.

Table B-1 Power Allocation Limits

HST SM3B POWER ALLOCATIONS		
Payload Component	Interface Location(s)	Power Allocation (Watts)
Total P/L: HST Attached: Peak Max. Cont. HST Not Attached: Peak Max. Cont.	Orbiter SIPs (P/L Pri Bus)	 6400 6100 3400 2800
HST: HST Attached: Peak	FSS Umbilical	3220 W @ 100 Amp
FSS: HST Attached: Peak HST Not Attached: Peak	Orbiter-to-FSS SIP (FSS Heaters + Avionics + DPC/HST)	4320[1] 975[1]
SAC: HST Attached: Peak HST Not Attached: Peak	Orbiter-to SAC SIP(SAC Heaters + Avionics)	825[2] 1100[2]
MULE: HST Attached: Peak HST Not Attached: Peak	Orbiter-to MULE SIP(MULE Heaters + Avionics)	975[2] 1300[2]

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Notes:

1. Consists of 235 W FSS power, 50 W PCU (PPCU and SPCU) dissipation and 4035 W DPC input (based on 100 Amp output @ 34.7 V and 86% efficiency).
2. 32.0 volts at Orbiter-to-SSE SIP

SCN 003

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Table B-2 Voltage Limits

HST SERVICING MISSION 3B VOLTAGE LIMITS			
Payload Component	Interface Location	Volts- Minimum	Volts- Maximum
HST: Main Bus: Ess Bus:	FSS Umbilical	 32.1[1]/31.0[2] 29.0[2]	 35.0[3]/33.8[4] 32.3[5]
FSS: HST Attached: HST Not Attached:	Orbiter-to-FSS SIP FSS SIP	 24.9[6] 24.7[6]	 32.0 32.0
FSS DPC:	DPC Input	24.0	32.0
FSS/MULE FMDM:	FMDM Input	24.5[7]	32.0
SAC:	Orbiter - to-SAC SIP	24.9[8]	32.0
MULE:	Orbiter - to-MULE SIP	24.7[9]	32.0

Notes:

1. Protects Battery Discharge Limit with 85 amps on Main Bus (requires DPC regulation voltage of 34.7 volts).
2. Ensures sufficient DPC rollover margin with 118 amp (maximum DPC capability) load on Main Bus and 40 watt load on Essential Bus.
3. Protects Main Bus Survival Limit with no load on Main Bus.
4. Protects Main Bus Operating Limit with 25 amp (minimum) load on Main Bus.
5. Protects Essential Bus Operating Limit with no load on Main Bus (requires 3 series diodes on Essential Bus service).
6. Based on End-of-Life (EOL) Fuel Cell performance at the peak power allocation.

7. Provides 0.5 V margin against FMDM shutdown voltage of 24.0.
8. Protects 24.0 volt SAC minimum design voltage at peak load. SCN 003
9. Protects MULE minimum design voltage at peak loads.

Table B-3 Electrical Energy Limits

HST SERVICING MISSION 3B TOTAL ENERGY		
Item	Control Authority	Total Energy
Total Energy	PIP 14009	600 kWH

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B.3.5 DESIGN AND CONSTRUCTION

B.3.5.1.1 Mass Properties. The mass properties for the Hubble Space Telescope are defined in ST/SE-04.

The weight of all payload-chargeable SSE and ORUs shall not exceed the total weight limit in Table B-4, and margins shall be maintained in accordance with the "SM3 Weight Control Plan," SMR-3091.

B.3.5.1.1.1 Contract End Item Weight Allocation. Hardware weight allocations are shown in Table B-4. These values shall be considered as not-to-exceed weights and shall be used as design criteria for the SSE and ORUs. The SSE weight allocations include Government Furnished Equipment (GFE) latch hardware.

B.3.5.2.2 Contamination Monitoring. The on-orbit contamination environment in the ASIPE shall be passively monitored during the servicing mission. The active contamination instrumentation (Contamination Environmental Package - CEP) flown on previous servicing missions is not required for SM3B. SCN 004

B.4.7 REQUIREMENTS ALLOCATION/TRACEABILITY MATRIX

The requirements allocation/traceability for SM3B shall be derived from the requirement allocation/traceability matrix for the core document provided in Appendix C. This derivation shall be based on the SM3B unique hardware and system requirements identified in this appendix and the applicable requirements of the core document.

SCN 002

Table B-4 Weight Allocation for SM3B Hardware

SM3B HARDWARE	ALLOCATION (lbs)
FSS FSS Structure + Anc. ORUs	4900
RAC RAC Structure + Anc. SA3 ORUs	5450
SAC SAC Structure + Anc. ACS ORUs	5600
MULE MULE Structure + Anc. ORUs	3300
Misc (Middeck and Tool Stowage Assembly)	250
SM3B MISSION TOTAL	19500

Appendix C

Third Servicing Mission

Requirements Allocation/

Traceability Matrix

C.1 SCOPE

Table C-1 Third Servicing Mission Requirements Allocation/ Traceability Matrix provides a summary of the flow down of requirements from Level II to Level III as well as the applicability of requirements to SM elements. Column 1 in the matrix identifies the paragraph numbers in the Level II document (STR-80) from which the Level III requirements are derived from. Column 2 and 3 show the paragraph number and description of Level III requirements as given in STR-81. The remaining columns in the matrix identify the SM3 hardware or system element(s) to which each requirement is allocated to.

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION													
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	SCN 002
	3.1	SERVICING MISSION REQUIREMENTS The planning and operation of the mission, as specified herein, shall ensure to the maximum possible extent that no degradation to flight hardware occurs, including cases with HST appendages deployed.											X	X		
1.2 3.3.1	3.1.1	Mission Description The SM Hardware shall support the HST SM3A and SM3B parts of the mission at the maximum retrieval orbital altitudes specified in Appendices A and B respectively with a 28.5 degree inclination. Reboost to a higher orbit is not required during SM3A or SM3B, but is desired during SM3B. There is no requirement for re-rendezvous after deployment. There is no requirement to return the HST to the ground during SM3. The objectives of the SM3 are stated in Paragraph 1.2 of the Hubble Space Telescope Third Servicing Mission Level II Requirements, STR-80.											X	X		
1.2	3.1.1	Mission Description The SM3 Carriers, Flight Support System (FSS), Orbital Replacement Unit Carrier (ORUC), Rigid Array Carrier (RAC), Second Axial Carrier (SAC), and Multi-Use Light-weight Equipment (MULE) Carrier, composed of a Upper Atmosphere Research Satellite (UARS) Avionics and Support Electronics (UASE) cradle, shall carry a complement of ORUs and other designated HST equipment to the HST for on-orbit servicing. During Extra-Vehicular Activity (EVA), new ORUs will be installed into HST and the changeout ORUs will be removed from the HST and stowed for Earth return by EVA crew members. EVA activities will also include installation of the NICMOS Cooling System (NCS) including the Electronics Support Module (ESM), and the New Outer Blanket Layer (NOBL).											X	X		SCN 002

