JSC 27296 (Revision A)

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PROGRAM REQUIREMENTS DOCUMENT AND PROJECT MANAGEMENT PLAN FOR THE ALPHA MAGNETIC SPECTROMETER (AMS) PAYLOAD INTEGRATION HARDWARE (PIH)

Space and Life Sciences Directorate

Flight Projects Division

Revision A

August 2000

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

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Technical Work Plan HECSMBS2

Prepared by
Lockheed Martin Space Operations
Houston, Texas

Contract NAS 9-19100

Prepared for

Planning & Integration Branch
Flight Projects Division

Space and Life Sciences Directorate

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS

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PROGRAM REQUIREMENTS DOCUMENT AND PROJECT MANAGEMENT PLAN FOR THE ALPHA MAGNETIC SPECTROMETER PAYLOAD INTEGRATION HARDWARE

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DOCUMENT CHANGE/REVISION LOG

CHANGE/ REVISION	DATE	DESCRIPTION OF CHANGE	PAGES AFFECTED
Baseline	10/24/97	Baseline	All
	7/15/98	Updated Appendix A, Master List of Documents	Appendix A
	7/15/98	Changed JSCM 8080 to JHB 8080.5	Appendix B
	{TBD}	Revision A	All

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ACRONYMS AND ABBREVIATIONS

^{0}C	DEGREES CENTIGRADE
ACOP	AMS CREW OPERATIONS POST
AMS	ALPHA MAGNETIC SPECTROMETER
AMS-01	AMS PRECURSOR FLIGHT ON STS-91
AMS-02	AMS OPERATIONAL FLIGHT ON ISS
AP	ATTACHED PAYLOAD
APCU	ASSEMBLY POWER CONVERTER UNIT
CDR	CRITICAL DESIGN REVIEW
CG	CENTER OF GRAVITY
CITE	CARGO INTEGRATION TEST EQUIPMENT
CMP	CONFIGURATION MANAGEMENT PLAN
CMS	CONFIGURATION MANAGEMENT SYSTEM
COTS	COMMERCIAL OFF THE SHELF
DCU	DATA CONVERSION UNIT
DOE	DEPARTMENT OF ENERGY
EA	JSC ENGINEERING DIRECTORATE
ECAL	ELECTRONIC CALORIMETER
E-CAL	ELECTRONIC CALORIMETER
EEE	ELECTRONIC, ELECTRICAL, AND ELECTROMECHANICAL
EMC	ELECTROMAGNETIC COMPATIBILITY
EMI	ELECTROMAGNETIC INTERFERENCE
ESTL	ELECTRONIC SYSTEMS TEST LABORATORY
EVA	EXTRAVEHICULAR ACTIVITY
FEM	FINITE ELEMENT MODEL
FRGF	FLIGHT RELEASABLE GRAPPLE FIXTURE
GFE	GOVERNMENT FURNISHED EQUIPMENT
GHE	GROUND HANDLING EQUIPMENT
GSE	GROUND SUPPORT EQUIPMENT
HLIF	HRF LAUNCH INTEGRATION FACILITY
HQ	HEADQUARTERS
HRF	HUMAN RESEARCH FACILITY
ICD	INTERFACE CONTROL DOCUMENT/DRAWING
IDRD	INCREMENT DEFINITION AND REQUIREMENTS DOCUMENT
IMS	INVENTORY MANAGEMENT SYSTEM
IRD	INTERFACE REQUIREMENTS DOCUMENT

ACRONYMS AND ABBREVIATIONS

(CONTINUED)

ISS	INTERNATIONAL SPACE STATION
ITA	INTERNAL TASK AGREEMENT
IVA	INTRAVEHICULAR ACTIVITY
IVT	INTERFACE VERIFICATION TEST
JSC	LYNDON B. JOHNSON SPACE CENTER
KSC	JOHN F. KENNEDY SPACE CENTER
LEPS	LOW ENERGY PARTICLE SHIELD
LMSMSS	LOCKHEED MARTIN SPACE MISSION SYSTEMS AND SERVICES
LMSO	LOCKHEED MARTIN SPACE OPERATIONS
MAPTIS	MATERIALS AND PROCESSES TECHNOLOGY INFORMATION SYSTEM
MDF	MANIPULATOR DEVELOPMENT FACILITY
MDL	MASTER DOCUMENT LIST
MIP	MISSION INTEGRATION PLAN
MIT	MASSACHUSETTS INSTITUTE OF TECHNOLOGY
MMPTD	MANUFACTURING, MATERIALS, AND PROCESS TECHNOLOGY DIVISION (FORMERLY TECHNICAL SERVICES DIVISION)
MSFC	GEORGE C. MARSHALL SPACE FLIGHT CENTER
NASA	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NBL	NEUTRAL BUOYANCY LABORATORY
NPSL	NASA PARTS SELECTION LIST
NSTS	NATIONAL SPACE TRANSPORTATION SYSTEM
OIU	ORBITER INTERFACE UNIT
OLMSA	OFFICE OF LIFE AND MICROGRAVITY SCIENCES AND APPLICATIONS
OPF	ORBITER PROCESSING FACILITY
PAS	PAYLOAD ATTACH SYSTEM
PDIP	PAYLOAD DATA INTERFACE PANEL
PDL	PAYLOAD DATA LIBRARY
PDR	PRELIMINARY DESIGN REVIEW
PEDS	PASSIVE ELECTRICAL DISCONNECT SYSTEM
PFR	PORTABLE FOOT RESTRAINT
PGSC	PAYLOAD AND GENERAL SUPPORT COMPUTER
PIA	PAYLOAD INTEGRATION AGREEMENT

ACRONYMS AND ABBREVIATIONS

(CONCLUDED)

PIB	PLANNING AND INTEGRATION BRANCH
PIH	PAYLOAD INTEGRATION HARDWARE
PMP	PROJECT MANAGEMENT PLAN
POIC	PAYLOAD OPERATIONS INTEGRATION CENTER
PRD	PROGRAM REQUIREMENTS DOCUMENT
PRP	PRESSURIZED PAYLOAD
PVGF	POWER VIDEO GRAPPLE FIXTURE
RECON	RECONFIGURATION
RICH	RING IMAGING CHERENKOV COUNTER
ROEU	REMOTELY OPERATED ELECTRICAL UMBILICAL
SA	JSC SPACE AND LIFE SCIENCES DIRECTORATE
SAIL	SHUTTLE AVIONICS INTEGRATION LABORATORY
SESL	SPACE ENVIRONMENT SIMULATION LABORATORY
SML	STRUCTURES AND MECHANICS LABORATORY
SRD	SYNCHROTRON RADIATION DETECTOR
SSPF	SPACE STATION PROCESSING FACILITY
STA	STRUCTURAL TEST ARTICLE
STD	STANDARD
STE	SPECIAL TEST EQUIPMENT
STS	SPACE TRANSPORTATION SYSTEM
SVMF	SPACE VEHICLE MOCKUP FACILITY
SWG	STRUCTURES WORKING GROUP
TBD	TO BE DETERMINED
TIP	(NASA) TRAINING IMPLEMENTATION PLAN
ToF	TIME OF FLIGHT
TPS	TASK PERFORMANCE SHEET
TRD	TRANSITION RADIATION DETECTOR
UMA	UMBILICAL MECHANISM ASSEMBLY
UPP	UNPRESSURIZED PAYLOAD
USS	UNIQUE SUPPORT STRUCTURE
UF	UTILIZATION FLIGHT
UMA	UMBILICAL MECHANISM ASSEMBLY
VATF	VIBRATION - ACOUSTIC TEST FACILITY

ACRONYMS AND ABBREVIATIONS

(CONCLUDED)

VC	VACUUM CASE

PREFACE

This revision of the Program Requirements Document and Project Management Plan (PRD/PMP) references the Alpha Magnetic Spectrometer (AMS) experiment and describes the Payload Integration Hardware (PIH) required for a three (3) year operational flight on the International Space Station (ISS) to be initiated with the ISS Utilization Flight 4 (UF4) mission (ISS-26-UF4 and Shuttle flight STS-130 at publication of this document).

A precursor flight (AMS-01) was accomplished on the Space Shuttle during the Shuttle STS-91 flight and was addressed with the previous versions of this document. The AMS-01 was successfully operated for approximately 8.5 days during the flight.

This Revision A of the PRD/PMP is directly related to the three (3) year operational flight (AMS-02) on the International Space Station initiated with Flight UF4 . The AMS-02 mission baseline is 1000 days of operational time (24,000 hours) in full deep space view.

1.0 INTRODUCTION

1.1 DOCUMENT PURPOSE

This Program Requirements Document (PRD)/Project Management Plan (PMP) establishes the overall program requirements for the mission management of the Alpha Magnetic Spectrometer (AMS-02) payload. Mission Management hardware development responsibility is limited to the Payload Integration Hardware as described in this document. This document complies with the intent of requirements defined by NMI-8010.1 Rev A and designated as Class C payloads. The AMS Mission Manager of the Planning and Integration Branch (PIB) of the Flight Projects Division of the Space and Life Sciences Directorate, Lyndon B. Johnson Space Center (JSC) is the controlling authority for this document.

The purpose of the PRD/PMP for the AMS-02 payload is as follows:

- Identify AMS-02 payload program participants and major responsibilities
- Delineate program requirements necessary for the design, development, fabrication, testing, verification and delivery of AMS-02 payload flight and ground support hardware, and associated integration hardware.
- Establish the hardware and software design criteria and verification requirements for the AMS-02 flight systems and associated software.

1.2 DOCUMENT SCOPE

This document establishes the program, design, safety, reliability, quality assurance, test facility, integration test and shipping requirements for the AMS-02 payload. Planning and Integration Branch hardware development is limited to the Payload Integration Hardware (PIH) as described in this document. It does not address the internal AMS-02 Experiment configuration. It does address the configuration of the AMS-02 interfaces to the Space Shuttle and International Space Station.

These requirements apply to new flight hardware and to modifications of previously flown flight hardware.

All new hardware design and modifications to existing hardware shall be constrained to limitations in and coordinated through requirements of SSP 57113, “Alpha Magnetic

Spectrometer - 02 (AMS) Payload Integration Agreement." (This document is in development).

The Engineering Directorate (EA) responsibilities for the AMS will be fully and completely described in the Internal Task Agreements (ITAs) between EA and the Space and Life Sciences Directorate (SA). The task support in the ITAs supercede any descriptions of task support in this PMP. The EA task support in this PMP is typical of EA services, in general, through various working groups and activities and does not fully describe the specific support for AMS or address the resources or schedule requirements.

Revisions and changes to this document will be issued as needed.

1.3 AMS-02 PAYLOAD DESCRIPTION

In this document "AMS" will refer to the total complement of activities, hardware, software, test, integration and operation of the Alpha Magnetic Spectrometer. The flight hardware is referred to as the "AMS Payload" and is comprised of two parts: the "AMS Experiment" provided by the international AMS Experiment Collaboration and the "AMS Payload Integration Hardware (PIH)" provided by the JSC Planning and Integration Branch of the Flight Projects Division with the support of Lockheed Martin Space Operations (LMSO). Also in this document, AMS-01 and AMS-02 are used and they refer specifically to the configuration as it was for STS-91 (AMS-01) and for the Space Station (AMS-02). The term AMS will be used in a more general case but specifically includes the Space Station configuration.

