National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
2101 NASA Parkway
Houston, Texas 77058-3696

March 17, 2010

Reply to Attn of: NE141-10-123

TO: EA3/AMS-02 Project Manager

FROM: NE/Executive Officer, Payload Safety Review Panel

SUBJECT: Alpha Magnetic Spectrometer-02 (AMS-02) Phase III Hazard Report (HR) Approval

Refer to your memorandum EA3-09-035, dated November 30, 2009, and subsequent updates provided by your representative on February 8, 2010. AMS-02 HRs have been approved out-of-board by Mr. M. R. Surber, Chair, Payload Safety Review Panel, on February 12, 2010. The signed HRs (see chart below), are enclosed for your retention.

HR Number:	HR Title:
STD-AMS-02-F02	Standard Hazards
AMS-02-F02	Toxic Material Offgassing
AMS-02-F16	Shatterable Material Release
AMS-02-F20	Crew Exposure to Coherent Light

Please direct any questions to Mr. P. Mensingh, telephone (281) 335-2363, or Mr. R. Rehm, telephone (281) 335-2364, or Ms. K. Chavez, telephone (281) 335-2374, at Mail Code NA2450.

Patrick J. Mitchell

Enclosures

cc:
See List

cc: (*h/c memo and encl.)
CB/J. Rickard
DA8/B. W. Christen
EA44/L. C. Benal
EP5/J. A. Jeevarajan
NE/M. Fodroci
OE/R. W. Guidry
OE/P. L. Mitchell
OE/D. W. Moreland
OE/M. R. Surber
OE/N. Vassberg
OE/S. L. Wolf
SF/R. L. Spann
MSFC/JS-11/P. T. Johnson
MSFC/VP35/J. E. Johnson
MSFC/TBE/FD32/R. B. Heinisch
Boeing/HS3-30/A. B. Green
NA2450/SAIC/M. L. Mudd*
NA2450/SAIC/K. Chavez
NA2450/SAIC/P. Mensingh
NA2450/SAIC/S. Nash
NA2450/SAIC/R. Rehm
NA2450/SAIC/T. Wong
Wyle/HEF/37A/H. Garcia
Wyle/HEF/37A/C. Lam
Wyle/HEF/37A/R. Ramanathan

FLIGHT PAYLOAD STANDARDIZED HAZARD CONTROL REPORT	A. NUMBER	B. PHASE	C. DATE
	STD- AMS-02-F02	Phase III	February 8, 2010

D. PAYLOAD, DTO, DSO or RME *(Include Part Number(s), if applicable)*	HAZARD TITLE	E. VEHICLE
Alpha Magnetic Spectrometer (AMS-02) Orbiter Interior Elements–See Attached List	STANDARD HAZARDS	Shuttle

F. DESCRIPTION OF HAZARD:	G. HAZARD CONTROLS: *(complies with)*	H. APP.	I. VERIFICATION METHOD, REFERENCE, AND STATUS:
1. Structural Failure *(payloads must comply with the listed requirements for all phases of flight)* *Note: Locker and Soft Stowage items only.*	Designed to meet the standard modular locker stowage requirements of NSTS 21000-IDD-MDK or equivalent IDD _____.	☒	1.1.1. SVM: Review for compliance with Middeck ICD 1.1.1 STATUS: Closed. ESCG Memorandum ESCG-4295-10-CPAS-MEMO-0002, "DDRS-02 Hazard Controls," dated February 2, 2010
2. Structural Failure of Sealed Containers **Note 1: Only sealed containers made of conventional metal (metal alloy) can use the 1230 form. Sealed containers made of unconventional metals or non-metallic materials shall be documented on Unique Hazard Reports.** **Note 2: The 1230 form is not applicable for "sealed container"(s) employed in levels of containment control of hazardous fluid.**	Sealed containers must meet the criteria of NASA-STD-5003, Para. 4.2.2.4.2.3a, contain a substance which is not a hazard if released, be made of conventional metals (e.g. Al, inconel, monel, steel or titanium), contain less than 14,240 foot-pounds (19,130 Joules) of stored energy due to pressure, and have a maximum delta pressure of 1.5 atm.	☐	**N/A.** – No Sealed Containers used as structure (No Sealed Containers for any purpose)

APPROVAL	PAYLOAD ORGANIZATION	SSP/ISS
PHASE I		
PHASE II		
PHASE III	2/8/10	2/12/10

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FLIGHT PAYLOAD STANDARDIZED HAZARD CONTROL REPORT	A. NUMBER	B. PHASE	C. DATE
	STD- AMS-02-F02	Phase III	February 8, 2010

D. PAYLOAD, DTO, DSO or RME *(Include Part Number(s), if applicable)*	HAZARD TITLE	E. VEHICLE
Alpha Magnetic Spectrometer (AMS-02) Orbiter Interior Elements–See Attached List	STANDARD HAZARDS	Shuttle

F. DESCRIPTION OF HAZARD:	G. HAZARD CONTROLS: *(complies with)*	H. APP.	I. VERIFICATION METHOD, REFERENCE, AND STATUS:
3. Structural Failure of Vented Containers	For intentionally vented containers, vents are sized to maintain a 1.4 factor of safety for Shuttle or a 1.5 factor of safety for Station with respect to pressure loads. Meets all of the applicable pressure rates defined for one or more of the following.		N/A. – No confined volumes in hardware design.
	a) Shuttle payload bay – ICD 2-19001, Para. 10.6.1	☐	
	b) Station environment – SSP 52005, paragraph 4.3 or equivalent payload specific ICD_____ .	☐	
	c) Station PFE discharge – SSP 57000, Para. 3.1.1.4K, or equivalent payload specific ICD _____ .	☐	
	d) Shuttle Middeck – NSTS 21000-IDD-MDK, Section 6.1.	☐	
4. Sharp Edges, Corners, and/or Protrusions.	Meets the **intent** of one or more of the following:		4.a.1 SVM: Inspection of payload provided flight hardware for sharp edges, corners and protrusions. 4.a.1 STATUS: Closed. ESCG Memorandum ESCG-4295-10-CPAS-MEMO-0002, "DDRS-02 Hazard Controls," dated February 2, 2010
	a) NASA-STD-3000 / SSP 50005	☒	
	b) SLP 2104	☐	
	c) NSTS 07700 Vol. XIV App. 7 (EVA hardware)	☐	
	d) NSTS 07700 Vol. XIV App. 9 (IVA hardware) / SSP 57000	☐	
	e) SSP 41163, Para. 3.3.6.12.3 (EVA), Para. 3.3.6.12.4 (IVA).	☐	