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION													
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	SCN 002
1.2	3.1.2-1	SM Objectives SM3 has four Level II objectives which must be satisfied. The first objective is to provide an enhanced Orbital Replacement Instrument (ORI) that will satisfy the HST Level I Requirements. The servicing element which satisfies this objective is the Advanced Camera for Surveys (ACS). ACS shall replace the Faint Object Camera (FOC) in the (-V2, -V3) axial bay of the HST aft shroud.		X												
1.2	3.1.2-2	SM Objectives The second objective is to replace certain failed or malfunctioning ORUs and upgrade other ORUs with new technology units to enhance the reliability and ensure the long term scientific productivity of the HST. These replacement units shall maintain the operational capability and redundancy required by Level I. For ORUs where parts are no longer available or if the state of the art technologies make improvements cost effective and technically feasible, those enhancements may be made. The spacecraft elements which satisfy this objective are Fine Guidance Sensor-2 replacement (FGS-2R), Advanced Computer (HST486) and Y harness, Third Solar Array (SA3) including the SA3 Diode Boxes (DBA2), Rate Sensor Units (RSU-1R), (RSU-2R) and (RSU-3R), Solid State Recorder (SSR-3), Voltage/ Temperature Improvement Kit (VIK), the Power Control Unit (PCU), the New Outer Blanket Layer and Shield/Shell Replacement Fabric (NOBL/SSRF), the S-Band Single Access Transmitter (SSAT), the Reaction Wheel Assembly-1 (RWA-1R), the PDU-2 P16R Fuse Plug Assembly (FPA), which will replace the existing FPA as part of the PCU change-out, and nominally 6 handrail contamination covers and three door knob contamination covers.			X	X										SCN 002, 004

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	
1.2	3.1.2-3	SM Objectives The third objective of SM3 is to restore the scientific capability of the HST at near-infrared wavelengths. The servicing element which satisfies this objective is the Near Infrared Camera and Multi-Object Spectrometer (NICMOS) Cooling System (NCS) which will be installed during SM3B. The ESM which houses the electronics for the NCS (and the Aft Shroud Cooling System intended for SM4) and a sensor to monitor and trend the aft shroud pressure environment will also be installed during SM3B. In preparation for NCS installation, the NICMOS cooling line valves will be opened during SM3A.			X											SCN 002
1.2 3.3.1	3.1.2-4	SM Objectives The fourth objective of SM3 is to increase the orbit altitude of HST as much as Space Transportation System (STS) propellant reserves permit, so that orbit decay will not constrain science operations or shorten mission life below Level I requirements. The goal (to be achieved during SM3B) is a post-deployment HST orbit that is energy equivalent to a circular orbit with a mean altitude as specified in Appendix B.											X	X		
1.2 3.0	3.1.2-5	SM Objectives. A subset of the following elements as specified in Appendices A and B respectively for SM3A and SM3B shall be carried to support unplanned activities during each mission: two each of contingency Power Distribution Unit (PDU) P15, P16, and P17 Fuse Plug Assemblies (FPAs); contingency P25, P26, P27A and P28A Optical Telescope Assembly (OTA) Fuse Module Assemblies (FMAs); one spare/contingency RSU, one contingency ECU, one spare 486 and Y harness, one spare DBA2, two spare SADA manacle clamps and two spare VIKs. Additionally, contingency hardware and tooling shall be identified and carried to ensure mission success; this shall include eight solar array bistem brace kits and Aft Shroud Latch Repair (ASLR) mechanism assemblies as defined in Appendices A and B.					X									SCN 002
1.2 3.1.1 3.1.2	3.1.2-6	SM Objectives. The requirements for the above Spacecraft Hardware are found in Section 3.2. The changeout priority of the hardware is defined in STR-80 (HST SM3 Level II Requirements), Table 1-2 Servicing Mission Priorities.		X	X	X	X									

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION													SCN 002
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	
3.3.7	3.1.2-7	SM Objectives. The SSE consists of those hardware items that are mounted on, stowed on, and transported by the Orbiter for on-orbit servicing of the HST with ORUs. The SSE will provide environmental protection for ORUs during pre-launch, launch, on-orbit servicing, return, and post-landing. SSE that services HST includes: the Flight Support System (FSS); the Orbital Replacement Unit Carrier (ORUC), which includes two (one radial and one axial) Scientific Instrument Protective Enclosures (SIPEs) and ORU Protective Enclosure(s) (OPEs); the Rigid Array Carrier (RAC); the Second Axial Carrier (SAC) which includes one axial SIPE and OPEs; and the MULE. Crew Aids and Tools will aid the crew in the removal, temporary storage (parking), translation, and installation activities associated with HST servicing. The requirements for the SSE and CATS are found in Section 3.4.						X	X	X	X	X			X	SCN 002
3.1.1 3.1.2 3.3.7	3.1.2-8	SM Objectives. Section 3.5 contains design and construction requirements for SM hardware.		X	X	X	X	X	X	X	X	X			X	
3.1.2.1	3.2	SERVICED SPACECRAFT HARDWARE PERFORMANCE REQUIREMENTS The performance requirements for the new science instruments shall satisfy the specifications in this section assuming the following image stability while under Fine Guidance System (FGS) control and guiding in fine lock:		X												
3.1.2.1-a	3.2-1a	SERVICED SPACECRAFT HARDWARE PERFORMANCE REQUIREMENTS a. Line of sight instrument image motion delivered by the OTA due to all causes shall be less than 0.007 arc sec r.m.s. over a period of 24 hours.		X												
3.1.2.1-b	3.2-1b	SERVICED SPACECRAFT HARDWARE PERFORMANCE REQUIREMENTS b. A time average of 60 seconds focal plane line-of-sight jitter shall be: less than or equal to 0.007 arc sec for no less than 95% of any given orbit and less than or equal to 0.012 arc sec for no less than 100% of any given orbit.		X												
3.1.2.1-c	3.2-1c	SERVICED SPACECRAFT HARDWARE PERFORMANCE REQUIREMENTS c. A loss of fine lock shall occur, on average, no more often than one out of 15 orbits.		X												

SCN 002

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION												
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC
3.	3.2-2	SERVICED SPACECRAFT HARDWARE PERFORMANCE REQUIREMENTS ORUs to be installed in the HST shall meet or exceed the performance requirements of the hardware to be replaced. When possible, replacement hardware shall include up-grades necessary to provide protection against failure modes/degraded performance realized on-orbit. All replacement hardware connectors shall be compatible with the orientation and configuration of the connectors on the existing hardware. Provisions shall be made to protect connectors to ensure that ORUs are not damaged during launch, on-orbit operations, and landing. If the potential exists for leakage of working fluids from ORUs to the S/C volume, provisions shall be made to monitor the pressure rise inside the AS and to ensure the safety of SIs against high voltage arcing.	X		X	X	X								
3.1.2.1	3.2.1.1	Advanced Camera for Surveys Requirements. The Advanced Camera for Surveys (ACS) is an advanced science instru-ment camera with greater capability than the first or second generation HST scientific instruments. It will take full advantage of the available HST image quality with improved throughput, field of view, sampling, and red rejection in the far ultraviolet. The ACS replaces the HST's first generation FOC. The ACS shall meet the requirements stated in the "Hubble Space Telescope Advanced Camera Contract End Item (Part I)", STE-47.		X											

Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix

Lev II STR-80 Para	Lev III STR-81 Para	Requirement Statement	SM3 HARDWARE ALLOCATION												
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC
3.1.2	3.2.1.2	HST486 Requirements. The HST486 incorporates advance semi-conductor technology to support the additional computational requirements of STIS, NICMOS, and the growth which will occur because of ACS and Vision 2000. Vision 2000 is a development project intended to auto-mate HST operations. The HST486 replaces and extends the capabilities of HST's DF-224 and Coprocessor computer. The HST486 shall meet the interface controls defined in the "Hubble Space Telescope HST486 Computer to Data Management Unit and Data Interface Units Interface Control Document," ST-ICD-94 and "Hubble Space Telescope HST486 Computer Functional Interface Document," SDM-1030. The HST486 shall meet the requirements stated in the "Hubble Space Telescope HST486 Contract End Item (CEI) Specification," STE-49. In addition, a Y harness which provides HST heater power as backup volatile memory power shall meet the requirements stated in STE-65, "HST SM Harness Extension Assemblies Requirements Specification".				X									
3.1.2	3.2.1.3	Fine Guidance Sensor Requirements. The replacement FGS shall meet the requirements stated in ST-ICD-01, STE-02, and STR-01. This FGS shall replace FGS-2 in the +V3 radial bay. The refurbishment of the FGS and its compatibility with the HST PCS shall not prevent the HST from meeting the image motion requirements stated in paragraphs a and b of section 3.2. The Optical Control Electronics (OCE) Enhancement Kit (OCE-EK) installed during SM2 in the OTA Equipment Section Bay C shall be reconfigured by connecting the OCE-EK cables identified as P11A/J11A in line with the OCE P11 to HST J11 connectors.				X									

SCN 002

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION												
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC
3.1.2	3.2.1.4	Third Solar Array, Diode Box, and SADM Requirements. The SA3 shall meet the interface controls defined in the "Level II Interface Control Document Third Solar Array to Support Systems Module," ST-ICD-93 and "HST Third Solar Array Contract End Item Specification, Part 1," STE-51. The design of the SA3 and its compatibility with the HST PCS shall not prevent the HST from meeting the image motion requirements stated in paragraphs a, b, and c of section 3.2. The DBA2 shall meet the requirements stated in the "Solar Array 3 Diode Box Assembly Contract End Item (CEI) Specification," STE-53. The Solar Array Drive Mechanism shall meet the requirements stated in the "Third Solar Array Drive Mechanism (SADM) Contract End Item Specification,"STE-52.				X								
3.1.2	3.2.1.5	Rate Sensing Unit Requirements. The RSU shall meet the requirements stated in "Rate Gyro Assembly Specification", LMSC 4171761 and ST-ICD-01.				X									
3.1.2	3.2.1.6	NICMOS Cooling System (NCS) Requirements. The NICMOS Cooling System shall meet the interface controls defined in "Aft Shroud Cooling System to Axial Scientific Instrument and Support Systems Module (SSM) Interface Control Document," ST-ICD-98. The NCS shall meet the requirements stated in "Hubble Space Telescope Aft Shroud Cooling System Contract End Item Specification," STE-55. The design of the NCS and its compatibility with the HST PCS shall not prevent the HST from meeting the image motion requirements stated in paragraphs a, b, and c of Section 3.2.			X									

SCN 002

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION													
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	SCN 002
3.1.2	3.2.1.7	Aft Shroud Cooling System (ASCS) Requirements. (Deleted)														SCN 002
3.1.2	3.2.1.8	New Outer Blanket Layer (NOBL) and Shield/Shell Replacement Fabric (SSRF) Requirements. The NOBL/SSRF shall meet the requirements stated in the "Hubble Space Telescope (HST) New Outer Blanket Layer (NOBL) Shield/ Shell Replacement Fabric (SSRF) Contract End Item Specification," STE-59. The Bay #1 NOBL shall be added to maintain the Data Management Unit, without additional heater support, at temperatures within ±5 degree C of the on-orbit operating temperature extremes experienced during normal and software safemode operations between launch and SM3. The Bay #1 NOBL shall only be installed in conjunction with the HST 486 Computer.				X										
3.1.1	3.2.1.9	Solid State Recorder (SSR) Requirements. The replacement SSR shall meet the requirements stated in "Solid State Recorder Contract End Item Specification" STE-48" and the system performance requirements specified in "Solid State Recorder Requirements Document, STR-76.				X										
3.1.1	3.2.1.10	S-Band Single Access Transmitter. The SSAT-2R shall meet the requirements specified in LMSC 4171870, Space Teles-cope S-band Single Access Transmitter Specification.				X										
3.1.2	3.2.1.11	V/T Improvement Kit. The VIK shall meet the requirements of STE-57 Voltage/Temperature Improvement Kit CEI Specification.				X										

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION													
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	SCN 002
3.1.1	3.2.1.12	Power Control Unit. The PCU shall meet the requirements of LMSC 4172016, Engineering Critical Component Specification, Power Control Unit and ST-ICD-01.				X									X	SCN 002
3.1.1	3.2.1.13	PDU-2 P16 Fuse Plug Assembly Requirements. Fuses to be used in the PDU power distribution circuits shall meet the circuit protection requirements of ST-ICD-01, ST-ICD-02, ST-ICD-03, and ST-ICD-93 and LMSC drawing 4174331. The replacement P16 FPA shall meet the -511 assemblies requirements. The fuses shall be tested individually to the requirements specified in SMR-1035, HST First SM Fuse Plug Assembly Integration and Test Plan.				X										SCN 004
3.1.1	3.2.1.14	Reaction Wheel Assembly (RWA) Requirements. The RWA meet the requirements of LMSC 4171463, Reaction Wheel Assembly Specification and ST-ICD-01.				X										SCN 004
3.	3.2.2	Contingency Component Requirements. The HST hardware manifest for SM3 shall include contingency and spare hardware deemed essential for recovery from credible single and common-mode failures which may occur during servicing operations.					X									
3.	3.2.2.1	Rate Sensing Unit Requirements. The spare/contingency RSU shall meet the requirements stated in "Rate Gyro Assembly Specification", LMSC 4171761 and ST-ICD-01.					X									SCN 002
3.	3.2.2.2	Electronics Control Unit Requirements. The spare/contingency ECU shall meet the requirements stated in "Rate Gyro Assembly Specification", LMSC 4171761 and ST-ICD-01.					X									
3.	3.2.2.3	HST486 Requirements. The spare HST486 shall meet the interface controls defined in the ST-ICD-94 and SDM-1030. The spare HST486 shall meet the requirements stated in the STE-49. In addition, the spare Y harness shall meet the requirements stated in STE-65.					X									

SCN 002

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION													
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	
3.	3.2.2.4	Fuse Plug Assemblies (FPAs) Requirements. Fuses to be used in the PDU power distribution circuits shall meet the circuit protection requirements of ST-ICD-01, ST-ICD-02, ST-ICD-03, and ST-ICD-93 and LMSC drawing 4174331. The replacement P15, P16 & P17 FPAs shall meet the -509, -511 and -513 assemblies respectively. Fuses to be used in the OTA Electrical Power/Thermal Control Electronics (EP/TCE) power distribution circuits shall meet the circuit protection requirements of Hughes Danbury Optical System (HDOS) SD-679-1807 and ST-SE-5375. The fuses shall be tested individually to the requirements specified in SMR-1035, Hubble Space Telescope First Servicing Mission Fuse Plug Assembly Integration and Test Plan.					X									
3.	3.2.2.5	DBA2 Requirements. The spare DBA2 shall meet the requirements of STE-53.					X									
3.	3.2.2.6	VIK Requirements. The spare VIK shall meet the requirements of STE-57.					X									