The AMS Experiment is a state-of-the-art particle physics detector containing a large, cryogenic superfluid helium superconducting magnet that will be designed, constructed, tested and operated by an international team organized under United States Department of Energy (DOE) sponsorship. The AMS Experiment will use the unique environment of space to advance knowledge of the universe and potentially lead to a clearer understanding of the universe's origin. Specifically, the science objectives of the AMS are to search for cosmic sources of antimatter (i.e., anti-helium or heavier elements) and dark matter. Reference is made to Figure 1-1 and Figure 1-2 for graphic descriptions of the AMS payload.

1.4 PAYLOAD CLASSIFICATION

This equipment class was determined in accordance with NMI 8010.1, Rev A "Classification of NASA Space Transportation System (STS) Payloads" and was designated as a Class C payload. This document had a "sunset clause" and is no longer in effect, but we will continue to apply the criteria to the AMS. This is also consistent with a "Complex Payload Bay Secondary" payload as defined by Appendix A of JSC 61100, "Project Management Guide" and with NSTS 07700, Volume XIV, paragraphs 6.4 and 6.5, "Space Shuttle System Payload Accommodations."

Figure 1-1 AMS PAYLOAD ON THE USS

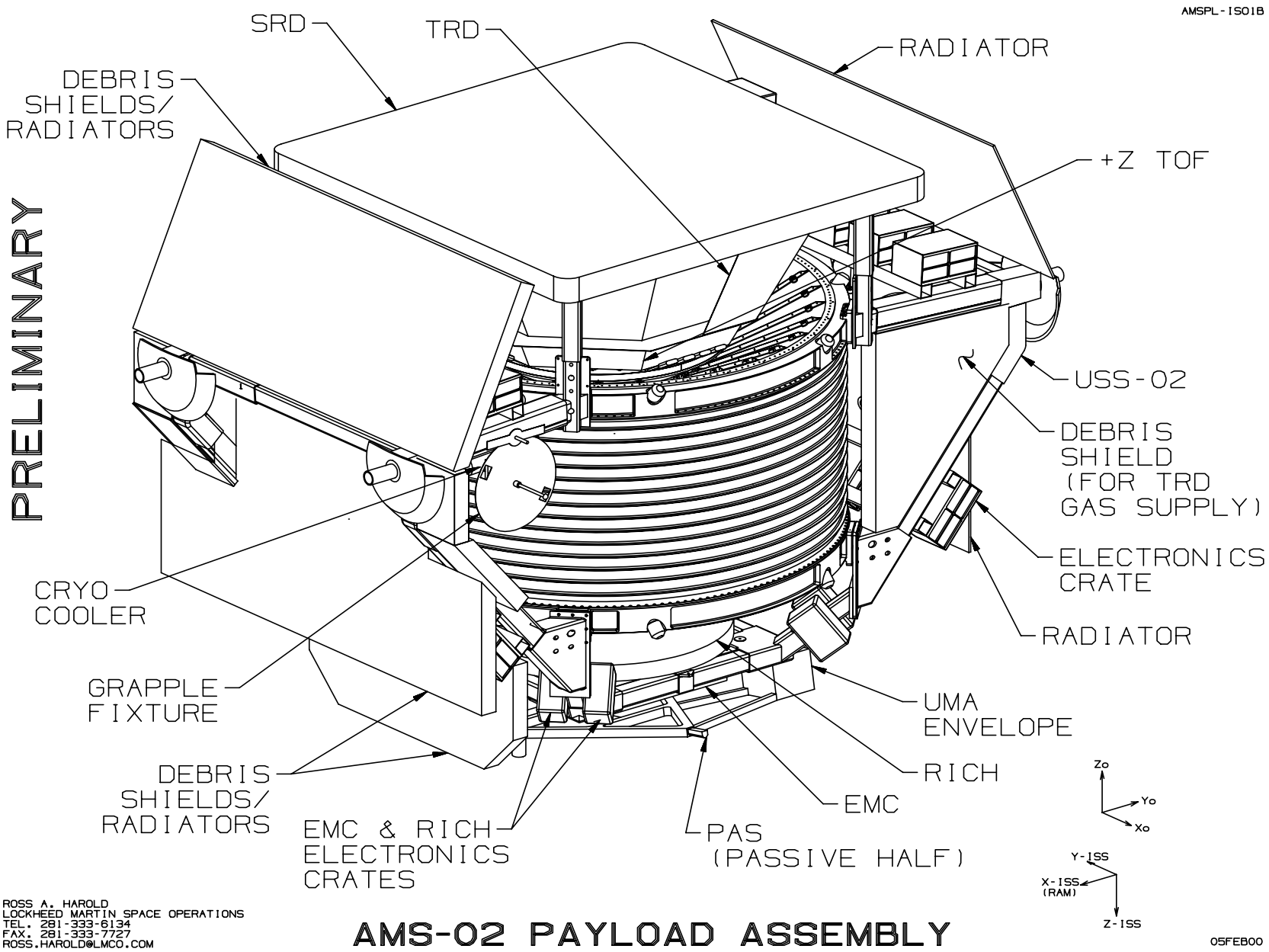
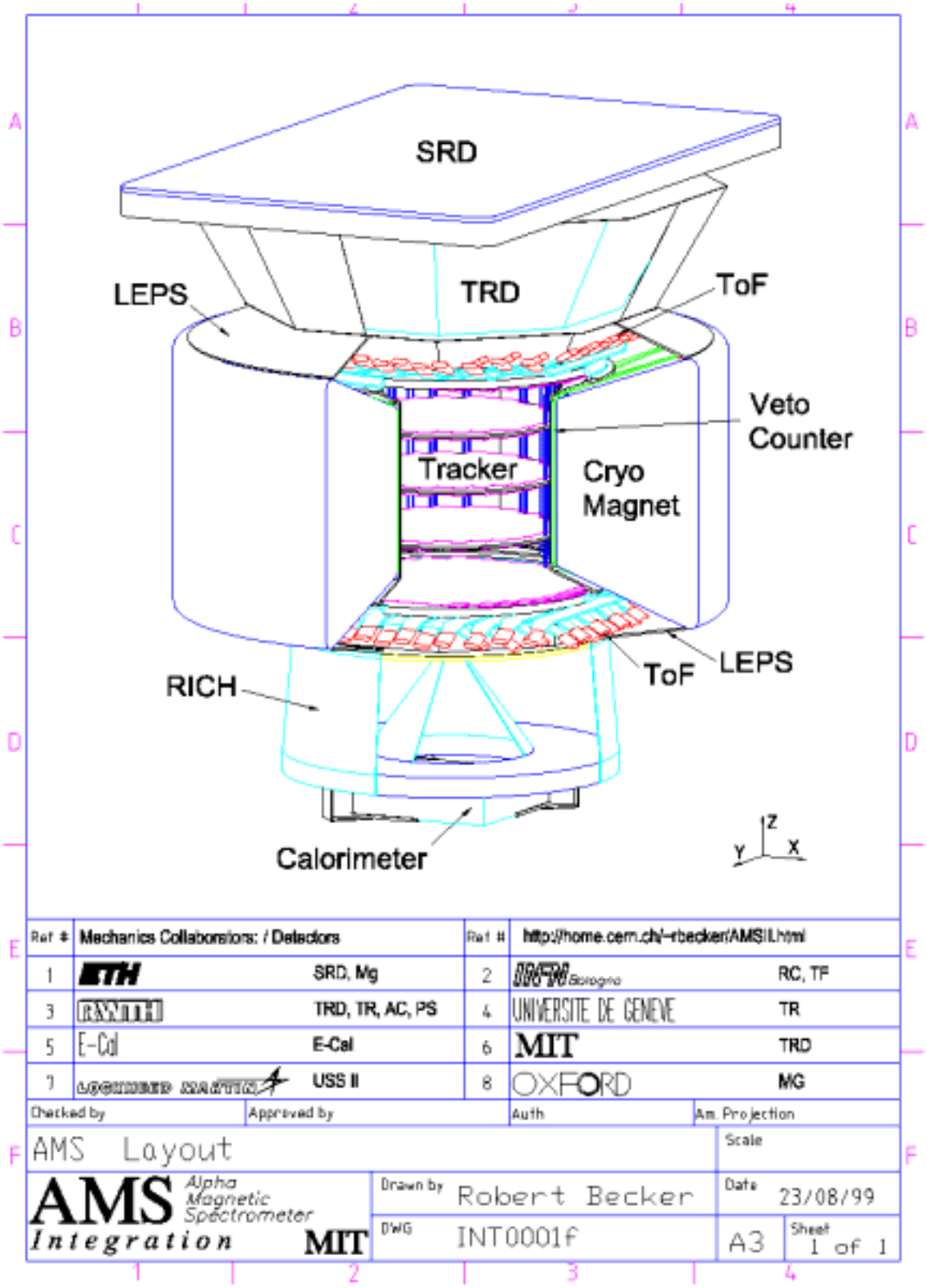


Figure 1-2 AMS GENERAL ASSEMBLY



2.0 PROGRAM, MILESTONES AND HARDWARE DELIVERABLES

2.1 ORGANIZATION

The AMS payload program organization is shown in Figure 2-1. The Planning and Integration Branch (PIB) of the Flight Projects Division of the Space and Life Sciences Directorate, Lyndon B. Johnson Space Center (JSC) is responsible for the mission management of the AMS payload. The PIB has been delegated responsibility for implementing the AMS program by the NASA Headquarters Office of Life and Microgravity Science and Applications (OLMSA). The PIB will serve as the AMS representative and will act as the single point of contact between the AMS program and the ISS and Shuttle programs. The PIB is the AMS representative to all other NASA organizations providing equipment, materials, and services for the AMS program.

2.2 RESPONSIBILITIES

The PIB is responsible for the payload integration activities for the AMS payload (AMS-02). The PIB will develop and specify the requirements and procedures for ground test and verification of the AMS payload. The AMS will provide verification to the Payload Integration Function of the ISS and they will integrate it into the overall documentation and requirements for the Space Station integrated payloads for the UF4 flight. This will include the integrated Shuttle requirements and agreements, physical integration on the Space Station, and Space Station operations requirements. The PIB will ensure that NASA provides the appropriate flight payload accommodations, engineering support, mission peculiar hardware and software, AMS to carrier integration support, payload safety certification, facilities for final assembly, testing and checkout, NASA control center accommodations for AMS operation and monitoring, and provide AMS housekeeping, science data to the DOE-sponsored team as required for the mission.

Responsibilities of the AMS participants and NASA are listed in Table 2-1. The “Responsibility” column designates the organization(s) singular or joint control and/or the development of the document or function described. The “Support” column designates organizations that are required to contribute to development and

implementation of the documents and or functions and/or are expected to contribute to review of the appropriate documents.

There may be cases where JSC AMS Mission Manager has custody and control for AMS experiment hardware or software such as flight, ground test/support, training or integration hardware or software received at JSC. Those items will be classified as Customer Supplied Products (CSPs) and the handling of that hardware and/or software will comply with the following JSC System Level Procedures: JSC-SLP 4.7 Control of Customer- Supplied Product, JSC-SLP 4.8 Product Identification and Traceability, and JSC-SLP 4.15 Handling, Storage, Packaging, Preservation, and Delivery. This includes controlling, handling, storage, verification, traceability, and maintenance of items supplied by the external customer. Items to be supplied and Roles and Responsibilities covering these requirements, while in the custody of JSC, are notes in the separate Alpha Magnetic Spectrometer-02 (AMS-02) Experiment/Payload Integration Hardware (PIH) Interfaces, ICD-C-TBD Part 1.

The NASA/JSC on-site facilities that are required to support AMS activities are listed in Table 2-2. Each facility used by the AMS will be coordinated with the appropriate Division on an as required / as available basis by the use of an Internal Task Agreement (ITA).