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FLIGHT PAYLOAD STANDARDIZED HAZARD CONTROL REPORT	A. NUMBER	B. PHASE	C. DATE
	STD- AMS-02-F02	Phase III	February 8, 2010

D. PAYLOAD, DTO, DSO or RME *(Include Part Number(s), if applicable)*	HAZARD TITLE	E. VEHICLE
Alpha Magnetic Spectrometer (AMS-02) Orbiter Interior Elements–See Attached List	STANDARD HAZARDS	Shuttle

F. DESCRIPTION OF HAZARD:	G. HAZARD CONTROLS: *(complies with)*	H. APP.	I. VERIFICATION METHOD, REFERENCE, AND STATUS:
5. Shatterable Material Release	a) All materials are contained. b) Optical glass (i.e. lenses, filters, etc.) components of crew cabin experiment hardware that are non-stressed (no delta pressure) and have passed both a vibration test at flight levels and a post-test visual inspection. c) Payload bay hardware shatterable material components that weigh less than 0.25 lb and are non-stressed (no delta pressure) or non-structural.	☐ ☐ ☐	**N/A**. No Identified Shatterable Materials
6. Flammable Materials	a) A-rated materials selected from MAPTIS, or b) Flammability assessment per NSTS 22648	☐ ☒	6.b.1 SVM: Review of design for appropriate use of non-flammable materials. 6.b.2 SVM: Review and approval of flammability assessment by JSC/ES4. 6.b.1 STATUS: Closed. ESCG Memorandum ESCG-4390-08-SP-MEMO-0021_RevA, "IVA Offgassing and Flammability," dated February 17, 2009 6.b.2 STATUS: Closed. JSC Materials and Fracture Control Certification MATL-09-036, "Alpha Magnetic Spectrometer (AMS-02) Data Interface Hardware," Approved 3/25/2009
7. Materials Offgassing	Offgassing tests of assembled article per NASA-STD-6001 (previously published as NHB 8060.1C).	☐	Reference Hazard Report AMS-02-F02
8. Nonionizing Radiation 8.1 Non-transmitters	Meets all that apply: a) Pass ICD-2-19001, 10.7.3.2.2 / SSP 30238 EMI compatibility testing, or b) NSTS/USA approved analysis ICD Section 20, or c) ISS/EMEP approved TIA d) Meets SSP 41163, Para. 3.3.6.6 **and** SSP 50094, Para. 3.4.	☒ ☐ ☐ ☐	8.1.a.1 SVM: EMI testing results reviewed and approved by JSC/EV4 8.1.a.1 STATUS: Closed. Test Reports EV5-09-EMC-010R, "Test Report Electromagnetic Interference (EMI) of the Engineering Evaluation For The Alpha Magnetic Spectrometer (AMS-02) – USB422 Assembly," dated August 25, 2009 and Universita' Degli Studi Di Perugia Polo Scientifico E Didattico Di Terni, Facolta di Ingegneria, Laboratorio di Caratterizzazione Electromagnetica Test Report No. 099, AMS02 Digital Data Recording System USB – RS422 Interface, April 12, 2007. Approved by EV/Scully, EV/Tarditi

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FLIGHT PAYLOAD STANDARDIZED HAZARD CONTROL REPORT		A. NUMBER	B. PHASE	C. DATE
		STD- AMS-02-F02	Phase III	February 8, 2010
D. PAYLOAD, DTO, DSO or RME *(Include Part Number(s), if applicable)*		HAZARD TITLE		E. VEHICLE
Alpha Magnetic Spectrometer (AMS-02) Orbiter Interior Elements–See Attached List		STANDARD HAZARDS		Shuttle
F. DESCRIPTION OF HAZARD:	**G. HAZARD CONTROLS:** *(complies with)*	**H. APP.**	**I. VERIFICATION METHOD, REFERENCE, AND STATUS:**	
8.2 Lasers **NOTE: Lasers operating at class levels 3b and 4, meeting ANSI Z136.1, shall be documented on Unique Hazard Reports.**	Meet ANSI Z136.1-2000 for class 1, 2, or 3a Lasers (as measured at the source).	☐	**N/A.** Internal elements of AMS-02 do not generate coherent light.	
9.1 Alkaline cells and batteries made of alkaline cells, connected in series or in parallel, up to 12 V and with up to 60 Watt-hours capacity, no potential charging source and cells are not in a gas-tight compartment.	Cells and batteries pass acceptance tests that include loaded and open circuit voltage measurements, visual examination, and leakage check under vacuum (e.g. 6 hours at 0.1 psia).	☐	**N/A.** AMS-02 Interior elements utilize no batteries. Submission of EP-Form-03(including the form's approved reference number) for EP5 approval Information to be included on the EP5 reviewed/approved Form-03: application and protective circuit schematics	
9.2 Primary button cells such as Li-(CF)x, Li-iodine, LiV_2O_5, $LiMnO_2$, Ag-Zn and rechargeable button cells such as LiV_2O_5, Li-ion, Ni-Cd, Ni-MH, Ag-Zn cells or batteries, which have a capacity of 300 mAh or less and no more than 3 cells per common circuit, and cells are not in a gas-tight compartment.	Cells and batteries pass acceptance tests that include loaded and open circuit voltage measurements, visual examination, and leakage check under vacuum (e.g. 6 hours at 0.1 psia). Note: Above acceptance testing for button cells in Section 9.2 which are soldered to a circuit board in commercial equipment (not applicable to those button cells in a spring-loaded clip) is limited to a functional check of the equipment utilizing the subject battery.	☐ ☐ ☐	**N/A.** AMS-02 Interior elements utilize no batteries. Submission of EP-Form-03(including the form's approved reference number) for EP5 approval Information to be included on the EP5 reviewed/approved Form-03:: application and protective circuitry.	
9.3 COTS NiMH, NiCd and Ag/Zn cells and batteries for IVA use up to 20 V and 60 Wh	Cells and batteries purchased in one lot; pass acceptance tests that include loaded and open circuit voltage measurements, visual examination, leakage check under vacuum (e.g 6 hours at 0.1psia) and vibration to workmanship levels with functional checks which include charge/discharge cycles for rechargeable batteries.	☐	**N/A.** AMS-02 Interior elements utilize no batteries. Submission of EP5 Form-03(including the form's approved reference number) for approval Information to be included on the EP5 reviewed/approved Form-03: manufacturer's specification, battery protective features and charger schematics	