SCN 004

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	SCN 002
3.	3.2.2.7	Aft Shroud Latch Repair Mechanism Requirements. The ASLR Mechanism shall meet the requirements of LMMS/P505023, Requirements Specification for HST Aft Shroud Latch Repair Mechanism.					X									
3.	3.2.3	ORU Harnesses/Extensions/Converters Requirements. The ORU harnessess/extensions/converters manifested for SM3 shall meet the requirements specified in STE-65, HST SM Harness Extension Assemblies Requirements Specification.				X	X									
3.3.1, 3.3.4, 3.3.5, 3.3.6	3.3.1.1	Operations Planning. On-orbit operations timeline information shall be developed to support mission planning including detailed scenarios for EVA activities and servicing hardware operations. This timeline information shall be suitable to support the Shuttle requirements for HST payload operations timeline development and the HST project requirements for flight operations development. The timeline information shall be incorporated into the integrated timeline to be developed by the HST O&GS project. Detailed timeline supporting information shall be provided for the ORUs. Operational constraints and restrictions documentation for ORUs, operations scenarios for SSE, and EVA test support and contingency procedures for EVA training, testing, and familiarization activities shall be developed and incorporated for use in servicing mission execution. All relevant hardware operational sensitivities shall be identified, including mechanical, electrical, thermal, and contamination, and appropriate hardware and/or operational controls shall be implemented to ensure the integrity of sensitive equipment for its intended usage. These sensitivities shall be documented in either Annex 2 Part 2, HST SM3 EVA Requirements (SMR-3026/3028) or HST Constraints and Restrictions Document, SMO-1020.												X		SCN 004

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION													
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	
3.3.1, 3.3.2	3.3.1.2	SM Returned Hardware. Mission planning shall support the return from orbit of the replaced hardware. During this servicing mission (SM) there is no requirement for a return mission (i.e. to return the HST to the ground). It is not a requirement for the replaced hardware to be maintained in an operational state once the successful installation of replacement hardware into the HST has been verified. Prior to this verification, functional hardware which has been removed from the HST shall be protected against environmental conditions which would preclude its reinstallation or create a contamination risk to hardware remaining in orbit.							X	X	X	X		X		
3.3.3	3.3.1.3	Uninstalled Replacement Hardware. Mission planning shall support the return of uninstalled replacement hardware from orbit. SM planning shall provide conditions which protect such hardware from thermal environments which violate the non-operate temperature limits of the hardware. Structural loads experienced by uninstalled hardware during nominal landings shall not preclude its re-flight. SM planning shall permit this hardware to be cleaned to a flightworthy condition after a nominal landing.							X	X	X	X		X	X	SCN 002
3.4	3.3.1.4	Contingency Plans. Alternative operations shall be planned and developed for use in the event of failure of on-orbit servicing operations and supporting operations which are safety critical or mission critical. Procedures shall be developed for reaching decisions on use of the alternative options. The ability to rapidly replan the remaining mission timeline shall be provided.														
3.3.1	3.3.1.5	Orbital Predictions. Prediction of HST orbital altitude decay shall be generated for use in mission planning and HST altitude reboost requirement determination.											X			
3.3.4	3.3.1.6	Solar Array Configuration. Nominal SM reboost planning shall assume the successful installation of the HST Third Solar Array (SA3), reference ST-ICD-93. SM hardware change-out operations planning shall minimize the time the HST is exposed to the retraction and stowage of the HST Solar Array II, reference ST-ICD-49.												X		

SCN 002

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	
3.3.6	3.3.1.7	Servicing Mission Duration. The planned duration (nominal plus reserved contingency) of shuttle-based servicing shall be sufficiently long to accomplish the replacements listed in STR-80 Tables 1-2 and 1-3 and to ensure that the HST is left in an operational state.											X	X		
3.3	3.3.1.8	PCU Changeout Nominal PCU changeout shall require interruption of power to S/C loads (including heaters and mechanisms). All spacecraft hardware shall be maintained above their minimum survival temperatures during this power interruption period. Contingencies shall be identified, and for each case plans and contingency hardware to assure HST health and safety shall be in place.				X							X	X		SCN 002
3.3.5, 3.3.6	3.3.2-1	EVA Procedures and Hardware Development. The SM3 EVA operations and the associated timeline shall be planned for successful accomplishment within the time allocated by the Payload Integration Plan (PIP). Procedures and timelines for on-orbit servicing of HST by Shuttle EVA crew shall be developed and exercised using simulators of HST, SIs, ORUs, interface hardware, crew aids, tools, Shuttle equipment, and the zero-gravity space environment. The procedures and timeline are to be developed in detail suitable for supporting Shuttle training and documentation requirements. The procedure development is to be interactive with design and development of hardware, interfaces, crew aids, and tools, including: expected environments; contamination; constraints and restrictions. All servicing operations shall be conducted without damaging the HST, FSS, ORUC, RAC, SAC, MULE, ORUs, and CATs including cases when the HST appendages are deployed.										X		X		SCN 002

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION													
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	SCN 002
3.3.5	3.3.2-2	EVA Procedures and Hardware Development The EVA procedures and crew interfaces, and the hardware simulators used in their development shall be adequate for use by the Shuttle program for crew training. High Fidelity Mechanical Simulator (HFMS) ORU simulator requirements shall be documented in the HFMS ORU simulator CEI Specifications. Differences between the flight hardware and the HFMS simulators, Neutral Buoyancy Laboratory (NBL) hardware, and Vehicle Electrical System Test (VEST) shall be documented.												X		
3.3.5	3.3.2-3	EVA Procedures and Hardware Development Crew familiarization and Form, Fit, and Function Test exercises shall be conducted using high fidelity one-gravity simulators and flight hardware.		X	X	X		X	X	X	X	X	X		X	SCN 002
3.3.5	3.3.2-4	EVA Procedures and Hardware Development Proper engagement of all fasteners and mechanisms shall be confirmed by torque limiting and/or visual inspection and telemetry monitoring.										X		X		
3.3.5	3.4.1	Shuttle Support Planning and execution of the servicing mission shall meet the requirements of the "Payload Integration Plan, Hubble Space Telescope, NSTS 14009." The entire complement of payload (including the Shuttle attached HST), carriers, tools, and crew aids shall meet the requirements of "NSTS 07700, Vol. XIV Space Shuttle System Payload Accommodations." The HST payload shall meet the requirements of "Space Shuttle/HST Interface Control Document", ICD-A-14009-SM.	X	X	X	X	X	X	X	X	X	X	X	X	X	
3.3.5, 3.3.7	3.4.2-1	Space Support Equipment The SSE hardware shall be operationally compatible with the Orbiter, HST, applicable crew systems, ORU hardware, crew aids, and tools.						X	X	X	X	X			X	