2.3 PROGRAM SCHEDULES

The controlling ISS milestones are jointly controlled between ISS and AMS and will be in accordance with SSP 57057, “ISS Payload Integration Template.” The shared schedule and the internal schedule are controlled by the PIB.

2.4 HARDWARE DELIVERABLES

The quantity of AMS hardware items to be delivered is listed in Tables 2-3 and 2-4.

Figure 2-1 AMS PAYLOAD PROGRAM ORGANIZATION

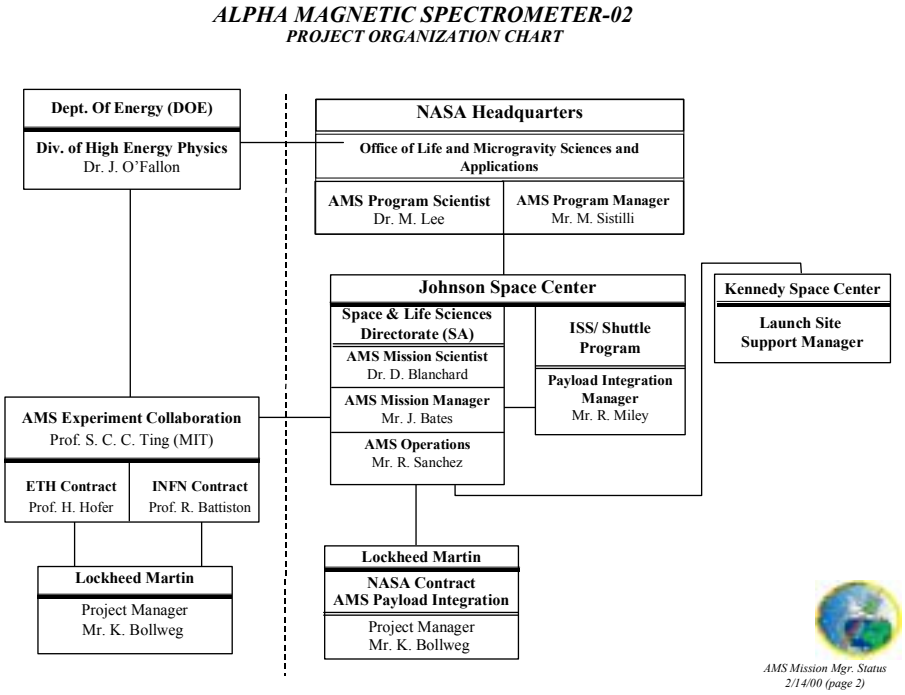


TABLE 2-1 AMS RESPONSIBILITY SUMMARY

PROGRAM ACTIVITY	RESPONSIBILITY	SUPPORT *
AMS Configuration Management Plan (CMP)	SF3/LMSO	AMS/NA
AMS Data Conversion Unit 02 (DCU-02) End Item Specification	SF3/LMSO	AMS/NA
AMS Experiment Flight & Ground Hardware	AMS	AMS/SF3/LMSO
AMS Integration Electrical design	SF3/LMSO	AMS
AMS Integration Ground Handling Equipment (GHE design)	SF3/LMSO	AMS
AMS Integration Ground Support Equipment (GSE) design	SF3/LMSO	AMS
AMS Integration Hardware Fabrication	SF3/LMSO	EM/NA^{+}
AMS Integration Mechanical design	SF3/LMSO	AMS/ES
AMS Integration Stress analysis	SF3/LMSO	AMS/ES
AMS Payload Interface Control Document (ICD) ICD-C-TBD	SF3/LMSO	AMS
AMS Payload Drawings	SF3/LMSO	EM/ AMS
AMS Payload Fracture analysis	SF3/LMSO	EM
AMS Payload Materials	SF3/LMSO	AMS/EM
AMS Payload PRD/PMP	SF3/LMSO	AMS, NA, EA, OZ
AMS Payload Thermal analysis	SF3/LMSO	AMS/ES, EC
AMS Structural Verification Plan	SF3/LMSO	AMS/ES
Government Certification Approval Request (GCAR)	SF3/LMSO	NT
IDRDs (Increment Definition and Requirements Documents) [Main Document]	OC	SF3/LMSO/AMS

IDRD Annex 1 [Manifest – up/down]	OC	SF3/LMSO
IDRD Annex 2 [On-orbit Maintenance]	OC	SF3/LMSO/OE

TABLE 2-1 AMS RESPONSIBILITY SUMMARY
(Continued)

PROGRAM ACTIVITY	RESPONSIBILITY	SUPPORT *
IDRD Annex 3 [Imagery]	OC	SF3/LMSO/OZ2
ISS Verification Plan	SF3/LMSO/OZ2	AMS
ISS/AMS ICD (Hardware)	OZ3	SF3/LMSO
ISS/AMS ICD (Software)	OZ3	SF3/LMSO/NA+
Mission Integration Plan (MIP) (Including Annexes)	MT	SF3/LMSO/OC/OZ2
NSTS/AMS ICD-A-TBD	MT	SF3/LMSO
Payload Data Library (PDL)	SF3/LMSO/OZ2	AMS
Payload Integration Agreement (PIA)	SF3/LMSO/OZ2	AMS
PIA Addendum	SF3/LMSO/OZ3	AMS
Safety Data Packages	SF3/LMSO	AMS/MA2/NC4/OE
Thermal Blankets Development	SF3/LMSO	AMS/EC
VC Development	SF3/LMSO	AMS/EM
USS Development	SF3/LMSO	AMS/EM
ACOP Development	SF3/LMSO	AMS/EM/EV
Verification test plans (ISS)	SF3/LMSO	OZ/NA^{+}
Verification test procedures (ISS)	SF3/LMSO	OZ/OB/NA^{+}
Verification test report (ISS)	SF3/LMSO	OZ/OB
Verification testing (ISS)	SF3/LMSO	EA/EC/ES/NA^{+}
Verification test plans (STS)	SF3/LMSO	ES/NA^{+}
Verification test procedures (STS)	SF3/LMSO	ES/EC/NA^{+}
Verification test report (STS)	SF3/LMSO	ES/EC

Verification testing (STS)	SF3/LMSO	ES/EC/NA[+]

* Supporting Organization List
[+] NA support for JSC on-site and off-site activities are per JSC and Lockheed-Martin standard practices

TABLE 2-1 AMS RESPONSIBILITY SUMMARY
(Concluded)

AMS Alpha Magnetic Spectrometer (Experiment)
EA Biomedical Hardware Development and Engineering Office
EC Crew And Thermal Systems Division
EM Manufacturing, Materials, & Process Technology Division
ES Structures And Mechanics Division
EV Avionics Systems Division
LMSO Lockheed Martin Space Operations
MA2 Space Shuttle Program Integration
MT Space Shuttle Customer & Flight Integration Office
NA Safety, Reliability And Quality Assurance Office
NC4 Payloads (PSRP) Group Lead
OB Vehicle Office
OC Operations and Utilization Office
OE Safety and Mission Assurance/Program Risk Office
OM Program Integration Office
OZ Payloads
OZ2 Mission Integration and Planning
OZ3 Hardware and Software Engineering Integration
SF3 Planning and Integration Branch

Additional detail on JSC Engineering Directorate support for AMS activities

EA Awareness of schedule and budgets for EA facilities and manpower support needed by AMS at JSC for the AMS Payload Integration Hardware Function.

EM MM&PTD Consultation and review of the requirements, mechanical design and drawings for all of the mechanical integration hardware. The Vacuum Case and some other hardware will be manufactured external to JSC. The Unique Support Structure (USS) and a large number of other pieces of integration hardware will also be manufactured, integrated and tested by MM&PTD. The Division will also advise and test materials as needed for the all of the integration hardware and work with AMS and ES on fracture control and support other analysis. This work will use facilities in JSC Buildings 9, 10 and White Sands Test Facility.

ES Structures and Mechanics Division will consult and review the integrated mechanical design, develop the integrated stress analysis. They will also consult on the Integrated Thermal Analysis. This Division will also be responsible for several aspects of AMS Verification Testing. These tests will include vibration, acoustics, modal testing. The Division will work with AMS to define the test requirements and the Division will be responsible for the test plans, procedures and operations. This work will use facilities in JSC Buildings 49 and 13. (Note: As an ISS task ES chairs the NASA/ES Structures Working Group, which is one of the approvals for ISS Payload Safety).

EC The Crew and Thermal Systems Division will be responsible for verification testing including thermal and thermal vacuum testing. The Division will work with AMS to develop requirements and modeling. For thermal, thermal vacuum, and other testing the Division will be responsible for the test plans, procedures and operations. The Division will assist AMS in defining the

requirements for thermal blankets and the Division will be responsible for the design, development, test and installation of the blankets for flight. This work will use facilities in Buildings 7, 32 and 33.

EV The Avionics Systems Division will be responsible for some of the verification testing of AMS data systems. This will include testing of high rate data, 1553 data, low rate data and commands. For this avionics testing in the Divisions laboratories the Division will be responsible for the test plans, procedures and operations. This work will use facilities in Buildings 14, 16 and 44.

Other There will undoubtedly be modifications, deletions and additions of testing to be accomplished.

TABLE 2-2 AMS SUPPORT FACILITIES REQUIREMENTS (JSC)

• J13 SML (Structures and Mechanics Laboratory) (for Modal & Static Testing)
• J14 EMI (Electromagnetic Interference) Chamber
• J16 SAIL (Shuttle Avionics Integration Laboratory)
• J32/J33 Thermal Vacuum Chambers (Thermal Vacuum & Thermal Cycle)
• J44 ESTL (Electronic Systems Test Laboratory)
• J49 VATF (Vibration and Acoustic Test Facility)
• J8 Photolab Facility
• J9/J10 MMPTD (Manufacturing, Materials & Process Technology Division)
• J9 SVMF (Space Vehicle Mockup Facility)
• J9 MDF (Manipulator Development Facility)
• TBD Offline Facility (Processing, Hardware Installation and Testing)
• Offsite NBL (Neutral Buoyancy Laboratory)
• Hypervelocity Impact Technology Facility
• J241 HLIF (HRF Launch Integration Facility)

TABLE 2-3 AMS PAYLOAD INTEGRATION HARDWARE DELIVERABLES

ITEMS	UNITS
* Berthing video camera system w/light package and cables (NASA GSE Kit)	1
* EVA (Extravehicular Activity) handrails/ Tether attach points	6 or less
* Flight Releasable Grapple Fixture (FRGF)	1
* Portable Foot Restraints (PFR) attach points	2 or less
* Power Video Grapple Fixture (PVGF)	1
* Remotely Operated Electrical Umbilical (ROEU) or Passive Electrical Disconnect System (PEDS) (passive half)	1
* Umbilical Mechanism Assembly (UMA) (passive half)	1
* Labels and Decals	TBD at CDR
AMS Science Data and Operations Equipment (ACOP) (Flight)	2
ACOP (Ground/Training)	3
Cables & Brackets	TBD at CDR
Cryomagnet Vacuum Case (VC) (Flight Article)	1
VC Structural Test Article (STA)	1
Data Conversion Unit-02 (DCU-02)	2
GHE (Ground Handling Equipment) Stand	1
GHE Lifting Fixtures	3
GHE Pedestals	4
GHE Installation Brackets	8
GHE Assembly Fixture	1
STE (Special Test Equipment) - AMS Cryomag Cold Mass Simulator	1
STE equipment for structural testing	TBD at PDR
Orbital debris and meteoroid shields	TBD at CDR

Payload Attach System (PAS) (Passive Half)	1

TABLE 2-3 AMS PAYLOAD INTEGRATION HARDWARE DELIVERABLES

(Concluded)

ITEMS	UNITS
Trunnion scuff plates for deployable payloads	4 (Part of USS-02)
Thermal Blankets	TBD at CDR
Unique Support Structure-02 (USS-02)	1

* Items supplied by NASA STS or ISS and integrated into AMS payload by the JSC PIB.