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FLIGHT PAYLOAD STANDARDIZED HAZARD CONTROL REPORT	A. NUMBER	B. PHASE	C. DATE
	STD- AMS-02-F02	Phase III	February 8, 2010

D. PAYLOAD, DTO, DSO or RME *(Include Part Number(s), if applicable)*	HAZARD TITLE	E. VEHICLE
Alpha Magnetic Spectrometer (AMS-02) Orbiter Interior Elements—See Attached List	STANDARD HAZARDS	Shuttle

F. DESCRIPTION OF HAZARD:	G. HAZARD CONTROLS: *(complies with)*	H. APP.	I. VERIFICATION METHOD, REFERENCE, AND STATUS:
9.4 COTS Li-ion batteries up to 10 V and 60 Wh for IVA use	Batteries and charger shall be from a single lot; shall show one-fault tolerance at battery level and shall pass acceptance tests that include loaded and open circuit voltage measurements, visual examination, leakage check under vacuum (e.g 6 hours at 0.1psia) and vibration to environment or double the workmanship level, whichever is higher; and functional checks which include charge/discharge cycles.	☐	N/A. AMS-02 Interior elements utilize no batteries. Submission of EP-Form-03(including the form's approved reference number) for EP5 approval. Information to be included on the EP5 reviewed/approved Form-03: battery protective features and charger features Note: For hardware using batteries, and/or chargers additional levels of control shall be provided by the hardware
10. Touch Temperature	a) Within IVA touch temperature range of –18 Degrees C. (0 Degrees F.) and 49 Degrees C. (120 Degrees F.) and satisfies the intentional contact constraints of letter MA2-95-048 (if applicable). b) Meets EVA touch temperature criteria of NSTS 07700 Vol. XIV App. 7.	☒ ☐	10.a.1 SVM: Review of design to confirm low power application with electronic components are inaccessible to the crew. 10.a.2 SVM: Thermal Analysis to confirm that interface will not Exceed Touch Temperature Limits. 10.a.1 STATUS: Closed. Memo ESCG-4470-08-TEAN-DOC-0210, "Touch Temperature Analysis for Alpha Magnetic Spectrometer (AMS-02) Digital Data Recording System (DDRS)", dated January 14, 2008 documents power consumption and enclosure. 10.a.2 STATUS: Closed. Memo ESCG-4470-08-TEAN-DOC-0210, "Touch Temperature Analysis for Alpha Magnetic Spectrometer (AMS-02) Digital Data Recording System (DDRS)", dated January 14, 2008, documents touch temperature analysis compliance.
11. Electrical Power Distribution	a) Shuttle-powered payloads – Meets all circuit protection requirements of Letter TA-92-038. b) Station-powered payloads – Meets station interface circuit protection requirements of SSP 57000 and payload circuit protection requirements of Letter TA-92-038.	☒ ☐	11.a.1 SVM: Review of Design 11.a.1 STATUS: Closed. ESCG Memorandum ESCG-4175-09-REENTES-MEMO-0055, "Circuit Protection on DDRS-02," dated August 12, 2009 Note: The USB422 makes its interface is with the PGSC/NGLS and is not directly interfaced with the Shuttle power systems.
12. Ignition of Flammable Atmospheres in Payload Bay	All ignition sources in the Payload bay, for launch and landing, are controlled as required in Letter NS2/81-MO82, and MLI grounded per ICD 2-19001.	☐	N/A. Hardware addressed in this hazard report is within the crew habitable environment and not exposed to a flammable atmosphere in the Shuttle Payload Bay
13. Rotating Equipment	Rotating equipment meets criteria of NASA-STD-5003 for obvious containment.	☐	N/A. AMS-02 Internal hardware does not utilize any rotating equipment.

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FLIGHT PAYLOAD STANDARDIZED HAZARD CONTROL REPORT	A. NUMBER	B. PHASE	C. DATE
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D. PAYLOAD, DTO, DSO or RME *(Include Part Number(s), if applicable)*	HAZARD TITLE		E. VEHICLE
Alpha Magnetic Spectrometer (AMS-02) Orbiter Interior Elements–See Attached List	STANDARD HAZARDS		Shuttle