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION													
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	SCN 002
3.3.5, 3.3.7-a	3.4.2-2	Space Support Equipment The SSE hardware shall be operationally compatible with the Orbiter, HST, applicable crew systems, ORU hardware, crew aids, and tools. The SSE design shall permit the accommodation of ORUs designated for the SM3 in accordance with ST-ICD-97. The SSE shall provide environmental protection for the ORUs to ensure delivery of undamaged and uncontaminated hardware for on-orbit servicing and return of SM hardware to Earth.						X	X	X	X				X	
3.3.7-a	3.4.2-3	Space Support Equipment The Axial SIPE shall be configurable to support an axial SI with Optical Telescope Assembly (OTA) Axial bay 1 and 3 latch provisions. Axial SI interfaces with the SSE shall be as defined in ST-ICD-91 and the FGS interfaces with the SSE shall be as defined in ST-ICD-82.							X						X	SCN 002
3.3.5	3.4.2-4	Space Support Equipment The SSE shall meet the interface requirements of ICD-A-14009-SM.						X	X	X	X	X			X	
3.3.5	3.4.2-5	Space Support Equipment The SSE shall be operationally compatible with all phases of the servicing mission and shall support replacement of designated equipment by EVA.						X	X	X	X	X	X		X	
3.3.7-a	3.4.2-6	Space Support Equipment The carriers shall serve as a transportation and stowage platform from which the EVA crew can remove, stow, and replace various crew aids, tools, and ORUs.						X	X	X	X		X		X	
3.3.7-c	3.4.2-7	Space Support Equipment The design of the RAC, ORUC, FSS, SAC, and MULE as an integrated payload shall incorporate translation and access routes required for EVA crew members to perform HST servicing tasks.						X	X	X	X		X		X	
3.3.7-a	3.4.2-8	Space Support Equipment The carriers and associated Protective Enclosures (PE) in conjunction with the nominal mission attitude as defined in PIP and ICD-A-14009-SM shall provide thermal conditioning as specified in paragraph 3.5.6.2.1.3.							X	X	X				X	

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION													SCN 002
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	
3.3.7-a	3.4.2-9	Space Support Equipment For liftoff, landing, and transportation the SSE shall maintain the structural loads for the ORUs in accordance with ST-ICD-97 and for the latches in accordance with their structural limits. The SIPEs shall be compatible with the latch capabilities.							X	X	X				X	SCN 002
3.3.7-a	3.4.2-10	Space Support Equipment The SSE design shall permit direct line-of-sight visibility of the FSS berthing latch mechanisms and pivoter visual aid from the Orbiter Aft Flight Deck (AFD) viewing ports during HST berthing operations.						X	X		X		X		X	
3.3.5	3.4.2-11	Space Support Equipment The SSE shall meet the rapid safing requirements of NSTS 1700.7B.						X	X	X	X		X		X	
3.3.8 3.3.8.1	3.4.2-12	Space Support Equipment The SSE shall provide the resources necessary to support both passive and active on-orbit contamination monitoring.											X			
3.3.7-b	3.4.3.1	Flight Support System (FSS). The FSS will provide a service platform for the HST during the on-orbit servicing mission. This hardware has flown on other Orbiter missions, but shall be modified, as required, to meet requirements defined for the SM3. The FSS shall meet the interface requirements of ST-ICD-10 and ICD-A-14009-SM.						X								

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION													
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	SCN 002
3.3.7-b	3.4.3.1	Flight Support System (FSS). The FSS shall provide: 1. A remotely operated Berthing and Positioning System (BAPS) for HST servicing. The BAPS shall be capable of rotating the HST about the HST V_1 axis and pivot about an axis parallel to the Orbiter Y axis. 2. A remotely operated main umbilical mechanism which mates to and demates from the HST main umbilical. 3. Manual override of all FSS mechanisms with the exception of: the translator; berthing latch closing; main umbilical mating; and down lock mating. 4. A backup (deploy/return) umbilical mechanism which demates from the HST via AFD command. 5. The mounting of an Orbiter supplied Closed Circuit Television (CCTV) camera. 6. Crew aids attachments (tether attach points, handrails, portable foot restraint (PFR) attachments, Auxiliary Axial SI Handle, Low Gain Antenna Protective Cover and ancillary items defined by NBL simulations). 7. BAPS post mounting. 8. Operations of the BAPS mechanisms shall be conducted without damaging the HST and FSS, including cases when the HST appendages are deployed. 9. Visual indication of pivoter and rotator positions. 10. Support to maintain the HST, throughout the servicing mission, in a condition which permits the resumption of its science mission. footprint location that provides contamination monitor instrumentation viewing angles in all required directions, mounting interface from the contamination monitor to the FSS structure, and power. 12. ORU mounting provisions. The FSS shall include provisions for structural isolation and thermal control of ORUs as specified in ST-ICD-97. 13. Thermal Control. Provisions for MLI, heater power, and temperature monitoring 14. Contamination mitigation. Contamination protection shall be provided for items that are intended for installation or extended use (over one EVA day) in the AS as specified in ST-ICD-97.						X					X	X		SCN 002 SCN 002

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION												
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC
	3.4.3.1.1	FSS General Spacecraft Servicing. Modifications to the FSS shall not preclude its ability to support other-class spacecraft servicing.						X							
3.3.7-a, 3.3.8.1	3.4.3.2-1	Orbital Replacement Unit Carrier (ORUC) The ORUC shall provide for the following as specified in ST-ICD-97: 1. Thermal Control. (Provisions for MLI, heater power and temperature monitoring). 2. Contamination. (Provisions for GN_2 purge up to T-0). 3. Structural load isolation. 4. ORU mounting provisions. In addition, the ORUC shall provide: 1. Crew aids (tether attach points, handles, handrails, PFR attachments, etc.). 2. Visual indication and telemetry monitoring of active SI latch engagement.							X				X		
3.3.7	3.4.3.2-2	ORUC The ORUC design shall meet the mission requirements and support the SM3 carrying any and all parts of the ORUC ORU complement. Detailed design and performance requirements for the ORUC are defined in the "ORU Carrier Contract End Item Specification," STE-58.							X						
3.3.7	3.4.3.3-1	Rigid Array Carrier (RAC). The RAC shall provide for the following as specified in ST-ICD-97: 1. Thermal Control. (Provisions for MLI). 2. ORU mounting provisions. In addition, the RAC shall provide: 1. Crew aids (tether attach points, handrails, PFR attachments, etc.). 2. Visual indications for SA latch engagement/ disengagement.									X		X		
3.3.7-a	3.4.3.3-2	Rigid Array Carrier (RAC). The RAC design shall be able to support the SM3 carrying any part of the RAC ORU complement. Detailed design and performance requirements for the RAC are defined in the "Rigid Array Carrier Contract End Item Specification, STE-56".									X				