TABLE 2-4 AMS INTEGRATION HARDWARE SUPPLIED BY THE NSTS/ISS

(Reference Only)

ITEMS	UNITS
APCU (Assembly Power Converter Unit)	2
OIU (Orbiter Interface Unit)	2
PDIP (Payload Data Interface Panel)	1
PGSC (Payload and General Support Computer)	2
TBD (PEDS or ROEU) (active half)	1
Unique Cables	as required
PAS (active half)	1
UMA (active half)	1

3.0 REFERENCE DOCUMENTS

The reference documents that form part of this PRD/PMP are contained in Appendix A and are applicable to AMS as specified herein or in the AMS Verification Plan. The current document issue in effect on the date of approval of this PRD/PMP shall apply unless otherwise noted. A notation of “Current issue” after date of approval indicates all future changes and revisions are applicable to the AMS project as stated above. Appendix A of this document is a copy of the AMS Master Document List (MDL) as of the release of this document and includes all documentation currently planned by the AMS Project. Updates to the AMS Master Document List and their corresponding call-out in this and other AMS documents must be carefully considered as they may have significant impact to the hardware requirements, engineering, design, development, test, verification and operations.

4.0 REQUIREMENTS

4.1 PROGRAM REQUIREMENTS

The AMS-01 payload configuration that was developed for and flown on STS-91 was certified to fly by the Space Shuttle Program requirements that were implemented and certified by the previous version of this document and associated certification plans. The AMS being addressed by this revision of the PRD/PMP (AMS-02) is a payload for the ISS and therefore must comply with the ISS Program requirements for payloads. The ISS Addendum to NSTS 1700.7B supplements payload safety requirements, although the reporting method is the same.

Throughout this document and other updated AMS documentation, the ISS process will be referred to as payload verification. The former terms of acceptance and certification have their requirements and intent incorporated as part of the verification process.

The ISS and STS requirements for the AMS payload are listed in Table 4-1, ISS/AMS Documentation List. There are two groups that are tabulated. The first of these represents the generic requirements documents that ISS and STS impose on payloads. The second set of documents will be developed as “responses” to the generic requirements that are specific to the AMS payload. The developer of these documents is also listed as well as the control authorities. Figure 4-1, AMS Documentation Tree, shows the relationship of these documents and includes informational documents. The requirements for the operations implementation are not listed here as they are being developed. They will be incorporated in this document by a later change or revision.

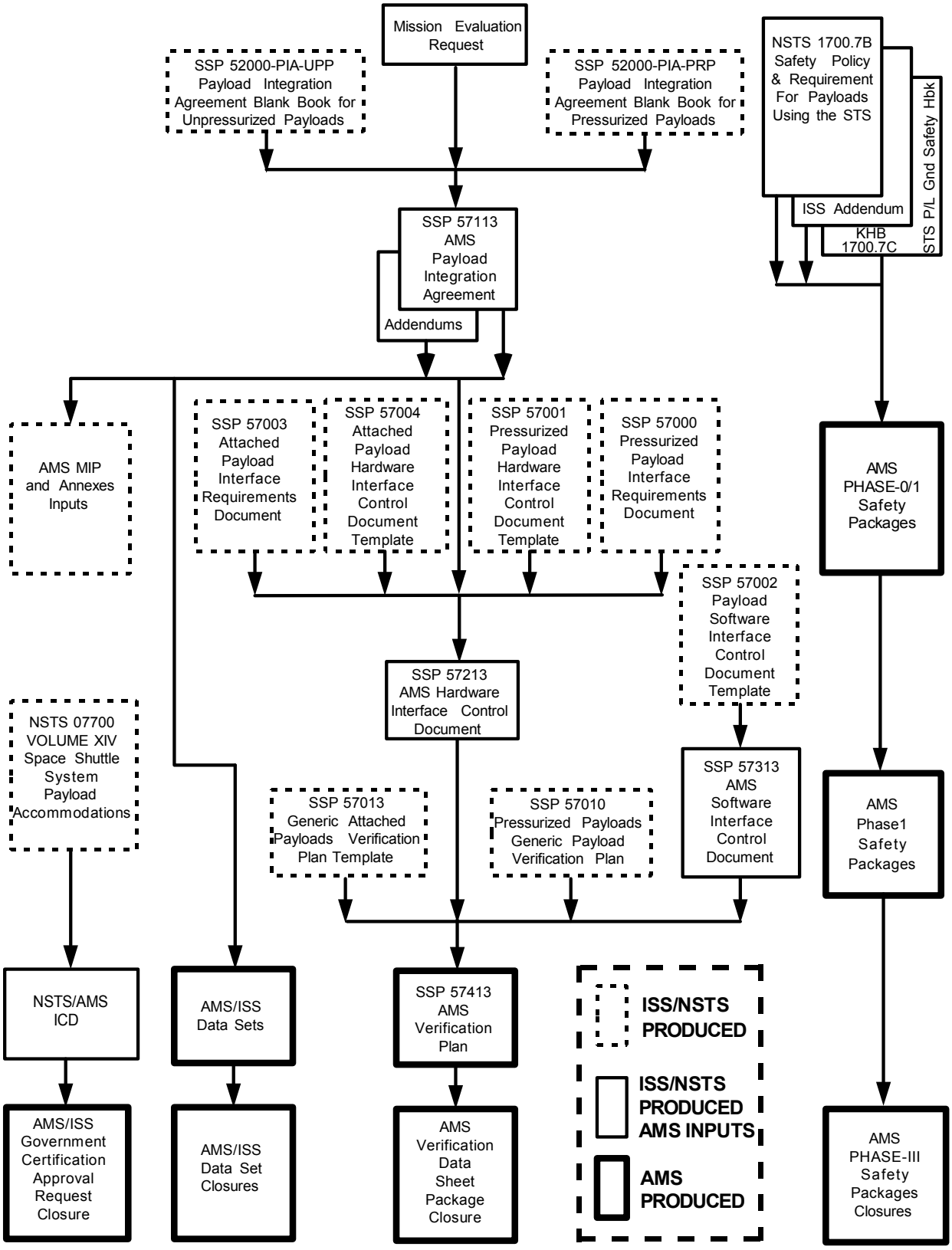
The AMS is an unpressurized payload; however, the onboard command and control and backup data recording hardware will require a location in the pressurized volume of the Station so that onboard crew can operate that hardware for those functions. This equipment is referred to as the AMS Crew Operations Post (ACOP). That hardware has to meet the requirements for pressurized payloads that have requirements that are not applicable to truss site-attached payloads. Those applicable portions of the pressurized

requirements will be included in the AMS Payload Integration Agreement, the AMS Hardware Interface Control Document, the AMS Verification Plan and the AMS Safety Packages. Vehicle software to support the AMS payload is to be developed by and integrated by STS or ISS and will have requirements

TABLE 4-1 ISS/STS/AMS DOCUMENTATION LIST

	Payload Requirements		AMS Requirements/Agreements/Data	Resp.	Control
SSP 52000-PIA-UPP	Payload Integration Blank Book for Attached Payloads	SSP 57113	AMS Payload Interface Agreement	ISS	ISS/AMS
SSP 52000-PIA-PRP	Payload Integration Blank Book for Pressurized Payloads				
SSP 57003	Attached Payload Interface Requirements Document	SSP 57213	AMS Hardware Interface Control Document	ISS	ISS/AMS
SSP 57004	Attached Payload Hardware Interface Control Document Template				
SSP 57000	Pressurized Payload Interface Requirements Document				
SSP 57001	Pressurized Payload Hardware Interface Control Document Template				
NSTS 07700 Volume XIV	Space Shuttle System Payload Accommodations	ICD-A-TBD	Shuttle Orbiter/AMS Cargo Element Interfaces	ISS	NSTS
SSP 57002	Payload Software Interface Control Document	SSP 57313	AMS Software Interface Control Document	ISS	ISS/AMS
SSP 57013	Generic Attached Payload Verification Plan Template	SSP 57413	AMS Verification Plan (AMS Verification Data Sheet Closures)	AMS	AMS/ISS
SSP 57010	Pressurized Payloads Generic Payload Verification Plan				
NSTS 1700.7B	Safety Policy and Requirements for Payloads Using the Space Transportation System	JSC TBD	AMS Phase 0/I Safety Package AMS Phase II Safety Package AMS Phase III Safety Package	AMS	ISS/AMS JSC PSRP
NSTS 1700.7B ISS Addendum	Safety Policy and Requirements for Payloads Using the International Space Station				
NSTS/ISS 13830C	Payload Safety Review and Data Submittal Requirements				
NSTS/ISS 18798B	Interpretations of NSTS/ISS Payload Safety Requirements				
KHB 1700.7C	Space Shuttle Payload Ground Safety Handbook	JSC TBD	AMS Phase 0/I Safety Package AMS Phase II Safety Package AMS Phase III Safety Package	AMS	ISS/AMS KSC GSRP

Figure 4-1 AMS DOCUMENTATION TREE



that will be documented in SSP 57313, “Alpha Magnetic Spectrometer (AMS) Software Interface Control Document.” The closure of the software interface verifications will be part of a single AMS Verification Plan. AMS Experiment internal software is the sole responsibility of the AMS Experiment team.

The AMS-02 design and development will have to proceed and precede some of the ISS generic schedules. Structural design and development is part of the critical flow and the AMS Vacuum Case must be completed prior to integrated testing between the USS-02, magnet, and experiment hardware. The structural verification plan (JSC 28792) has been taken to the STS Structures Working Group (SWG) and ISS Structures Team prior to the AMS Preliminary Design Review (PDR) in order to accelerate the structures development schedule.

4.1.1 CONFIGURATION MANAGEMENT

4.1.1.1 Purpose

The configuration management requirements, responsibilities and procedures are contained in JSC-27542, “AMS Configuration Management Plan (CMP).” All changes to this PRD/PMP shall be controlled by the AMS Configuration Control Panel as delegated by the Director, Space and Life Sciences. Documents jointly controlled (if applicable) by the CMP and the Shuttle Program are also in accordance with NSTS 07700, Volume IV, “Space Shuttle Configuration Management Requirements.” Documents jointly controlled by the CMP and the International Space Station Program are also in accordance with SSP 50123-01, “Configuration Management Handbook, Volume 1.” The purpose of this plan is to establish and implement an AMS configuration management system (CMS) to manage and control the following:

- AMS Payload Integration Hardware design requirements
- Interfaces (structural/mechanical, cable, display and control, command, telemetry and data) to the Orbiter, ISS and to the AMS Experiment
- Resource requirements consisting of power, weight, volume, and crew time
- ACOP software requirements
- ROEU or PEDS
- APCU requirements
- Mission requirements

- Power requirements from the APCU and the Orbiter

This process will ensure that all proposed changes to the baseline are evaluated and dispositioned in an orderly and coordinated manner and will maintain compatibility of the AMS instrument with the Orbiter and with the International Space Station.