F. DESCRIPTION OF HAZARD:	G. HAZARD CONTROLS: *(complies with)*	H. APP.	I. VERIFICATION METHOD, REFERENCE, AND STATUS:
14. Mating/demating powered connectors	a) Meets the low power criteria of letter MA2-99-170 or, b) Meets the paragraph 1 criteria of letter MA2-99-170 (e.g., IVA and open circuit voltage no greater than 32 volts).	☒ ☐	14.a.1 SVM: Review of Design. T 14.a.1 STATUS: Closed. ESCG Memorandum ESCG-4175-09-REENTES-MEMO-0055, "Circuit Protection on DDRS-02," dated August 12, 2009
15. Contingency Return and Rapid Safing	Shuttle Environment: a) If middeck payload – can be stowed within 50 min. (see paragraph 3 of letter MA2-96-190). b) If SPACEHAB transfer item – can establish a safe for return configuration within 3 min. (see paragraph 5 of letter MA2-96-190). Station Environment: c) Payload design does not impede emergency IVA egress to the remaining adjacent pressurized volumes.	☒ ☐ ☐	15a.1 SVM: Rapid Safing Assessment to establish that the PGSC and data cables can be stowed within 50 minutes. 15.a.1 STATUS: Closed. A. M. Vaughan/DO5 concurrence with AMS-02 assessment documented in ESCG Memorandum ESCG-4390-08-SP-MEMO-0011 Rev A., "AMS-02 Digital Data Recording Systems -02 (DDRS-02) Rapid Safing" that stowage of PGSC and DDRS-02 cabling will occur in approximately six minutes.
16. Release of Mercury from bulbs into crew habitable environment.	a) Mercury vapor bulbs contain less than 30 mg of Mercury per bulb, and b) No more than one bulb could break due to a single failure.	☐ ☐	N/A. AMS-02 internal hardware elements do not utilize mercury containing bulbs.

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PAYLOAD FLIGHT HAZARD REPORT				a. NO: AMS-02-F02
b. PAYLOAD	Alpha Magnetic Spectrometer-02 (AMS-02)			c. PHASE: III
d. SUBSYSTEM:	Materials, AMS-02 DDRS-02	e. HAZARD GROUP:	Injury/Illness	f. DATE: February 8, 2009
g. HAZARD TITLE:	Toxic Material Offgassing			i. HAZARD CATEGORY: CATASTROPHIC / CRITICAL **X**
h. APPLICABLE SAFETY REQUIREMENTS:	NSTS 1700.7B 209.3			

j. DESCRIPTION OF HAZARD:

Offgas evolution of toxic vapors from materials of construction of hardware used within the Orbiter crew habitable volume can result in injury/illness.

This hazard report covers the AMS-02 provided hardware to be used within the Shuttle Orbiter crew habitable volume during AMS-02 systems check out prior to deployment to the ISS. This hardware consists of interface cables and a RS 422 interface card to be Interfaced with the standard PGSC/NGLS through a USB port.

k. CAUSES

1. Use of hardware/materials of construction which offgas excessive levels of toxic products.

(list)

o. APPROVAL	PAYLOAD ORGANIZATION	SSP/ISS
PHASE I		
PHASE II		
PHASE III	[signature] 2/8/10	[signature] 2/12/10

PAYLOAD FLIGHT HAZARD REPORT	a. NO: AMS-02-F02
b. PAYLOAD Alpha Magnetic Spectrometer-02 (AMS-02)	c. PHASE: III

l. HAZARD CONTROL (CONTROL), m. SAFETY VERIFICATION METHODS (SVM), n. STATUS OF VERIFICATIONS (STATUS)	OPS CONTROL
1. CAUSE: Use of hardware/materials of construction which offgas excessive levels of toxic products.	
1.1 CONTROL: Materials of construction of the AMS-02 Interior cabling have been selected based on material ratings and past flight experience for cable construction to minimize offgassing potential. 1.1.1 SVM: Material Selection Assessment for Offgas Rating. 1.1.2 SVM: JSC ES4 approval of material certification. 1.1.3 SVM: QA certification of as built hardware. 1.1.1 STATUS: Closed. ESCG Memorandum ESCG-4390-08-SP-MEMO-0021_RevA, "IVA Offgassing and Flammability," dated February 17, 2009 1.1.2 STATUS: Closed. JSC Materials and Fracture Control Certification MATL-09-036, "Alpha Magnetic Spectrometer (AMS-02) Data Interface Hardware," Approved 3/25/2009 1.1.3 STATUS: Closed. DDRS-02 TPS providing QA approval: DDRS-02 Assembly p/n SED39136116-301 (s/n 1001 = 2A0920129, s/n 1002 = 2A0920130), USB422 Assembly p/n SED39137921-301 (s/n 1013 = 2A0920093, s/n 1014 = 2A0920094, s/n 1015 = 2A0920095, s/n 1016 = 2A0920096), USB-422/PDIP Cable Assy p/n SED39136111-301 (s/n 1001 = 2A0720285, s/n 1002 = 2A0720285), USB A/B Cable Assy p/n SED39136130-801 (s/n 1001 = 2A0920015, s/n 1002 = 2A0920100). Review and Summary Date January 21, 2010	
1.2 CONTROL: The DDRS2 USB interface hardware will be conformally coated and constructed of materials selected for IVA offgassing compatibility. 1.2.1 SVM: Review of Design. 1.2.2 SVM: QA inspection of flight hardware. 1.2.3 SVM: Material Selection Assessment for Offgas Rating. 1.2.4 SVM: JSC ES4 approval of material certification. 1.2.1 STATUS: Closed. ESCG Memorandum ESCG-4390-08-SP-MEMO-0021_RevA, "IVA Offgassing and Flammability," dated February 17, 2009 1.2.2 STATUS: Closed. DDRS-02 TPS providing QA approval: DDRS-02 Assembly p/n SED39136116-301 (s/n	

PAYLOAD FLIGHT HAZARD REPORT		a. NO: AMS-02-F02	
b. PAYLOAD	Alpha Magnetic Spectrometer-02 (AMS-02)	c. PHASE: III	
1001 = 2A0920129, s/n 1002 = 2A0920130), USB422 Assembly p/n SED39137921-301 (s/n 1013 = 2A0920093, s/n 1014 = 2A0920094, s/n 1015 = 2A0920095, s/n 1016 = 2A0920096), USB-422/PDIP Cable Assy p/n SED39136111-301 (s/n 1001 = 2A0720285, s/n 1002 = 2A0720285), USB A/B Cable Assy p/n SED39136130-801 (s/n 1001 = 2A0920015, s/n 1002 = 2A0920100). Review and Summary Date January 21, 2010 1.2.3 STATUS: Closed. Material Assessment documented in attachment to JSC Materials and Fracture Control Certification MATL-09-036, "Alpha Magnetic Spectrometer (AMS-02) Data Interface Hardware," Approved 3/25/2009 1.2.4 STATUS: Closed. JSC Materials and Fracture Control Certification MATL-09-036, "Alpha Magnetic Spectrometer (AMS-02) Data Interface Hardware," Approved 3/25/2009			
1.3 CONTROL: DDRS-02 COTS USB A-B connector will be tested for offgassing if material analysis and acceptance is not possible. 1.3.1 SVM: JSC ES4 Approval of materials analysis or offgas testing results (Note: If analysis is deemed sufficient the analysis will be tracked under SVM 1.1.1) 1.3.1 STATUS: Closed. JSC Materials and Fracture Control Certification MATL-09-036, "Alpha Magnetic Spectrometer (AMS-02) Data Interface Hardware," Approved 3/25/2009			
Notes:			