SCN 002

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION													
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	SCN 002
	3.4.3.4-1	Multi-Use Lightweight Equipment (MULE) Carrier. The MULE shall provide for the following as specified in ST-ICD-97: 1. Thermal Control. (Provisions for MLI, heater power, and temperature monitoring). 2. ORU mounting provisions. 3. Contamination mitigation. (Provisions for GN2 purge up to T-0). Contamination protection shall be provided for non-purged items that are intended for installation or extended use (over one EVA day) in the AS. In addition, the MULE shall provide: 1. Crew aids (tether attach points, handrails, PFR attachments, etc.).								X						SCN 002
	3.4.3.4-2	Multi-Use Lightweight Equipment (MULE) Carrier. The MULE design shall be able to support the SM3 carrying any part of the MULE ORU complement. Detailed design and performance requirements for the MULE are defined in the " Multi-Use Lightweight Equipment (MULE) Contract End Item Specification," STE-62.								X						
3.3.7-c	3.4.3.5	Crew Aids and Tools. Crew aids and tools are those items necessary to efficiently accomplish on-orbit servicing. The design and interface requirements for generic crew aids and tools (CATs) provided by HST, but which could be used on other Space Shuttle missions shall be based on the JSC Generic Design Requirements Document (GDRD), JSC 26626, Revision A, dated May 1995. Applicability of these requirements, and additional design requirements derived from STR-81 shall be documented in individual Specific Design Requirements Documents (SDRDs). The design and interface requirements for HST-unique CATs shall be documented in a CEI specification. Crew aids shall include protective covers that provide, as required, physical, cleanliness, illumination, anti-static and anti-arching protection.		X	X	X	X	X	X	X	X	X	X		X	SCN 002

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION													
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	SCN 002
3.3.7-c	3.4.3.5.1	Rotational and Translational Mass Stability. ORU attachments shall be located for restraints, tethers, and guides to prevent contributions to handling forces that could magnify element tumbling, misalignment, or binding during on-orbit servicing operations.		X	X	X	X					X	X			
3.3.7	3.4.3.6	Second Axial Carrier (SAC) The SAC shall provide for the following as specified in ST-ICD-97: 1. Thermal Control. (Provisions for MLI, heater power and temperature monitoring. 2. Contamination mitigation. (Provisions for GN2 purge up to T-0). Contamination protection shall be provided for non-purged items that are intended for installation or extended use (over one EVA day) in the AS. 3. Structural load isolation. 4. ORU mounting provisions. In addition, the SAC shall provide: 1. Crew aids (tether attach points, handrails, PFR attachments, etc). 2. Visual indication and telemetry monitoring of active SI latch engagement. 3. Temporary parking for ORUs not provided by other carriers.													X	SCN 002
3.3.7	3.4.3.6-1	The SAC design shall be able to support the SM3B carrying any part of the SAC ORU complement.													X	
3.3.7	3.4.3.6-2	Detailed design and performance requirements for the SAC are defined in the "Second Axial Carrier Contract End Item Specification, STE-41".													X	
3.3.5, 3.3.7-d	3.4.4	SSE Electrical Requirements. The SM3 payload power, command and data allocations shall comply with the applicable sections of the ICD-A-14009-SM and the PIP. SSE Power Margins. The SSE shall provide power margins for ORU payload growth.						X	X	X					X	

Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix

Lev II STR-80 Para	Lev III STR-81 Para	Requirement Statement	SM3 HARDWARE ALLOCATION												
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC
3.3.5	3.4.4.1	Total FSS Electrical Load. The total load served through the FSS shall not exceed the combined power allocation at the FSS Umbilical and the Orbiter-to-FSS Standard Interface Panel (SIP), as identified in Appendix A and B respectively for the SM3A and SM3B parts of the mission.						X					X		
3.3.5, 3.3.7-a	3.4.4.1.1	FSS-to-HST Electrical Interfaces. The FSS-to-HST power and voltage interfaces shall comply with ST-ICD-10, Paragraph 7.14.	X					X					X		
3.3.5, 3.3.7-a, 3.3.7-b	3.4.4.1.2	FSS-to-ORUC Electrical Interfaces. The FSS-to ORUC power and voltage interfaces shall comply with ST-ICD-10, Paragraph 7.16.						X	X				X		
3.3.5	3.4.4.1.3	FSS Avionics and Heaters. The FSS avionics and heaters power and voltage requirements shall comply with ST-ICD-10, Paragraph 7.15.						X							
3.3.5	3.4.4.2	Orbital Replacement Unit Carrier (ORUC). The ORUC shall be capable of operating from power, command, and interfaces provided by the FSS, as determined by the limiting set of Orbiter cabling allocations between the FSS and ORUC as specified in ICD-A-14009-SM. The ORUC power and voltage requirements shall comply with ST-ICD-10, Paragraph 7.16.							X						
3.3.5	3.4.4.3	Rigid Array Carrier (RAC). The RAC shall not be powered.									X				
3.3.5	3.4.4.4	Multi-Use Lightweight Equipment (MULE). The MULE power, command and data allocations shall comply with the applicable sections of ICD-A-14009-SM.								X					
3.3.5	3.4.4.5	Power Allocation, Minimum Voltage, and Energy Limits. The servicing mission power allocation and the voltage limits at the interfaces of major payload components, as well as the total energy allocation, including AC power loads, for the SM3A and SM3B parts of the mission are given in Appendices A and B respectively.						X	X	X			X		X
3.3.5	3.4.4.6	Second Axial Carrier (SAC) The SAC power, command and data allocations shall comply with the applicable sections of ICD-A-14009-SM.													X

SCN 002

SCN 002

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION													
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	SCN 002
3.3.5	3.5.1.1	Mass Properties. The mass properties for the Hubble Space Telescope are defined in ST/SE-04. The weight of all payload-chargeable SSE and ORUs shall not exceed the total weight limits identified in Appendix A and B respectively for SM3A and SM3B. Weight margins shall be maintained in accordance with the "HST SM3 Weight Control Plan," SMR-3091.											X			
3.3.5	3.5.1.1.1	Contract End Item Weight Allocation. Hardware weight allocations for SM3A and SM3B are given in the respective appendices. These values shall be considered as not-to-exceed weights and shall be used as design criteria for the SSE and ORUs. The ORUC and SAC weight allocations include Government Furnished Equipment (GFE) latch hardware.		X	X	X	X	X	X	X	X	X	X		X	SCN 002
3.3.5	3.5.1.1.2-1	Center of Gravity The placement of all cargo elements, other crew aids and additional mission-related hardware shall not exceed the Orbiter Payload Bay center of gravity (CG) envelope defined by the Mission Specific Flight Design Assessment.						X	X	X	X		X		X	
3.3.5	3.5.1.1.2-2	Center of Gravity The CG will be determined for each of the cargo elements and all other SSE manifested for SM3A and SM3B.						X	X	X	X				X	
3.3.5	3.5.1.2-1	Coordinate Systems The FSS, ORUC, RAC, SAC, and MULE shall use the coordinate axes as delineated in ICD-A-14009-SM.						X	X	X	X				X	
3.3.5	3.5.1.2-2	Coordinate Systems ORUs and SSE shall be marked or referenced on drawings in relation to either the Orbiter or HST coordinate systems, or both, as defined in PIP Annex 1.		X	X	X		X	X	X	X				X	
3.3.8, 3.3.8.1	3.5.2-1	Contamination Control The ACS and FGS life cycle, from build through the integration and test activity at GSFC, delivery to orbit and installation into the HST shall ensure ACS and FGS cleanliness levels that meet or exceed the levels specified in STR-29. More stringent ORI internal and optical surface contamination requirements have been established by the ACS developers to meet optical performance requirements. These requirements are stated in their Contamination Control and Implementation Plan.		X		X							X		X	