4.1.1.2 Design Reviews

Configuration of the integration hardware equipment will be established through appropriate design reviews. The AMS Preliminary and Critical Design Reviews (PDR/CDR) will be supported by a design review committee appointed from various JSC and AMS organizations and chaired by the NASA/JSC Flight Projects Division.

4.1.1.3 Baseline Design Configuration

A baseline configuration for payload integration hardware will be released via drawings and documentation in accordance with JPG 8500.4, Rev D, “JSC Engineering Drawing Practices.” These drawings shall define the configuration sufficiently to allow end item identification, end item modification, and end item fabrication/assembly, and safety assessment, as appropriate.

4.1.1.4 Fabrication and Assembly

Fabrication and assembly of flight integration hardware will follow the baseline design configuration and will be inspected to the requirements specified therein. Task Performance Sheets (TPSs) will be used to ensure conformance to the baseline design requirements. Data Package Requirements shall be satisfied by use of JSC Form 911 (JSC Projects Parts Tag) and/or JSC Form 772 (Functional Equipment Historical Record) will be used to track all hardware.

4.1.1.5 Testing and Verification

Verification testing shall be accomplished with approved test procedures or TPSs. Verification shall be accomplished in accordance with SSP 57413, “Alpha Magnetic Spectrometer - 02 (AMS) Attached Payload Verification Plan.”

4.1.1.6 AMS Payload Training

Payload training of the ISS crew, AMS trainees and operations personnel will be accomplished using AMS ground hardware, AMS training hardware and AMS flight

hardware. This training will be implemented by the JSC-36307, “NASA Training Implementation Plan (TIP).”

4.1.1.7 AMS Payload Operations

The AMS payload will be operated from an AMS Payload Operations Control Center which will have communications, video and data interfaces with the Payload Operations Control Center at MSFC. The payload operations will be in accordance with SSP 58311, Volume 1, “Payload Operations Integration Center Payload Operations Handbook” and SSP 58312, Volume 2, “Payload Operations Integration Center Payload Operations Handbook – Increment Operations.”

4.1.2 PROGRAM DOCUMENTATION REQUIREMENTS

Program requirements for Space Station Payloads are considerably different as explained in the previous section. STS requirements are now in the ISS documentation and they are called out in this document and other AMS documentation. Other STS requirements that were previously levied via the certification route have been incorporated in principle in the ISS requirements. Specific examples are the standards in JHB 8080.5, “JSC Design and Procedural Standards Manual” and SSP 50005, “ISS Flight Crew Integration Standard. These requirements have equivalents in SSP 57003, “Attached Payload Interface Requirements Document,” and 57004, “Attached Payload Hardware ICD Template.”

The left hand list of documents in Table 4-1 contains the ISS and STS requirements that are applicable to any pressurized or unpressurized payload. The right hand list of documents in Table 4-1 represents the final negotiated requirements that are applicable to AMS. The documents also define how those requirements will be met and also includes the methods and forms that will be used to document the implementation closures.

Table 4-1 is now the documentation required for AMS on the International Space Station including the requirements on the payloads that are needed to meet the Space Shuttle requirements.

One of the results of this is to delete the Appendix-B as we build this revision (Revision A) of this document. The applicable requirements are still valid, but included in 57003, "Attached Payload Interface Requirements Document;" 57004, "Attached Payload Hardware ICD Template," or other ISS documents. The requirements in the SSP 570XX series of documents includes all requirements applicable to the AMS as implemented by the SSP 57113, "Alpha Magnetic Spectrometer (AMS) Payload Integration Agreement;" SSP 57213, "Alpha Magnetic Spectrometer (AMS) Hardware Interface Control Document;" 57313, "Alpha Magnetic Spectrometer (AMS) Software Interface Control Document;" and as verified by the SSP 57413, Alpha Magnetic Spectrometer (AMS) Verification Plan" and verification data sheet closures.

Another result is that the other documents in Appendix A, AMS Master Document List, will contain few requirements on the AMS payload that have not been met by the ISS implementation. Any such requirements will be designated specifically in this document and referenced to the appropriate section of a document in the AMS Master Document List-Appendix A.

Most of the previous Certification Plans for AMS Hardware that were used for STS-91 have now been superseded by ISS requirements and implementation. These are no longer a part of the AMS documentation.

The AMS Structural Verification Plan (JSC 28792) for the AMS Payload will be incorporated by reference in the appropriate structures section of the AMS Verification Plan (SSP 57413). This particular document fits into the methodology of the SWG and the ISS Structures Team.

4.1.3 SAFETY, RELIABILITY & QUALITY ASSURANCE REQUIREMENTS

The requirements for STS and ISS Flight Payload Safety and KSC Ground Processing Safety are listed in Table 4-1, ISS/STS/AMS Documentation List. The methods of implementation, verification and closure are also per the documents listed. The overall AMS payload safety is the responsibility of all organizations involved. The major

organizations and/or functions are: OLMSA, AMS Payload Mission Manager, JSC STS Mission Management, ISS Management, LMSO and the AMS Experiment Collaboration.

The requirements for reliability and performance of the AMS Experiment are the responsibility of the funding organization (Department of Energy) and the AMS Experiment Collaboration.

The responsibility for the AMS integration function is with NASA Headquarters, OLMSA as represented by the AMS Principle Investigator and the Payload Mission Manager. The reliability and performance of the overall AMS payload will be considered continuously by all parties of the integrated AMS team in the process of design, development, engineering and test of the AMS payload.

4.2 DESIGN REQUIREMENTS

4.2.1 PHYSICAL REQUIREMENTS

4.2.1.1 Weight and Center of Gravity (CG)

The combined weight and Center of Gravity (CG) of the AMS payload, structural housing, electrical circuitry and connections, shall not exceed the maximum weight and CG specification (as applicable) specified in SSP 57113, “Alpha Magnetic Spectrometer (AMS) Payload Integration Agreement.”

4.2.1.2 Size

Maximum payload control dimensions of the AMS-02 payload shall be as specified in SSP 57113, “Alpha Magnetic Spectrometer (AMS) Payload Integration Agreement.”

4.2.1.3 Mounting Requirements

The AMS-02 Experiment will be attached to the USS-02 which will establish the required orientation of the payload and correct field of view. Mounting requirements for the AMS Experiment to the USS are presented in ICD-C-TBD, “Interface Control Document for Integration of the AMS payload to the USS.” Mounting requirements for installation of the AMS-02 payload in the Orbiter cargo bay are presented as part of an integrated payload bay NSTS/AMS ICD-A-TBD, “Shuttle Orbiter/AMS Cargo Element Interfaces.”

4.2.2 POWER REQUIREMENTS

The ISS/AMS power interface characteristics shall comply with the requirements presented in ISS/AMS ICD, SSP 57213, and shall comply with NSTS 1700.7B, NSTS 1700.7B ISS Addendum and NSTS/ISS 18798 with respect to over current protection, radiated interference and conducted interference.

The Orbiter/AMS power interface characteristics shall comply with the requirements presented in Orbiter/AMS ICD, and shall comply with NSTS 21000-IDD-ISS, NSTS 1700.7B and NSTS/ISS 18798 with respect to over current protection, radiated interference and conducted interference.

4.2.3 PERFORMANCE REQUIREMENTS

4.2.3.1 General

The AMS-02 payload experiment will be designed for limited operation of 100 hours aboard the Space Shuttle prior to removal from the Orbiter payload bay and installation on the ISS. (The AMS magnet is not planned to be operated in the Space Shuttle.) It will be designed to operate for a minimum of 1000 days (24,000 hours) of viable science operations aboard the ISS. The AMS-02 ISS operations will produce scientific data on charged particles passing through the stacked instruments with those particles under the influence of the large magnetic field produced by the cryogenic superconducting magnet. During the operational mission aboard the ISS, the initial AMS science objectives are as follows:

- To search for antimatter (anti-helium and anti-carbon) in space with a sensitivity of 10^4 to 10^5 better than current limits.
- Science Operations
- To search for dark matter (90% of the theoretical matter in the universe is not visible or currently detectable).
- To study cosmic ray physics.

4.2.3.2 Command and Control Requirements

Operations of the AMS payload will be controlled by commands issued by an operator in the AMS remote Payload Operations Control Center and routed through the POIC for validity checks. Details of the command and control interface between the AMS-02

payload DCU-02, OIU (including requirements for utilizing the MIL-STD-1553 data bus) and the Shuttle are presented in the AMS/ISS ICD, SSP 57213.

Details of the command and control interface between the AMS payload (including requirements for utilizing the MIL-STD-1553 data bus and the high rate data system) and the International Space Station are presented in SSP 57113, “Alpha Magnetic Spectrometer (AMS) Payload Integration Agreement ” and the ISS/AMS ICD, SSP 57213.

4.2.4 INTERFACE REQUIREMENTS

4.2.4.1 Orbiter Interface Requirements

The AMS payload to Orbiter interface requirements shall comply with the requirements defined in the ISS/AMS ICD, SSP 57213, and NSTS 21000-IDD-ISS, “Shuttle Orbiter/Space Station Interface Definition Document,” with which the AMS payload must be compatible.

4.2.4.2 ISS Interface Requirements

The AMS-02 payload to ISS hardware interface requirements shall comply with the requirements of the ISS/AMS ICD, SSP 57213, that will be developed using SSP 57003, the AP IRD; SSP 57000, “Pressurized Payloads Interface Requirements Document;” and SSP 57004, “Attached Payload Hardware Interface Control Document Template.” The AMS-02 payload to ISS software interface requirements shall comply with the requirements of SSP 57313, “Alpha Magnetic Spectrometer (AMS) Software Interface Control Document” that will be developed using SSP 57002, “Payload Software Interface Control Document Template.”

4.2.5 OPERABILITY REQUIREMENTS

4.2.5.1 Useful Life

The useful life of the system and its components generally shall be the sum of operational life and shelf life. With respect to the AMS payload integration hardware, the useful life shall be 10 years minimum.

4.2.5.2 Operational Life

Operational life is defined to apply to any hardware item that deteriorates with increased accumulation of operating time and/or cycles and thus requires periodic replacement or refurbishment to assure its operating characteristics have not been degraded beyond acceptable limits. Operational life includes the usage during flight, ground test, and prelaunch operations.

The operating life of the AMS payload shall be a minimum of 5 years.

4.2.5.3 Shelf Life

Shelf life is defined as that period of time that the components of the system can be stored under controlled conditions, during which they may be removed from storage and put into service without replacement of parts, beyond routine servicing and installation of consumables.

The shelf life of the AMS payload shall be a minimum of 5 years.

4.2.5.4 Limited Life

Limited life is defined as applying to any hardware item, whether installed or stored, that deteriorates with the passage of time and thus requires periodic replacement, refurbishment, retest, or operation to assure that its operating characteristics have not been degraded beyond acceptable limits. Limited life items will be identified in the AMS Verification Data Sheets.

4.2.6 GENERAL DESIGN REQUIREMENTS

This section lists some of the requirements that were implemented for the integration hardware for AMS-01 that flew on STS-91. Some of the general requirements are listed below. These may be added to, modified, or deleted as part of the ISS requirements for AMS on Space Station per the ISS/AMS ICD, SSP 57213.

The set of generic requirements that are levied on ISS payloads are listed on the left side of Table 4-1. The two primary documents are the SSP 57003, the AP IRD, and SSP 57004, "Attached Payload Hardware Interface Control Document Template." The AMS and the ISS will distill this set down to the requirements that are needed and applicable for the AMS to implement throughout the design, development, test and evaluation of the AMS Payload.