ACRONYMS	
AMS-02 – Alpha Magnetic Spectrometer 02	Ops – Operations
COTS – Commercial Off the Shelf	QA – Quality Assuranec
DDRS2 – Digital Data Recording System 2	SVM – Safety Verification Method
PGSC – Payload General Support Computer	

PAYLOAD FLIGHT HAZARD REPORT				a. NO:	AMS-02-F16
b. PAYLOAD	Alpha Magnetic Spectrometer-02 (AMS-02)			c. PHASE:	III
d. SUBSYSTEM:	Optics, Materials	e. HAZARD GROUP:	Impact/Collision, contamination, Injury/Illness	f. DATE:	February 8, 2010
g. HAZARD TITLE:	Shatterable Material Release			i. HAZARD CATEGORY:	CATASTROPHIC X CRITICAL
h. APPLICABLE SAFETY REQUIREMENTS:	NSTS 1700.7, NSTS 1700.7B ISS Addendum, 200.3, 206, 209, 215				
j. DESCRIPTION OF HAZARD:	The breakage of glass or other frangible material can results in contamination/damage of space suits (EMU, Orlan) or the generation of debris of sufficient size to cause a released mass hazard.				
k. CAUSES *(list)*	1. Release of shatterable materials				

o. APPROVAL	PAYLOAD ORGANIZATION	SSP/ISS
PHASE I		
PHASE II		
PHASE III	[signature] 2/8/10	Michael R. [signature] 2/12/10

PAYLOAD FLIGHT HAZARD REPORT		a. NO:	AMS-02-F16
b. PAYLOAD	Alpha Magnetic Spectrometer-02 (AMS-02)	c. PHASE:	III

l. HAZARD CONTROL (CONTROL), m. SAFETY VERIFICATION METHODS (SVM), n. STATUS OF VERIFICATIONS (STATUS)	OPS CONTROL
1. CAUSE: Shatterable Material Release	
1.1 CONTROL: The TOF and ACC Photomultiplier Tubes (PMT) are vacuum tubes, and have a reduced interior pressure. All photomultiplier tubes are sealed within PMT housings with potting used to protect the high voltage circuitry also preventing any potential broken glass from the rear of the assembly. The glass body of the PMT is covered with conductive paint and a protective coating that will protect and contain the glass in the event of a breakage. The glass front of the PMTs is covered with a polymer optical coupling/pad that will contain any fragments and preclude migration of glass. The PMTs are enclosed by an aluminum housing to additionally contain any fragments and preclude migration of fragments. Beyond the optical coupling/pad is the PMT support and the light guides that are sealed to the TOF PMT housing and within the housing for the ACC light guides. Additionally, an ACC PMT is sealed within a cover that is vented through a filter. 1.1.1 SVM: Review of Design. 1.1.2 SVM: Inspection of as built hardware. 1.1.3 SVM: Qualification of TOF & ACC PMT designs (vibration testing). 1.1.1 STATUS: Closed. ESCG Memorandum ESCG-4175-09-REENTES-MEMO-0016, "AMS-02 Photomultiplier Tube Safety Controls, " dated April 3, 2009 1.1.2 STATUS: Closed. Review of LTOF, UTOF and ACC Acceptance Data Package by Jacobs AMS-02 Project Manager confirms inspections documented. Confirmed in email "PMT Review" sent October 6, 2009 From John C. Tutt to Leland D Hill. ADPs on file in AMS-02 Project Archive. 1.1.3 STATUS: Closed. ACC PMT Vibration Testing has been documented in the ACC ADP to validate PMT vibrational design compatibility. ADP Posted March 9, 2009 to AMS-02 Project Archive.	
1.2 CONTROL: The RICH and ECAL Photomultiplier Tubes (PMT) are vacuum tubes, and have a reduced interior pressure. All photomultiplier tubes are sealed within PMT housings with potting used to protect the high voltage circuitry and preventing any potential release from the rear of the assemblies. The glass body of the PMT is covered with conductive paint and a protective coating that will protect and contain the glass in the event of a breakage. The glass front of the PMTs is covered with a polymer optical coupling/pad that will contain any fragments. The ECAL front face is additionally optically sealed to the ECAL lead optical fiber sandwiches to preclude any release path. The RICH polymer optical coating is compressed by the light guides held in place with nylon wires.	

PAYLOAD FLIGHT HAZARD REPORT		a. NO:	AMS-02-F16
b. PAYLOAD	Alpha Magnetic Spectrometer-02 (AMS-02)	c. PHASE:	III

1.2.1 SVM: Review of Design.

1.2.2 SVM: Inspection of as built hardware.

1.2.3 SVM: Qualification of PMT designs (vibration testing).

1.2.1 STATUS: Closed. ESCG Memorandum ESCG-4175-09-REENTES-MEMO-0016, "AMS-02 Photomultiplier Tube Safety Controls, " dated April 3, 2009

1.2.2 STATUS: Closed Carlo Gavazzi Space SpA document RICSYS-CC-CGS-001, "Certification of Conformity/Acceptance Rich Assy," dted June 23, 2008 and AMS Acceptance Data Package for Electromagnetic Calorimeter (ECAL) reviewed and accepted January 8. 2010.