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	
3.3.8	3.5.2-2	Contamination Control The ASCS/NCS and RSU internal aft shroud components life cycle, from build through the integration and test activity at GSFC, delivery to orbit and installation into the HST shall ensure cleanliness levels that meet or exceed the levels specified in STR-29. For the SSE and all other SM hardware (non-aft shroud), contamination requirements are defined in STR-29.			X	X	X	X	X	X	X	X	X		X	SCN 002
3.3.8.1	3.5.2.1	Contamination Budget. HST SM contamination budgets shall be allocated according to critical ORU end-of-life performance requirements. These budgets establish incremental and cumulative allocations per significant event.		X	X	X			X	X	X				X	
	3.5.2.2	Contamination Monitoring. During the servicing mission, the on-orbit contamination environment shall be monitored. Both particulate and molecular contamination shall be monitored via an active contamination instrumentation (Contamination Environmental Package - CEP). The CEP shall meet the requirements stated in "HST Second Servicing Mission Contamination Monitor End Item Specification", P-442-1285.											X		X	
3.3.5	3.5.3-1	Reliability The FSS, ORUC, RAC, SAC, and MULE shall be single fault tolerant against failure to support the baseline mission.						X	X	X	X				X	SCN 002
3.3.5	3.5.3-2	Reliability Crew aids and tools provisions shall be sufficient to provide single fault tolerance against failure to support the baseline mission.										X			X	
3.3.5	3.5.4	Safety The SM hardware and software (including the HST vehicle) shall be designed, maintained and operated to eliminate or control hazards during all phases of SM integration and test activities, transportation, on-orbit SM activities, Shuttle operations and EVA.		X	X	X	X	X	X	X	X	X	X	X	X	

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	SCN 002
3.3.5	3.5.4.1	Flight Safety Flight hardware and operations shall be designed and con-trolled per NSTS 1700.7B to ensure Orbiter and crew safety will not be compromised at any time under normal modes of operation and documented by approved (JSC/GSFC) Flight Safety Hazard Reports. The safety aspects of on-orbit work-arounds will be handled according to the guidelines specified in the flight rules. The payload hardware shall be designed to comply with the operational safety constraints and safety-critical inter-faces as specified in the SM3 PIP and ICD-A-14009-SM.		X	X	X	X	X	X	X	X	X	X	X	X	SCN 002
3.3.5	3.5.4.2	Ground Safety SM flight hardware and GSE planned for integration and test activities at KSC shall be designed and controlled per KHB 1700.7B to ensure that personnel and facilities safety are not compromised and documented by approved (KSC/GSFC) Ground Safety Hazard Reports. Mission critical hardware/GSE planned for integration and test activities at GSFC shall comply with P-442-0173.		X	X	X	X	X	X	X	X	X	X	X	X	
3.3.5	3.5.5-1	Maintainability The SM hardware shall be designed to perform without maintenance at any time during flight, with the exception of power tool battery replacement.		X	X	X	X	X	X	X	X	X			X	
3.3.5	3.5.5-2	Maintainability All other maintenance, repair, and adjustment of SM Hardware shall be accomplished on the ground prior to and following flight missions.		X	X	X	X	X	X	X	X	X			X	
3.3.5	3.5.5.1	Shelf Life. The design of the SSE shall take into account storage/use cycles. The nominal total protected storage time shall be 20 years with a mission use approximately every 2.5 years (no more than six missions).						X	X	X	X	X			X	
3.3.5	3.5.5.2	Orbital Usage Life. SSE shall be designed for a total orbital life of 54 days.						X	X	X	X	X			X	
3.3.5	3.5.6.1	Natural Environment. The SSE shall be designed to withstand the natural environments specified in NASA TM-78119.						X	X	X	X	X			X	

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION													
			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	SCN 002
3.3.5	3.5.6.1.1	Meteoroid Impact. The SSE shall withstand exposure to orbital meteoroid and orbital debris without loss of functional capability.						X	X	X	X	X			X	SCN 002
3.3.5	3.5.6.1.2	Radiation. The SSE shall withstand exposure to the on-orbit ionizing particle radiation environment for at least 54 days without loss of functional capability.						X	X	X	X	X			X	
3.3.5	3.5.6.2	Induced Environment. The SM Hardware shall be capable of surviving any environment or combination of environments, consistent with the mission phase (i.e. launch and ascent, on-orbit, descent, or landing), specified herein and in ICD-A-14009-SM.		X	X	X	X	X	X	X	X	X	X		X	
3.3.5	3.5.6.2.1	Thermal Requirement. Thermal design of the SM H/W shall be consistent with the Orbiter attitudes defined in ICD-A-14009-SM.						X	X	X	X	X	X		X	
3.3.5	3.5.6.2.1.1	SM Hardware Thermal Requirements. Thermal design of the SM H/W shall be consistent with the planned operations of the HST and shall not introduce any constraints to the baseline capabilities of the HST during normal operations or the Servicing Mission.		X	X	X	X	X	X	X	X	X			X	
3.3.5	3.5.6.2.1.2	Orbiter Bay Thermal Requirements. The SM hardware shall survive the Orbiter bay thermal environment defined in ICD-A-14009-SM. Safety related temperature limits and allowable exposure times for contingency situations shall be determined and maintained for all SM hardware.		X	X	X	X	X	X	X	X	X			X	
3.3.5	3.5.6.2.1.3	ORU Thermal Requirements. The carriers shall provide thermal conditioning of ORUs such that the non-operational limits are not violated while on the carriers or during transport and installation into the HST. The intent shall be to maintain ORUs above the minimum turn on temperature at HST installation to allow for immediate ORU turn on and checkout (no thermal timeline constraint).							X	X	X				X	
3.3.5	3.5.6.2.2-1	Loads and Deformations. SM hardware design shall accommodate flight and operational loads.		X	X	X	X	X	X	X	X	X	X		X	

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			HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	SCN 002
3.3.5	3.5.6.2.2-2	Loads and Deformations. Crew-imposed loads/forces and work restraints shall be as defined in NSTS 07700, Vol. XIV, Appendix 7 and ICD-A-14009-SM.		X	X	X	X	X	X	X	X	X	X		X	SCN 002
3.3.5	3.5.7.1	Transportation Load Criteria. The SM hardware shall be transportable by ground, air, and surface transportation as individual components, subassemblies, assemblies, or as a unit. All transportation loads shall be enveloped by flight loads.		X	X	X	X	X	X	X	X	X	X		X	
3.3.5	3.5.7.2	Ground Handling. The design of the FSS, ORUC, RAC, SAC, and MULE shall include 1-G handling points to permit installation and loading as a complete unit into the cargo bay.						X	X	X	X				X	
3.3.8	3.5.8	Storage of SSE During Storage, the SSE components and assemblies shall be packaged and preserved per NHB 6000.1 and individual Packaging Handling and Transportation Records kept as defined in NASA Form 1426.						X	X	X	X	X			X	
3.3.5	3.5.9-1	Ground Support Equipment Mechanical and electrical GSE shall be used for the support, testing, transportation, handling, installation, and servicing of SSE and ORU hardware. All test equipment shall be designed with a fail-safe goal such that equipment failure will not degrade flight hardware.Mechanical GSE. Factors of Safety and Proof test Loading shall be: a. Factor of Safety for lifting equipment = 5.0 (ult) b. Proof load Factor for lifting equipment = 2.0.		X	X	X	X	X	X	X	X					X	
3.3	3.5.9-2	Ground Support Equipment Electrical GSE. The electrical GSE shall provide the same interface characteristics to the SSE and ORUs as the STS and the HST.		X	X	X	X	X	X	X						
3.3.5	3.5.10.1-1	Design Factors of Safety. Two load criteria exist for metallic structures: SM Heritage hardware that was designed and built to MSFC safety factor guidelines as noted in Table 3-7. Analysis of SM hardware built to these earlier standards and showing positive margins of safety relative to this earlier criteria are acceptable.		X	X	X	X	X	X	X	X	X	X		X	