This set becomes the ISS/AMS ICD, SSP 57213, which then becomes the specific requirements to AMS, including the applicable generic requirements. Note that there are no requirements for performance or mission success in the above requirements as those are the responsibility of the AMS Experiment organizations.

The ISS/AMS ICD, SSP 57213, and SSP 57013, "Generic Attached Payload Verification Plan Template" are then used by the AMS Payload to develop the SSP 57413, "Alpha Magnetic Spectrometer (AMS) Attached Payload Verification Plan." When the AMS and the ISS agree to this plan, the total criteria for the verification of the AMS ICD is defined. When this activity and all safety activity are completed and closure agreed to by ISS and STS, the payload is considered to have completed its total verification and safety process.

4.2.6.1 Structural Design

For primary structure, minimum safety factors and loads as defined in JSC-28792, "AMS-02 Structural Verification Plan for STS and ISS," shall be used for structural design, analyses and testing. Ultimate loads are maximum operating loads multiplied by the safety factor. The USS-02 structural hardware will be strength tested; therefore, a minimum allowable safety factor shall be used as specified in the AMS-02 Structural Verification Plan and approved by the SWG and in accordance with Section 208.1 of NSTS 1700.7B, and by the ISS Structures/Verification Group and in accordance with Section 208.1 of NSTS 1700.7B ISS Addendum.

For most secondary structure a minimum safety factor of 2.0 shall be used as the standard value in structural design to determine ultimate loads. The resulting strength will be based on analysis only. This will require approval by the SWG and the ISS Structures Team. The complete listing of safety factors can be found in JSC-28792.

Fracture control requirements in NASA-STD-5003, “Fracture Control Requirements for Payloads Using the Space Shuttle,” and SSP 30558, “Fracture Control Requirements for Space Station” will both be implemented in accordance with JSC-25863, “Fracture Control Plan for JSC Flight Hardware.

4.2.6.2 Temperature Requirements and Thermal Control

The AMS-02 payload, other than the cryogenic cooled systems, will be maintained at a moderate temperature during all phases of the ground and mission operation. During flight operations closer limits will be desired. AMS-02 payload thermal control in the Shuttle payload bay is the responsibility of the AMS Experiment and will be maintained using a combination of orbiter attitude control, heaters, radiators and TBD. AMS-02 payload thermal control on the ISS truss is the responsibility of the AMS and will be maintained using a combination of heaters, radiators and TBD. Thermal control of the AMS ACOP in the ISS pressurized volume may be maintained using fans.

4.2.6.3 Manned Spacecraft Criteria and Standards

The JSC Design and Procedural Standards Manual, JHB 8080.5, will be screened with respect to the criticality and intended usage of the AMS payload, and those standards identified for AMS-02 will be implemented as part of the AMS Verification Plan.

4.2.6.4 Electromagnetic Interference/Electromagnetic Compatibility

The AMS-02 Payload shall minimize electromagnetic interference (EMI). Measured data from AMS-02 Payload EMI tests will be supplied to the STS and ISS per NSTS 21288, “Required Data/Guidelines for Payload/Shuttle Electromagnetic Comparability Analysis;” and SSP 30237, “Space Station Electromagnetic Emission and Susceptibility Requirements.” Those requirements of SSP 57003 (the AP IRD), NSTS 21288 and SSP 30237 that cannot be met will be addressed with the measured data as part of a waiver with rationale.

There are no ISS requirements for the AMS-02 payload to undergo Electromagnetic Compatibility (EMC) susceptibility testing; however, the AMS Payload will consider selected radiated testing such as Ku band interference.

4.2.7 FABRICATION REQUIREMENTS

This section lists some of the fabrication requirements that were implemented for the integration hardware for AMS-01 that flew on STS-91. Some of the general requirements are listed below. These may be added to, modified, or deleted as part of the ISS requirements for AMS on Space Station per the ISS/AMS ICD, SSP 57213.

4.2.7.1 Materials and Processes

Materials and processes for integration hardware manufactured at JSC shall meet SSP 57003 and SE-M-0096, “General Specification for Materials and Processes Requirements for JSC Controlled Payloads,” and the materials requirements of sections 208.3 and 209 of NSTS 1700.7B and NSTS 1700.7B ISS Addendum. Evaluation of materials for outgassing, flammability, corrosion, and stress corrosion cracking can be obtained from MSFC-HDBK-527/JSC-09604, “JSC GFE Materials Selection List and Materials Documentation Procedures,” and the Materials and Processes Technology Information System (MAPTIS) internet web site. Fracture control requirements in NASA-STD-5003, “Fracture Control Requirements for Payloads Using the Space Shuttle,” shall be implemented in accordance with JSC-25863, “Fracture Control Plan for JSC Flight Hardware.”

4.2.7.2 Finish Protection and Corrosion Prevention

All surface coatings on mating surfaces shall be electrically conductive, if practical, to prevent static charge accumulation. On the Orbiter, nonconducting mating surfaces shall be bonded with a grounding strap in accordance with the ISS/AMS ICD, SSP 57213. When installed on the ISS, nonconducting mating surfaces shall be bonded in accordance with the unique AMS attached payload ICD.

4.2.7.3 Electrical, Electronic and Electromechanical Parts

4.2.7.3.1 EEE Parts Selection for NASA/SF3 Fabrication

For items fabricated by NASA/SF3, Electronic, Electrical, and Electromechanical (EEE) parts shall be selected to the maximum extent possible consistent with availability and schedule from the NASA Parts Selection List (NPSL) internet web site,

http://misspiggy.gsfc.nasa.gov/npsl/. Integrity of commercial circuit boards will be preserved to the maximum extent possible.

4.2.7.3.2 Commercial Off-The-Shelf Equipment

When commercial off-the-shelf equipment (COTS) is considered as a space flight candidate, an analysis shall be conducted to determine the acceptability of the as-built equipment.

4.2.7.4 Sharp Edges

Sharp edges for the ISS attached payload hardware shall meet the criteria established in SSP 57003, the AP IRD, and for the ISS pressurized volume shall meet the criteria established in SSP 57000. Sharp edges for the STS shall meet the requirements of NSTS 07700, Volume XIV, Appendix 9 for IVA and shall meet the requirements of NSTS 07700, Volume XIV, Appendix 7 for EVA.

4.2.7.5 Cleanliness

The AMS hardware on the Shuttle shall meet the visibly clean requirements of SN-C-0005, “National Space Transportation System, Contamination and Control Requirements,” and JHB 5322.1, “Contamination Control Requirements Manual.” On the ISS, pressurized payloads shall met the requirements of SSP 57000 and unpressurized payloads shall meet the requirements of SSP 57003.

4.2.7.6 Surface Roughness

Surface roughness shall be defined on drawings in accordance with ANSI B46.1, “Surface Texture (Surface Roughness, Waviness, and Lay).”

4.2.8 INTERCHANGEABILITY AND REPLACEABILITY REQUIREMENTS

All replaceable parts or assemblies having the same part number shall be directly and completely interchangeable with each other with respect to installation and performance. Each assembly shall be designed to be replaceable with all other assemblies having the same part number without requiring the replacement of the other assemblies. Changes in part number shall be governed by the configuration management requirements of paragraph 4.1.1.

Interchangeability requirements are not applicable to detail parts of permanent assemblies, such as welded assemblies or matched detailed parts, such as lapped components. Interchangeability requirements do not apply to custom fitted or sized items.

4.2.9 IDENTIFICATION AND MARKING REQUIREMENTS

Identification and marking shall be compatible with SSP 50006, “International Space Station Internal and External Decals and Placards Specification.” The method of identification may have to be non-standard depending upon the size and shape of the item and the available suitable surfaces. Inventory Management System (IMS) bar code labels shall be affixed to the AMS-02 hardware as specified by SSP 50007, “Space Station Inventory Management System Label Specification.” The labels will be supplied to the AMS by the ISS.

4.2.10 DESIGN AND TEST ENVIRONMENTS

The AMS Payload Integration Hardware shall meet environmental requirements as specified in SSP 57003, the AP IRD, to the extent that the result of exposure does not create a safety hazard or damage the NSTS/ISS hardware or the hardware or operation of other NSTS/ISS experiments. Some functional testing of the AMS Payload Integration Hardware will be done, but performance criteria, if any, will be specified by the Payload Developer.

5.0 SAFETY, RELIABILITY AND QUALITY ASSURANCE PROVISIONS

The AMS Space Station payload mission is a flight of 3 years scientific operational duration on the ISS to be launched on the ISS-26-UF4 flight. A formal design verification program shall be conducted in accordance with SSP 57413, “Alpha Magnetic Spectrometer (AMS) Attached Payload Verification Plan” to demonstrate that the equipment is adequate to meet the requirements of this document for the International Space Station Program. This would include the shuttle interfaces and requirements. Several methods are available for verification of the equipment. These methods are verification by test, demonstration, analysis, and similarity.

Verification tests shall be performed using flight items with the exception of some of the structural testing. The detailed test requirements and the identification of the specifically required tests shall be defined in SSP 57413, “Alpha Magnetic Spectrometer (AMS) Attached Payload Verification Plan.”

5.1 TOUCH TEMPERATURES

The Intravehicular Activity (IVA) touch temperatures for the AMS pressurized volume equipment will meet the requirements of SSP 57000, “Pressurized Payloads Interface Requirements Document.”

The EVA touch temperatures for the AMS payload bay (attached payload) equipment will meet the requirements of SSP 57003, the AP IRD.

5.2 VERIFICATION TEST REQUIREMENTS

Some equipment provisioned under this document may be verification tested, stored, and processed for mission usage in accordance with approved procedures, test preparation sheets, and policies. Inspection shall be performed for conformance to released drawings and/or approved modification/assembly procedures. Most of the AMS Payload Integration Hardware will be used for flight as well as for verification, the environmental acceptance testing will be performed per SSP 57413, “Alpha Magnetic Spectrometer (AMS) Attached Payload Verification Plan.”

5.3 SAFETY

The requirements of NSTS 1700.7B, “Safety Policy and Requirements for Payloads Using the Space Transportation System;” NSTS 1700.7B ISS Addendum, “Safety Policy and Requirements for Payloads Using the International Space Station”; 45 SW HB S-100/KHB 1700.7, “Space Shuttle Payload Ground Safety Handbook;” and LMSMSS 31039, “Safety and Health Plan Science, Engineering, Analysis, and Test Contract” shall apply. Flight hazards shall be reviewed and approved by the Payload Flight Safety Panel and ground hazards by the KSC Ground Safety Panel in accordance with NSTS/ISS 13830, “Payload Safety Review and Data Submittal Requirements for Payloads Using the Space Shuttle and the International Space Station.”

5.3.1 SAFETY TECHNICAL REQUIREMENTS

The safety technical requirements for the flight hardware and flight operations are established by NSTS 1700.7B, “Safety Policy and Requirements for Payloads Using the Space Transportation System;” NSTS 1700.7B ISS Addendum, “Safety Policy and Requirements for Payloads Using the International Space Station;” and the safety interpretation letters in NSTS/ISS 18798, “Interpretations of NSTS/ISS Payload Safety Requirements.”

The safety technical requirements for the KSC ground equipment and ground operations are established by 45 SW HB S-100/KHB 1700.7, “Space Shuttle Payload Ground Safety Handbook.”

5.3.2 SAFETY DOCUMENTATION REQUIREMENTS

The safety documentation requirements for the flight and ground safety processes are established by NSTS/ISS 13830. Three (Phases 0/I, II and III) Flight Safety Data Packages and three (Phases 0/I, II, and III) Ground Safety Data Packages will be prepared in accordance with the format and data requirements of NSTS/ISS 13830. The Flight Safety Data Packages will be submitted through ISS Payloads to the JSC Payload Flight Safety Review Panel for approval. The Ground Safety Data Packages will be submitted through ISS Payloads to the KSC Payload Ground Safety Review Panel for approval.