1.2.3 STATUS: Closed. ECAL Vibration Testing conducted at SERMS in Terni ItalyNovember/December 2003, reported successful results to AMS-02 Collaboration on January 08, 2004 by Catherine Adloff.

1.3 CONTROL: All fiber optics cables (glass and polymer) are constructed to retain fibers within the cables and connectors by bonding the fibers or by sealing the end of the cables. Use of fiber optic cables are within the TAS and avionics integration hardware.

1.3.1 SVM: Review of Design.

1.3.2 SVM: Inspection of as built hardware.

1.3.1 STATUS: Closed. ESCG Memorandum ESCG-4175-09-REENTES-MEMO-0025, "Integration Cables Shatterable Materials Containment," dated May 4, 2009. "AMS-02 Tracker Alignment Control System (TAS)… response to information request #51…" From W. Wallraff, RWTH Aachen, November 30, 2004

1.3.2 STATUS: Close to SVTL. (NOTE: ESCG Internal email summarizing review of ADPs for TAS, ECAL and ACC for proper design of the fiber optics cables. Email between John C. Tutt (AMS-02 ESCG Project Manager) and Leland D. Hill (AMS-02 Safety Engineer) October 8, 2009, titled "TAS ADP." ADPs in Project File. Verification open pending KSC integration fiber optic cables inspection after final installation.)

1.4 CONTROL: The ACC fiber optic connectors must distribute the fibers (non-glass, non-frangible) to specific connector locations from the ACC panel cables ("Y" connector) and to the ACC PMT. The connectors utilize a free volume to route the individual fibers. This free volume is vented through filters to contain any possible broken fibers.

1.4.1 SVM: Review of Design.

1.4.2 SVM: Inspection of as built hardware.

PAYLOAD FLIGHT HAZARD REPORT	a. NO: AMS-02-F16
b. PAYLOAD Alpha Magnetic Spectrometer-02 (AMS-02)	c. PHASE: III

1.4.1 STATUS: Closed. ESCG Memorandum ESCG-4175-09-REENTES-MEMO-0017, "Frangible Materials in the AMS-02 Detectors," dated April 7, 2009.

1.4.2 STATUS: Closed. ACC Acceptance Data Package, Posted March 9, 2009 to AMS-02 Project ADP repository.

1.5 CONTROL: Fiber optics are used within the Tracker Laser Alignment System laser source boxes that are contained within the structure of the box and a simple sheath and the 50 micron sized box vents preclude the release of any possible generation of glass particulates that get by fiber optics covering.

1.5.1 SVM: Review of Design.

1.5.2 SVM: Inspection of as built hardware.

1.5.1 STATUS: Closed. ESCG Memorandum ESCG-4175-09-REENTES-MEMO-0017, "Frangible Materials in the AMS-02 Detectors," dated April 7, 2009.

1.5.2 STATUS: Closed. TAS Acceptance Data Package, Sonia Natalie, October 8, 2009 and confirmation of final construction inspection by Prof. em. Dr. Klaus Luebelsmeyer, RWTH Aachen on 11/4/2009.

1.6 CONTROL: The Tracker Silicon Wafers are glued to a flexible metalized film that will retain any fractured pieces. The film is Upilex which is supported (adhered to) on 5 mm Airex Foam. The foam is glued to a carbon fiber layer which is glued to the aluminum ladders that support the sensors as a whole. In addition, the light tight air vents have been fitted with a mesh screen to preclude the release of any particles.

1.6.1 SVM: Review of Design.

1.6.2 SVM: Inspection of as built hardware.

1.6.1 STATUS: Closed. ESCG Memorandum ESCG-4175-09-REENTES-MEMO-0017, "Frangible Materials in the AMS-02 Detectors," dated April 7, 2009.

1.6.2 STATUS: Closed. Installation of Tracker Silicon Wafers and light tight air vents visually confirmed by a designated verifier (DV), T. Martin on September 25, 2007 and documented in correspondence to Safety Engineer on that same date.

1.7 CONTROL: The Laser Diodes and optics are mounted within the Tracker Laser Alignment System laser source boxes and are contained within the structure of the box. Fiber optics within the box are contained within jackets and are contained by structure of the enclosure in the event of breakage.

1.7.1 SVM: Review of Design.

1.7.2 SVM: Inspection of as built hardware.

1.7.1 STATUS: Closed. ESCG Memorandum ESCG-4175-09-REENTES-MEMO-0017, "Frangible Materials in the AMS-02 Detectors," dated April 7, 2009.

1.7.2 STATUS: Closed. TAS Acceptance Data Package, Sonia Natalie, October 8, 2009 and confirmation of final construction inspection by Prof. em. Dr. Klaus Luebelsmeyer, RWTH Aachen on 11/4/2009.

1.8 CONTROL: The ACC imbeds a polymer (non-glass, non-frangible) fiber optics in the BICRON BC 414 scintillator panels using optical cement (BC 600) to retain the fibers in place.

1.8.1 SVM: Review of Design.

1.8.2 SVM: Inspection of as built hardware.

1.8.1 STATUS: Closed. ESCG Memorandum ESCG-4175-09-REENTES-MEMO-0017, "Frangible Materials in the AMS-02 Detectors," dated April 7, 2009.

1.8.2 STATUS: Closed. ACC Acceptance Data Package, Posted March 9, 2009 to AMS-02 Project ADP repository.

1.9 CONTROL: The ECAL is constructed using layers of grooved lead (lead-antimony alloy) with doped polystyrene fibers (PolHiTech 0046) strands (non-glass, non-frangible) placed in the groves. The layers of lead and the fibers are assembled together using optical cement. The fibers are retained by the tight tolerance construction and adhesive.

1.9.1 SVM: Review of Design.

1.9.2 SVM: Inspection of as built hardware.

1.9.1 STATUS: Closed. ESCG Memorandum ESCG-4175-09-REENTES-MEMO-0017, "Frangible Materials in the AMS-02 Detectors," dated April 7, 2009.