Lev II STR-80 Para	Lev III STR-81 Para	Table C-1 Third Servicing Mission Requirements Allocation/Traceability Matrix Requirement Statement	SM3 HARDWARE ALLOCATION HST	ACS	ASCS/NCS	ORUS	SPARES	FSS	ORUC	MULE	RAC	CAT	SYST	MSNMGMT	SAC	SCN 002
3.3.5	3.5.10.1-2	Design Factors of Safety. The more recent safety factor guidelines defined in specification GSFC-GEVS-SE, shown in Table 3-8, shall be used for any SM specific hardware, hardware design changes or new SM design.		X	X	X	X	X	X	X	X	X	X		X	SCN 002
3.3.5	3.5.10.2	Fatigue The effects of repeated loads and pressure cycles on the design of SSE missions will be evaluated. Fatigue analysis shall be performed using MIL-HDBK-5 as the primary source of fatigue properties. Structural elements fabricated from composite materials shall be verified by test and analysis, in accordance with NSTS 14046.		X	X	X	X	X	X	X	X	X	X		X	
3.3.5	3.5.10.3	Fracture Control All items whose structural failure could result in a hazard to the Orbiter or crew shall be subject to fracture control per NHB 8071.1.		X	X	X	X	X	X	X	X	X	X		X	
3.3.5	3.5.10.4	Pyrotechnic Devices The SM hardware shall not include pyrotechnic devices.		X	X	X	X	X	X	X	X	X			X	
3.3.5	3.5.10.5	Latching and Attach Mechanisms All attachment and operating interfaces shall protect against inadvertent actuation. All hardware which can move and interface with crew activities shall, while in the loosened configuration, have integrated restraints which are capable of withstanding Shuttle Vernier Reaction Control System (VRCS) jet firings without gross motion.		X	X	X	X	X	X	X	X	X			X	
3.3.5	3.5.10.6	Castings Castings shall not be used in any SM Hardware component designs without prior approval from the Flight Assurance Manager.		X	X	X	X	X	X	X	X	X			X	
3.3.5	3.5.10.7-1	Markings All SM Hardware, including crew aids and tools, shall be clearly marked and labeled as to name and function, and any alignment constraint as applicable to facilitate crew interface and functions.		X	X	X	X	X	X	X	X	X			X	
3.3.5	3.5.10.7-2	Markings The CG of the loaded RAC, FSS, ORUC, SAC, and MULE shall be determined and documented prior to ground-handling operations. The CG of ORIs shall be identified and clearly marked prior to ground-handling operations and installation into the HST.		X	X			X	X	X	X				X	

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3.3.5	3.5.11.1	Grounding and Bonding All SSE hardware shall be designed to ensure a single point ground configuration consistent with the requirements of NSTS 37330. Grounding and bonding shall be in accordance with NSTS 37330. Grounding of multi-layer insulation shall be per ICD-A-14009-SM.		X	X	X	X	X	X	X	X	X			X	SCN 002
3.3.5	3.5.11.2-1	Electrical Fault Protection SSE power circuits shall be designed so that faults within the SSE or SSE interfaces to HST will not damage Orbiter circuits as defined in the applicable documents specified in section 3.5.4, Safety.						X	X	X					X	
3.3.5	3.5.11.2-2	Electrical Fault Protection The SSE shall be designed so that faults within SSE shall not damage the HST. Faults within one SSE subsystem shall not propagate to other SSE subsystems.						X	X	X					X	
3.3.5	3.5.11.3	ElectroStatic Discharge Protection. SSE items requiring bonding to prevent static charge buildup shall be bonded per NSTS 37330, Class S, except for multi-layer insulation blankets. MLI, including the PE foam shall meet the surface property requirements of ICD-A-14009-SM, paragraph 10.7.4.2.3.5.1. SSE shall not be susceptible to damage by static discharge.						X	X	X	X		X		X	
3.3.5	3.5.11.4	Corona Suppression. SSE electrical hardware shall be designed to eliminate corona discharges in the on-orbit environment.						X	X	X			X		X	

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3.3.5	3.5.11.5	Connector Protection All connectors with potential exposure to inadvertent contact or debris shall be protected as follows: . Test/unused connectors on new hardware shall be capped at all times. . As required by safety mandates per MA2-97-093 "Crew Mating/Demating of Powered Connectors", second letter to NSTS/ISS 18798B. . All connectors with 22 AWG or smaller pins, and all non-scoop-proof connectors with pin contacts that are exposed to risk of damage due to inadvertent contact during EVA, shall be capped. Such connectors on replaced hardware shall be protected from inadvertent contact until the installed hardware is verified. . All connectors on new hardware, and hardware that may be re-installed, shall be protected from debris during launch and/or SSE stowage. . The EVA crew shall inspect all connectors, except those that have been capped since launch, immediately prior to mating.		X	X	X	X						X			
3.3.5	3.5.12-1	Electromagnetic Compatibility (EMC) The SSE shall be designed for electromagnetic self-compatibility and for electromagnetic compatibility with the HST and with the Orbiter in accordance with Electromagnetic Compatibility Requirements Systems, MIL-E-6051, and ICD-A-14009-SM.						X	X	X		X	X		X	SCN 002
3.3.5	3.5.12-2	Electromagnetic Compatibility (EMC) The SSE electrical and electronic components shall not be a source of, nor be susceptible to, electromagnetic interference as required by GSFC-GEVS-SE, section 2.5, EMC.						X	X	X		X			X	
3.3.5	3.5.13	Human Engineering The SM hardware shall be designed in accordance with the human engineering guidelines in NSTS 07700, Vol. XIV, Appendix 7. Generic CATS shall also be subject to the requirements in JSC-26626A.		X	X	X	X	X	X	X	X	X			X	

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3.3.5	3.5.14	<u>Previously Certified Hardware</u> All hardware items that were developed, built, verified and certified for flight in support of the first HST Servicing Mission shall be re-certified using the following criteria: 1) All safety critical age or wear sensitive equipment (i.e. lubricants, vespel inserts, etc.) shall be refurbished or replaced to meet the SM2 requirements. 2) If there are design changes, function changes, or hardware modifications, then the hardware shall be refurbished or replaced in accordance with the SM2 requirements. 3) If there are no hardware changes, based on the above criteria, then no reverification shall be required.				X	X	X	X	X	X	X			X		SCN 002