5.4 RELIABILITY TECHNICAL & DOCUMENTATION REQUIREMENTS

The AMS Payload Project has determined that only minimal reliability activities are realistic for the integration hardware that will be used for the AMS-02 mission.

Testing will be performed with the ACOP which is made up of off-the-shelf-modified hardware and the system will have sufficient verification, functional, integrated and end-to-end testing throughout the integration and test phase of the payload integration activity.

The AMS USS-02 Unique Support Structure and the AMS-02 Vacuum Case will have all of their requirements, tests and analysis established as part of JSC-28792, “Alpha Magnetic Spectrometer – 02 Structural Verification Plan for the Space Transportation System and the International Space Station.”

Any AMS Payload Integration Hardware built at JSC or off-site, that is delivered to the STS by GCAR (Government Certification Approval Request) will have its reliability assessed by JSC/NT per an AMS Payload Integration Certification Plan.

5.5 QUALITY ASSURANCE TECHNICAL AND DOCUMENTATION REQUIREMENTS

The AMS payload quality assurance will comply with JPD 5335.1 for on-site JSC activities. Design, development and maintenance and will be in accordance with the requirements specified in JPG 5300.4 (1D-2), “Safety, Reliability, Maintainability, and Quality Provisions for the Space Shuttle Program,” as implemented by JSC-16427, “Procurement Quality Provisions for NASA JSC Space Transportation System Payloads,” with the exception of the following paragraphs of JPG 5300.4 (1D2):

- ID 500.6 Management Assessment Data
- ID 505.8 Walk Through Shakedown Inspection
- ID 505.9 Quality Assurance Designee
- ID 505.10 Vehicle Access Control

Quality Assurance at Lockheed-Martin Houston off-site facilities will comply with LMSEAT-31041, Lockheed-Martin Quality System Manual, SEAT Contract.

5.6 WORKMANSHIP

AMS Payload Integration Hardware manufactured at JSC will comply with the following workmanship standards:

- GSFC S312-P-003
- IPC 2221 “Generic Standard on Printed Wiring Board Design”
- IPC 2222 “Sectional Design Standard for Rigid Organic Printed Boards”
- IPC 6011 “Generic Performance Specification for Printed Boards”
- IPC 6012 “Qualification and Performance for Rigid Printed Boards”
- NASA-STD-8739.3 “Requirements for Soldered Electrical Connections”
- NASA-STD-8739.4 “Requirements for Interconnecting Cables, Harnesses and wiring”
- NASA-STD-8739.5 “Workmanship Standard for Fiber Optic Terminations, Cable Assemblies, and Installation”
- NASA-STD-8739.7 “Electrostatic Discharge Control (Excluding Electrically Initiated Explosive Devices”
- NAS 5300.4(3J-1) “Workmanship Standard for Staking and Conformal Coating of Printed Wiring Boards and Electronic Assemblies”
- NAS 5300.4(3M) “Workmanship Standard for Surface Mount Technology”

Workmanship for AMS PIH manufactured by LMSO at the JSC site or at Lockheed-Martin off-site facilities will comply with LMSEAT-31041, “Lockheed-Martin Quality System Manual for SEAT.”

6.0 TEST FACILITY REQUIREMENTS

JSC test facilities will be required to conduct the tests listed below. The AMS Mission Manager will coordinate with each for test facility scheduling. Funding for the tests will be provided by the payload Planning and Integration Branch as required, and the appropriate test request forms will be submitted.

6.1 SPACE ENVIRONMENTAL SIMULATION LABORATORY

Thermal vacuum chamber(s) in the Space Environmental Simulation Laboratory (SESL), JSC Building 32 or 33 will be used, as required, for engineering and verification testing of the AMS payload hardware in a space thermal vacuum environment.

6.2 VIBRATION AND ACOUSTIC TEST FACILITY

Test facilities in the VATF, JSC building 49, will be used for shock and vibration testing of AMS payload hardware for verification testing as specified in SSP 57413**, "**Alpha Magnetic Spectrometer (AMS) Attached Payload Verification Plan**."**

6.3 EMI/EMC TEST FACILITY

The EMI/EMC test facility in JSC Building 14 will be used as required for testing the AMS payload hardware and selected components to ensure compatibility with the EMI requirements specified in SSP 57003, the AP IRD.

6.4 ORBITER INTERFACE UNIT (OIU) LABORATORY

The Orbiter Interface Unit Laboratory of United Space Alliance will be used for testing the OIU/AMS MIL-STD-1553 data bus system. APCU interfaces will be tested and verified.

6.5 ELECTRONIC SYSTEM TEST LABORATORY

The Electronic Systems Test Laboratory (ESTL) located in JSC Building 44 will used as required for testing the AMS Ku-Band interface.

6.6 STRUCTURES AND MECHANICS LABORATORY

The Structures and Mechanics Laboratory (SML) in JSC Building 13 will be used for the AMS static test and modal test. The vacuum case STA, several AMS-02 component STAs and the flight USS-02 will be used in the tests. The test results will be used to correlate the AMS-02 finite element model (FEM).

6.7 INTEGRATION FACILITY

JSC Building 16 shall be used as the integration facility for the AMS payload integration hardware prior to shipping to the AMS Experiment in Europe or to KSC.

6.8 HYPERVELOCITY IMPACT TECHNOLOGY FACILITY

This facility at White Sands will be used for assessing the damage to various AMS materials that will be exposed on orbit. The AMS team will use the data to estimate failure probability of the AMS experiment operation during its residence on the ISS.

6.9 SPACE VEHICLE MOCKUP FACILITY

The SVMS will be used for assessing fit and function of the AMS payload on the ISS truss and the fit, function and operation of the ACOP items stowed and operated in the ISS pressurized volume. The facility will also be used for some integrated training, training for removal, translation and deployment of the AMS on the truss, and training for the removal from the truss, translation and placement/attachment in the STS payload bay.

6.10 MANIPULATOR DEVELOPMENT FACILITY

The MDL may be used with an AMS mockup to assess manipulator requirements for operations stated in section 6.9.

6.11 NEUTRAL BUOYANCY LABORATORY (NBL)

A mockup of the AMS payload may be used in the NBL to evaluate payload movement as described in sections 6.9 and 6.10 and to evaluate EVA requirements. The NBL will be used for crew training for possible EVAs in the AMS vicinity and to evaluate access to various locations on the AMS.

6.12 HRF LAUNCH INTEGRATION FACILITY (HLIF)

This facility will be used for AMS data and electrical interface verification. It contains high fidelity testing equipment built by Boeing Huntsville and used by JSC/ISSP developed or managed payloads for interface testing. The HLIF is located in JSC building 241.

7.0 INTEGRATION TEST REQUIREMENTS

7.1 JOHNSON SPACE CENTER

There will be no electrical functional testing of the entire AMS payload at JSC.

7.2 KENNEDY SPACE CENTER

The following engineering tests will be performed at KSC during the processing of the payload for launch. At times when engineering processing or test is not being performed at the locations listed below, the AMS instrument should be available for science verification testing, baseline data collection and/or calibration.

7.2.1 PAYLOAD PROCESSING FACILITY

Functional checkout of the AMS payload shall be performed during the off-line testing in the KSC Space Station Processing Facility (SSPF) or other payload processing facility as designated by KSC. This processing will include cryogenic servicing of the superfluid helium dewar on the AMS.

7.2.2 SPACE STATION PROCESSING FACILITY

Interface verification testing (IVT) shall be performed at the SSPF Cargo Integration Test Equipment (CITE) stand utilizing the flight AMS Payload. In addition, a CITE end-to-end test will be performed utilizing the Orbiter Ku-Band system while the Orbiter is in the Orbiter Processing Facility (OPF). KSC may designate other facilities than the SSPF for this testing listed above with the exception of the CITE testing. This processing will include cryogenic servicing of the superfluid helium dewar on the AMS.

7.2.3 ORBITER PROCESSING FACILITY

IVT (i.e., AMS payload to Ku-Band interface), shall be performed at the KSC OPF utilizing an AMS payload simulator and the Space Shuttle flight Ku-Band antenna.

7.2.4 LAUNCH PAD

Launch pad procedures will include removal of any protective covers from the AMS payload, closeout photos, etc. IVT of the AMS payload with the Orbiter will be performed as well as an S-Band end-to-end test from the AMS Payload in the Orbiter to the Payload Operations Integration Center (POIC) and on to the AMS Payload

operations facility. This processing will include cryogenic servicing of the superfluid helium dewar on the AMS.

8.0 SHIPPING REQUIREMENTS

The requirements specified herein will govern the preparation for shipment and the transportation of the AMS payload to all contractor and Government facilities or test sites. The methods of packaging, as well as the necessary special controls during transportation, will adequately protect the AMS payload from damage or degradation in reliability or performance that could be incurred from natural and induced environments encountered during transportation and subsequent storage.

Packaging, handling, and transporting will be in general accordance with the guidelines of NTG 6000.1D, “Requirements for Packaging, Handling and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components,” as supplemented or amended by the following paragraphs.

8.1 PACKAGING LEVELS AND METHODS

Packaging, packing and rough handling requirements will use the document formerly known as MIL-STD-794, “Parts and Equipment, Procedures for Packaging of” as a guideline even though the standard has been cancelled.

Where transport and associated handling operations are under the strict control of specially designated a.) personnel and, b.) handling and transport equipment, rough handling requirements will be reduced to magnitudes commensurate with the reduced hazard exposure.

8.2 PACKAGING DESIGN VERIFICATION/QUALIFICATION

Verify by analysis, assessment or similarity.that packages meet requirements (including vibration, drop (shock), superimposed load, tip over, and impact).

8.3 MILITARY TRANSPORTATION PROCEDURES DOCUMENTATION AND REPORTS

Shipments entered into the military airlift system shall be documented and reported in accordance with DODR 4500.32R, “Military Standard Transportation and Movement Procedures.”

8.4 MARKING FOR SHIPMENT

Interior and exterior container labeling will use the standard formerly known as MIL-STD-129, “Marking for Shipment and Storage,” even though the standard has been cancelled. An exception is that labels with lettering of an appropriate size may be used in lieu of stenciling for all markings.

APPENDIX A: MASTER LIST OF DOCUMENTS AND SPECIFICATIONS FOR ALPHA MAGNETIC SPECTROMETER PAYLOAD INTEGRATION HARDWARE

Program documentation references for the AMS PIH are identified in the following List of Documents for Alpha Magnetic Spectrometer, on the Space Station flight UF4 currently manifested as ISS-26-UF-04 on STS-130.