1.9.2 STATUS: Closed. ECAL Acceptance Data Package, Posted March 9, 2009 to AMS-02 Project ADP repository.

1.10 CONTROL: RICH aerogel and sodium fluoride blocks are adhered to the "upper" structure of the RICH, a volume which is vented through filters. The aerogel and sodium fluoride blocks are covered by a Plexiglas plane that is sealed to the block support structure. This volume is vented through filters to contain released particles.

1.10.1 SVM: Review of Design.

1.10.2 SVM: Inspection of as built hardware.

1.10.1 STATUS: Closed. ESCG Memorandum ESCG-4175-09-REENTES-MEMO-0017, "Frangible Materials in the AMS-02 Detectors," dated April 7, 2009.

1.10.2 STATUS: Closed. RICH ADP/ Ciemat Log Sheet/Historical Record for RICH Aerogel Assy, Assembly P/N 11-RICSYS-10.000 dated June 19, 2007

1.11 CONTROL: The construction of the Star Tracker Lenses and filters are provides vent paths around the optics to preclude pressure loading of the optical components. The lenses are secured using standard optics interfaces without glue or potting compounds. No optical component of the Star Tracker exceeds 0.25 pounds; the heaviest glass component is approximately 55 grams.

1.11.1 SVM: Star Tracker Lenses will be vibration tested to flight levels and inspected for damage.

1.11.2 SVM: Star Tracker Lenses will be pressure decay tested to confirm venting performance without damage or release.

1.11.3 SVM: Review of Design to confirm mass of optical components.

1.11.1 STATUS: Closed. Vibration Test Report, VIBRPT30_S0100R_24JAN2K6.doc, dated 26 January 2006, from Laboratorio per lo Studio degli Effetti delle Radiazioni sui Materiali per lo Spazio, confirms no damage to optics or released masses.

1.11.2 STATUS: Closed. Report AMIF/LETV/1/A, Issue 1, dated 23 October 2006 from Center for Advanced Research in Space Optics, documents the successful thermal vacuum testing of the lenses without damage or released masses.

1.11.3 STATUS: Closed. Communications from Paolo Trampus, Star Tracker Project, confirmed mass of optical components individually under 0.25 pounds. Email dated 31 March 2006 addressed to AMS-02 Safety Engineer Leland Hill, Titled "Safety Issue". File transmitted to AMS-02 Safety Verification Records.

1.12 CONTROL: The construction of the AMS-02 does not present any frangible material exposure to established EVA translation paths or work sites. Neither EVA Crew contact or EVA tool contact can result in the generation of frangible material debris.

1.12.1 SVM: Review of AMS-02 Design to confirm no frangible materials in EVA translation paths and around

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EVA work sites. 1.12.1 STATUS: Closed. ESCG Memorandum ESCG-4175-09-REENTES-MEMO-0043, "EVA Shatterable Material Release," dated July 1, 2009.		
Notes:		

ACRONYMS	
°C – Degrees Centigrade (Celsius)	F – Fluoride
°F – Degrees Fahrenheit	Na – Sodium
ACC – Anti-Coincidence Counter	PFTE - Polytetrafluoroethylene
AMS-02 – Alpha Magnetic Spectrometer - 02	PMT – Photomultiplier Tube
CFRC – Carbon Fiber Reinforced Composite	RICH – Ring Imaging Cherenkov (detector)
ECAL – Electromagnetic Calorimeter	TOF – Time of Flight
EMU – Extravehicular Mobility Unit	UMA – Umbilical Mating Assembly
EVA – Extravehicular Activity	DV – Designated Verifier

PAYLOAD FLIGHT HAZARD REPORT			a. NO: AMS-02-F20
b. PAYLOAD	Alpha Magnetic Spectrometer-02 (AMS-02)		c. PHASE: III
d. SUBSYSTEM: Tracker Alignment System	e. HAZARD GROUP: Injury/Illness		f. DATE: February 8, 2010
g. HAZARD TITLE: Crew Exposure to Coherent Light			i. HAZARD CATASTROPHIC X CATEGORY: CRITICAL
h. APPLICABLE SAFETY REQUIREMENTS:	NSTS 1700.7B and ISS Addendum, 200.1b, 212.3		
j. DESCRIPTION OF HAZARD:	Operation of the Laser for the Tracker Alignment System makes use of coherent light pulses. Should these irradiate the Crew, there is a potential for ocular damage.		
k. CAUSES (list)	1. Laser Power Output Exceeds Design Capability 2. Loss of Beam Path Containment and Integrity		

o. APPROVAL	PAYLOAD ORGANIZATION	SSP/ISS
PHASE I		
PHASE II		
PHASE III	2/8/10	Michael K. Lueke 2/9/10

PAYLOAD FLIGHT HAZARD REPORT		a. NO:	AMS-02-F20
b. PAYLOAD	Alpha Magnetic Spectrometer-02 (AMS-02)	c. PHASE:	III

l. HAZARD CONTROL (CONTROL), m. SAFETY VERIFICATION METHODS (SVM), n. STATUS OF VERIFICATIONS (STATUS)	OPS CONTROL
1. CAUSE: Laser Power Output Exceeds Design Capability	
1.1 CONTROL: The Tracker Alignment System (TAS) generates laser energy from ten independent laser diodes, pairs of the diodes contained within five Laser Fiber Coupler (LFCR) boxes. This energy is generated by Eagleyard EYP-RWL-1083 infrared (1083 nm) laser diodes with a maximum power output of 80 mW. Each laser diode will emit at a maximum 1 kHz interval with a maximum of 8 μs pulse duration when operating. Each laser diode's emissions are split into four output fibers, each with approximately one quarter of the total power output. The operation of the TAS consists of less than 1% of the AMS-02 operational time. The LFCR boxes are light tight and can not release any laser emissions with the exception of the fiber ports where laser emission are nominal design features. 1.1.1 SVM: Review of design. 1.1.2 SVM: Inspection of as-built hardware. 1.1.1 STATUS: Closed. ESCG Memo ESCG-4390-07-SP-MEMO-0007, "Review of TAS Design", August 14, 2007. 1.1.2 STATUS: Closed. AMS-02 Tracker Alignment System (TAS) ADP dated October 8, 2009	
2. CAUSE: Loss of Beam Path Containment and Integrity	
2.1 CONTROL: The connectors used by the TAS at the LFCR are FC-type and will not inadvertently release. The fiber optics cables are restrained. 2.1.1 SVM: Review of design. 2.1.2 SVM: Inspection of as built hardware. 2.1.1 STATUS: Closed. ESCG Memo ESCG-4390-07-SP-MEMO-0007, "Review of TAS Design", August 14, 2007. 2.1.2 STATUS: Closed. AMS-02 Tracker Alignment System (TAS) ADP dated October 8, 2009	