MASTER DOCUMENT LIST

FOR

ALPHA MAGNETIC SPECTROMETER (AMS-02)

PAYLOAD INTEGRATION HARDWARE (PIH)

Technical Work Plan HECSMBS2

DOCUMENT NUMBER	REV / CHANGE NO./IRN	ISSUE DATE	TITLE
NASA DOCUMENTS			
ES2-99-027	Orig.	8/11/99	Alpha Magnetic Spectrometer – Second Mission
GSFC S312-P-003			
ICD-C-TBD		TBD	Alpha Magnetic Spectrometer – 02 (AMS-02) Experiment /Payload Integration Hardware (PIH) Interfaces
IPC 2221	Basic	Sept 1991	Generic Standard on Printed Board Design
IPC 2222	Basic	Sept 1991	Sectional Design Standard for Rigid Organic Printed Boards
IPC 6011	Basic	1/1/96	Generic Performance Specification for Printed Boards
IPC 6012	Basic	1/1/96	Qualification and Performance for Rigid Printed Boards
JHB 5322.1	C	Feb 1994	Contamination Control Requirements Manual
JHB 8080.5	Basic	2/14/96	JSC Design and Procedural Standards Manual
JPD 5335.1	Basic	4/11/97	JSC Quality Manual
JPG 8500.4	D	5/29/98	Engineering Drawing System Manual
MSFC-HDBK-527/JSC-09604	F	9/30/88	JSC GFE Materials Selection List and Materials Documentation Procedures
JSC-16427	C	Jun 1985	Procurement Quality Provisions for NASA JSC Space Transportation System Payloads
JSC-20545	A	April 1988	Simplified Design Options for STS Payloads
JSC-23642	C	Jun 1992	JSC Fastener Integrity Testing Program
JSC-25863	A	8/28/98	Fracture Control Plan for JSC Flight Hardware
JSC-27378	A	Aug 1997	Alpha Magnetic Spectrometer Structural Verification Plan for the STS Flight #91
JSC-27542 LMES-32218	Orig.	Jan 1997	Alpha Magnetic Spectrometer Configuration Management Plan
JSC-28792	Orig.	Oct 1999	Alpha Magnetic Spectrometer – 02 Structural Verification Plan for the Space Transportation System and the International Space Station
JSC-36307		8/29/97	NASA Training Implementation Plan (TIP)
JSC-61100	PMG-02	2/28/96	Project Management Guide
JSC SLP 4.7	C	8/25/98	Control of Customer-Supplied Product
JSC SLP 4.8	B	6/2/99	Product Identification and Traceability
JSC SLP 4.15	B	12/12/97	Handling, Storage, Packaging, Preservation, and Delivery

JSC-SPEC-M1	B	Nov 1985	Specification Marking, Identification, and Inspection

DOCUMENT NUMBER	REV / CHANGE NO./IRN	ISSUE DATE	TITLE
45 SW HB S-100/KHB 1700.7	C	Aug 1999 (Current Issue)	Space Shuttle Payload Ground Safety Handbook
MSFC-SPEC-522	B	July 1987	Design Criteria for Controlling Stress Corrosion and Cracking
NAS 5300.4 (3J-1)	Basic	April 1985	Workmanship Standard for Staking and Conformal Coating of Printed Wiring Boards and Electronic Assemblies
NAS 5300.4 (3M)	Basic		Workmanship Standard for Surface Mount Technology
NASA-STD-5003	Basic	10/7/96	Fracture Control Requirements for Payloads Using the Space Shuttle
NASA-STD-8739.3	Basic	12/15/97	Soldered Electrical Connections
NASA-STD-8793.4	Basic	2/9/98	Crimping, Interconnecting Cables, Harnesses, and Wiring
NASA-STD-8793.5	Basic	Feb 1998	Fiber Optic Terminations, Cable Assemblies, and Installation
NASA-STD-8793.7	Basic	Dec 1997	Electrostatic Discharge Control (Excluding Electrically Initiated Explosive devices)
NTG 6000.1D	D	Sep. 1990	Requirements for Packaging, Handling and Transportation for Aeronautical and Space System Equipment and Associated Components
NMI 8010.1	A	11/21/90	Classification of NASA Payloads
NSS/GO-1740.9B		Nov 1991	Safety Standard for Lifting Devices and Equipment
NSTS/AMS ICD-A-TBD		TBD	Shuttle Orbiter/AMS Cargo Element Interfaces
JPG 5300.4 (1D-2)	Basic Chg 1	9/6/97 10/14/98	Safety, Reliability, Maintainability, and Quality Provisions for the Space Shuttle Program
NSTS 07700, Vol. IV, Book 1	K Chg 185	5/21/98 12/21/99	Space Shuttle Configuration Management Requirements
NSTS 07700, Vol. XIV Appendix 7	J thru Change 1	3/29/88 6/14/89	System Description and Design Data – Extravehicular Activities
NSTS 07700, Vol. XIV Appendix 9	K	12/16/92	System Description and Design Data – Intravehicular Activities
NSTS 07700, Vol. XIV	K Chg 3	3/23/93 5/24/95	Space Shuttle System Payload Accommodations
NSTS 08307	A Chg 3	7/6/98	Criteria for Preloaded Bolts
NSTS/ISS 13830	C Chg 1	7/13/98 2/2/00	Payload Safety Review and Data Submittal Requirements

	Chg 1	2/2/99 (Current Issue)	
NSTS 14046	D	7/2/97	Payload Verification Requirements

DOCUMENT NUMBER	REV / CHANGE NO./IRN	ISSUE DATE	TITLE
NSTS 1700.7B	B Chg 6	1/13/89 7/99 (Current Issue)	Safety Policy and Requirements for Payloads Using the Space Transportation System
NSTS 1700.7B ISS Addendum	Basic	12/8/95 (Current Issue)	Safety Policy and Requirements for Payloads Using the International Space Station
NSTS/ISS 18798	B Chg 3	9/97 12/10/98 (Current Issue)	Interpretations of NSTS/ISS Payload Safety Requirements
NSTS 21000-IDD-ISS	A	2/18/98	Shuttle Orbiter/International Space Station Interface Definition Document Cargo Element Interfaces
NSTS 21288	Orig.	1/3/94	Required Data/Guidelines for Payload/Shuttle Electromagnetic Compatibility Analysis
NSTS 32329		Mar 1999	Structural Integration Analyses Responsibility Definition for Space Shuttle Vehicle and Cargo Element Developers
PRC-0001	B	July 1999	Process Specification for the Manual Arc Welding of Aluminum Alloy Flight Hardware
PRC-0008	A	July 1999	Process Specification for the Qualification of Manual Arc Welders
PRC-6002	A	Dec 1999	Process Specification for the Assembly of Composite Sandwich Structures
PRC-6501	A	Aug 1998	Process Specification for Ultrasonic Inspection of Composites
SE-M-0096	A	June 1982	Materials and Processes Requirements for JSC Controlled Payloads, General Specification
SN-C-0005	D Chg 6	2/15/89 7/20/89	Specification, Contamination Control Requirements for the Space Shuttle Program
SP-106		1966	The Dynamic Behavior of Liquids in Moving Containers with Applications to Space Vehicle Technology
SSP 30237	D	7/21/98	Space Station Electromagnetic Emission and Susceptibility Requirements
SSP 30558	B	6/30/94	Fracture Control Requirements for Space Station
SSP 30559	B	June 1994	Structural Design and Verification Requirements for the ISS

SSP 42004	D	5/1/96	Mobile Servicing System to User (generic) Interface Control Document, Part 1
SSP 50005			International Space Station Flight Crew Integration Standard
SSP 50006	A	11/29/95	International Space Station Internal and External Decals and Placards Specification
SSP 50007	A	10/16/98	Space Station Inventory Management System Label Specification
DOCUMENT NUMBER	**REV / CHANGE NO./IRN**	**ISSUE DATE**	**TITLE**
SSP 50123-01	Basic	6/18/99	Configuration Management Handbook
SSP 52000-PIA-PRP	B	10/27/99	Payload Integration Agreement Blank Book for Pressurized Payloads
SSP 52000-PIA-UPP	Basic	TBD	Payload Integration Agreement Blank Book for Unpressurized Payloads
SSP 57000	B	11/4/98	Pressurized Payloads Interface Requirements Document
SSP 57001	B	12/8/99	Pressurized Payloads Hardware Interface Control Document Template
SSP 57002	Basic	TBD	Payload Software Interface Control Document Template
SSP 57003	Basic	11/18/99	Attached Payload Interface Requirements Document
SSP 57004	Basic	11/18/99	Attached Payload Hardware Interface Control Document Template
SSP 57010	A	10/19/99	Pressurized Payloads Generic Payload Verification Plan
SSP 57013	Basic	TBD	Generic Attached Payload Verification Plan Template
SSP 57057			ISS Payload Integration Template
SSP 57113	Basic	TBD	Alpha Magnetic Spectrometer (AMS) Payload Integration Agreement
SSP 57213	Basic	TBD	Alpha Magnetic Spectrometer (AMS) Hardware Interface Control Document
SSP 57313	Basic	TBD	Alpha Magnetic Spectrometer (AMS) Software Interface Control Document
SSP 57413	Basic	TBD	Alpha Magnetic Spectrometer (AMS) Attached Payload Verification Plan
SSP 58311			Payload Operations Integration Center Payload Operations Handbook
SSP 58312	D	7/29/99	Payload Operations Integration Center Payload Operations Handbook – Increment Operations
SW-E-0002	E Chg 68	2/20/92 12/2/99	Ground Support Equipment General Design Requirements

TN 531		1960	Experimental Investigation of the Natural Frequencies of Liquids in Toroidal Tanks
TN D-1709		1963	Preliminary Experimental Investigation of Frequencies and Forces Resulting from Liquid Sloshing in Toroidal Tanks
CONTRACTOR DOCUMENTS			
EID-02322-1		5/23/97	ISS Plasma Contactor Unit (PCU) Xenon Tank Damping and Fluid-Structure Interaction (Boeing)
EID-02325		4/16/97	Fracture and Stress Analysis Report of Sphere, Xenon Storage, Filament Wound (Boeing)
HDID-SAS-98-0247		7/23/98	Report of Flight Accelerations Recorded by the WBSAAMD on STS-91 (LMSO)
DOCUMENT NUMBER	**REV / CHANGE NO./IRN**	**ISSUE DATE**	**TITLE**
LMSEAT-31041			Quality System Manual for the Science, Engineering, Analysis and Test (SEAT) Operations
LMSMSS-31039	A	½/97 (Current Issue)	Safety and Health Plan Science, Engineering, Analysis, and Test Contract
SDU 74-SH-0002B		Dec 1977	Space Shuttle GSE Design Guide
SMD-93-0287		5/7/93	Mass Acceleration Curves for Trunnion Mounted Payload Components (LMSO)
TM 270-400-99-081		8/30/99	Space Shuttle Structural Math Model and Forcing Function Delivery (Boeing)
DOD DOCUMENTS			
DODR-4500.32R	Vol. 1 Vol. 2	3/15/87 2/15/87	Military Standard Transportation and Movement Procedures
MILITARY DOCUMENTS			
MIL-HDBK-5H		12/1/98	Metallic Materials and Elements for Aerospace Vehicle Structures
MIL-STD-129	N	5/15/97	Marking for Shipment and Storage
MIL-STD-794	Orig		Parts and Equipment, Procedures for Packaging of
MIL-STD-1522	A thru Notice 3	5/28/84 9/4/92	Standard General Requirements for Safe Design and Operation of Pressurized Missile and Space Systems
MIL-STD-1553	B thru Notice 3	9/21/78 1/31/93	Aircraft Internal Time Division Command/Response Multiplex Data Bus

INDUSTRY DOCUMENTS			
ANSI B46.1	Thru chg 2	4/29/71	Surface Texture (Surface Roughness, Waviness and Lay)
WORLD WIDE WEB SITES			
GCAR Instructions	N/A	N/A	Government Certification Approval Request Instructions (http://wwwsrqa.jsc.nasa.gov/gcars/)
MAPTIS	N/A	N/A	Materials and Processes Technology Information System
NPSL	N/A	N/A	NASA Parts Selection List (http://misspiggy.gsfc.nasa.gov/npsl/)