PAYLOAD FLIGHT HAZARD REPORT		a. NO:	AMS-02-F20
b. PAYLOAD	Alpha Magnetic Spectrometer-02 (AMS-02)	c. PHASE:	III

2.2 CONTROL: The connectors to make fiber to fiber connections are clamped subminiature fiber connectors. The connectors are attached to Patch Panels at the rim of the tracker plate, restraining the fibers and connectors.

2.2.1 SVM: Review of Design

2.2.2 SVM: Inspection of as built hardware

2.2.1 STATUS: Closed. ESCG Memo ESCG-4390-07-SP-MEMO-0007, "Review of TAS Design", August 14, 2007.

2.2.2 STATUS: Closed. AMS-02 Tracker Alignment System (TAS) ADP dated October 8, 2009

2.3 CONTROL: Fibers are fixed within the beamport boxes by use of standard fiber connectors to provide careful alignment with the optics of the beamport boxes.

2.3.1 SVM: Review of Design

2.3.2 SVM: Inspection of as built hardware

2.3.1 STATUS: Closed. ESCG Memo ESCG-4390-07-SP-MEMO-0007, "Review of TAS Design", August 14, 2007.

2.3.2 STATUS: Closed. AMS-02 Tracker Alignment System (TAS) ADP dated October 8, 2009

2.4 CONTROL: Fibers that interconnect the LFCR, patch panels and beamport boxes are Corning HI 1060RC type with cladding (0.08mm diameter) and jacket (diameter 0.165 mm). In addition the fibers are "armored" with Nylon (diameter 0.9 mm). Routed fibers are bundled in standard braided installation sleeves and fixed with tie wraps to cable fixation points. Cable routing considers the minimum bending radius of the individual fibers and bundled fibers, 20 mm and 40 mm respectively.

2.4.1 SVM: Review of Design

2.4.2 SVM: Inspection of as built hardware

2.4.1 STATUS: Closed. ESCG Memo ESCG-4390-07-SP-MEMO-0007, "Review of TAS Design", August 14, 2007.

2.4.2 STATUS: Closed. AMS-02 Tracker Alignment System (TAS) ADP dated October 8, 2009

PAYLOAD FLIGHT HAZARD REPORT		a. NO:	AMS-02-F20
b. PAYLOAD	Alpha Magnetic Spectrometer-02 (AMS-02)	c. PHASE:	III

2.5 CONTROL: Laser beams are emitted across the interior of the Tracker. The Tracker is designed to be light tight, and vent ports are specifically designed to preclude the entry and exit of light.

2.5.1 SVM: Review of Design

2.5.2 SVM: Inspection of As Built Hardware

2.5.1 STATUS: Closed. ESCG Memo ESCG-4390-07-SP-MEMO-0007, "Review of TAS Design", August 14, 2007.

2.5.2 STATUS: Closed. Installation of light tight air vents visually confirmed by a designated verifier (DV), T. Martin on September 25, 2007 and documented in correspondence to Safety Engineer on that same date.

2.6 CONTROL: The laser energy is carried from the LFCR boxes by fibers that interface with the LFCR by way of FC-type connectors. These fibers are routed from the M-structure mounted LFCR boxes to the rim of the outer tracker plate where there are subminiature fiber-fiber connectors. From these connectors the fibers are routed to the beam port boxes (positioned within the tracker at the "top" and "bottom" of the tracker. The connectors are securely held in place and should there be a release of a fiber, either through connector failure or fiber breakage, the NOHD for the laser energy has been established to be just under 2 inches. The fibers are routed under the MLI of the AMS-02 and are not exposed to the exterior environment.

2.6.1 SVM: Review of design.

2.6.2 SVM: Inspection of as-built hardware.

2.6.3 SVM: Laser Safety Analysis

2.6.1 STATUS: Closed. ESCG Memo ESCG-4390-07-SP-MEMO-0007, "Review of TAS Design", August 14, 2007.

2.6.2 STATUS: Closed. AMS-02 Tracker Alignment System (TAS) ADP dated October 8, 2009

2.6.3 STATUS: Closed. Laser Safety Analysis Documented in ESCG Memo ESCG-4390-07-SP-MEMO-0002, "Safety Analysis of the TAS Laser", dated 23 June, 2007.

PAYLOAD FLIGHT HAZARD REPORT		a. NO:	AMS-02-F20
b. PAYLOAD	Alpha Magnetic Spectrometer-02 (AMS-02)	c. PHASE:	III
NOTES:			

ACRONYMS	
AMS-02 – Alpha Magnetic Spectrometer	MLI – Multilayer Insulation
ANSI – American National Standards Institute	mm – millimeter
CFC – Carbon Fiber Composite	mW – milliWatt
CW – Continuous Wave	nm – nanometer
Hz – Hertz	NOHD – Nominal Ocular Hazard Distance
LASER – Light Amplification by Stimulated Emission of Radiation	OD – Outer Diameter
LBBX – Laser Beamport Boxes	Si – Silicon
LDDR – Laser Diode DriveR	TAS – Tracker Alignment System
LFCR – Laser Fiber (Fibre) Coupler	TRD – Transition Radiation Detector
LFIB – Laser Fibers (Fibres)	