FLIGHT PAYLOAD STANDARDIZED HAZARD CONTROL REPORT	A. NUMBER	B. PHASE	C. DATE
	STD- AMS-02-F01	Phase II	May 22, 2006

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

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 ___ .	☐	Reference AMS-02-F01, Structural Failure of Hardware
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.	☐	This hazard is not applicable, the AMS-02 does not make use of sealed containers within its design

APPROVAL	PAYLOAD ORGANIZATION	SSP/ISS
PHASE I		
PHASE II		
PHASE III		

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		STD- AMS-02-F01	Phase II	May 22, 2006
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Alpha Magnetic Spectrometer –02 (AMS-02) (Exterior Elements)		STANDARD HAZARDS		Shuttle/Station
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. 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.	☒ ☐ ☐ ☐	3.a.1. SVM: Review of Design to demonstrate compliance with ICD 2-19001 paragraph 10.6.1 3.a.1 STATUS: Open. AMS-02 Chief Engineer Report on AMS-02 Venting Note: Attachments to STD-AMS-02-F01 includes a tabulation of vented containers and compartments and the features and verification for each that will be considered in the Chief Engineer's Report.	
4. Sharp Edges, Corners, and/or Protrusions.	Meets the **intent** of one or more of the following: 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).	☐ ☐ ☐ ☐ ☐	Reference AMS-02-F14, EVA Operations Hazard NOTE: there are sharp edges on the star tracker baffle that can not be eliminatecd from the design; use of JSC Form 1230 is not applicable due to this design feature.	

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Alpha Magnetic Spectrometer –02 (AMS-02) (Exterior Elements)		STANDARD HAZARDS		Shuttle/Station
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.	☐ ☐ ☐	Reference AMS-02-F16, Shatterable Material Release. Hardware exists in Orbiter payload bay and on ISS exterior, the latter condition not addressed in JSC Form 1230.	
6. Flammable Materials	a) A-rated materials selected from MAPTIS, or b) Flammability assessment per NSTS 22648	☐ ☐	Reference AMS-02-F10, Flammable Materials in Payload Bay	
7. Materials Offgassing	Offgassing tests of assembled article per NASA-STD-6001 (previously published as NHB 8060.1C).	☐	N/A- Exterior elements only in this hazard report	
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 ~~c)~~ b) NSTS/USA approved analysis ICD Section 20, or ~~d)~~ c) ISS/EMEP approved TIA ~~e)~~ d) Meets SSP 41163, Para. 3.3.6.6 **and** SSP 50094, Para. 3.4.	☐ ☐ ☐ ☐	Reference AMS-02-F07, Excessive Radiated Field Strengths, EMI, Magnets. Hardware exists in payload bay and on ISS exterior, the latter condition not addressed in JSC Form 1230.	
8.2Lasers **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).	☐	Reference Hazard Report AMS-02-F20, Crew Exposure to Coherent Light	

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Alpha Magnetic Spectrometer –02 (AMS-02) (Exterior Elements)		STANDARD HAZARDS		Shuttle/Station
F. DESCRIPTION OF HAZARD:	G. HAZARD CONTROLS: *(complies with)*	H. APP.	I. VERIFICATION METHOD, REFERENCE, AND STATUS:	
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).	☐	Reference AMS-02-F13, Battery Failure 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.	☐ ☐ ☐	Reference AMS-02-F13, Battery Failure 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.	☐	Reference AMS-02-F13, Battery Failure 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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Alpha Magnetic Spectrometer –02 (AMS-02) (Exterior Elements)		STANDARD HAZARDS		Shuttle/Station
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.	☐	Reference AMS-02-F13, Battery Failure 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.	☐ ☐	Reference AMS-02-F14, EVA Operations Hazard	
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.	☐ ☐	Reference AMS-02-F17, Electrical Power Distribution Damage. JSC Form 1230 does not address power supplied by exterior circuitry of ISS or power received by SSRMS.	
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.	☒	12.1.1 SVM: Review of Design to confirm no arcing/sparking components powered during ascent. 12.1.2 SVM: Thermal analysis to confirm no component will operate or fail exceeding autoignition temperature 12.1.3 SVM: Grounding testing of MLI 12.1.1 STATUS: Open. 12.1.2 STATUS: Open. 12.1.3 STATUS: Open.	

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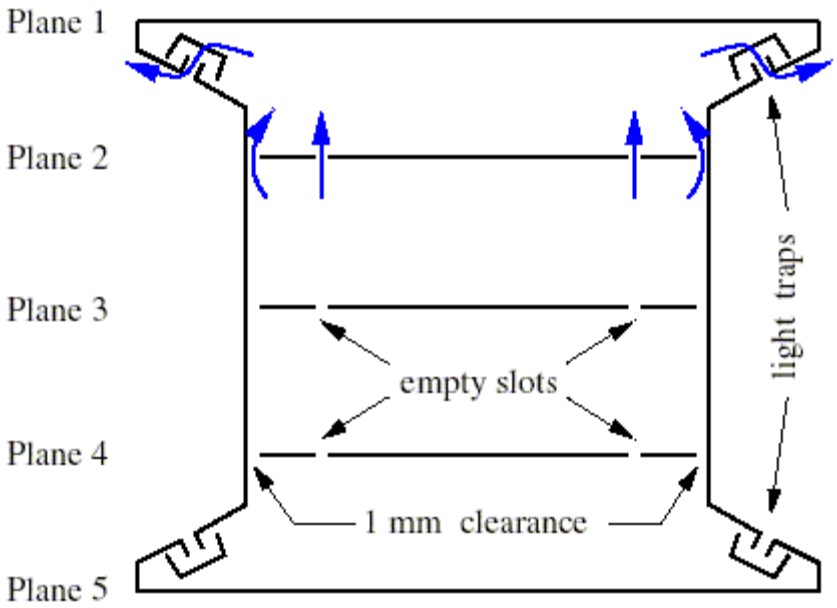
F. DESCRIPTION OF HAZARD:	G. HAZARD CONTROLS: *(complies with)*	H. APP.	I. VERIFICATION METHOD, REFERENCE, AND STATUS:	
13. Rotating Equipment	Rotating equipment meets criteria of NASA-STD-5003 for obvious containment.	☒	13.1.1 SVM: Fracture Control Summary 13.1.1 STATUS: Open	
14. Mating/demating powered 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).	☐ ☐	Reference AMS-02-F12 , Mate/Demate of Connectors	
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.	☐ ☐ ☐	Reference AMS-02-F18, Rapid Safing/Payload Reconfiguration	
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 – This hazard report addresses only exterior elements – No elemental mercury is used in AMS-02	

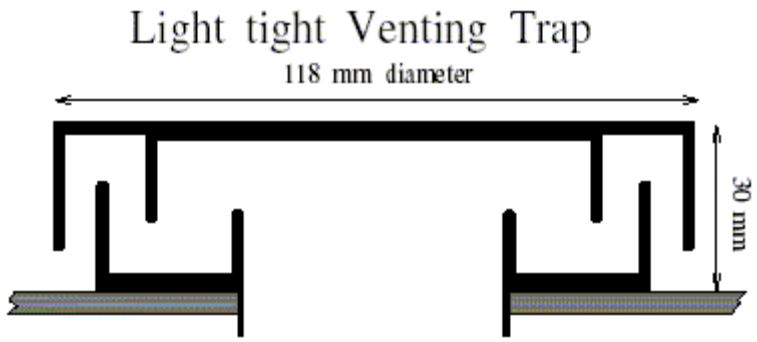
Vented Containers/Structures

Ref	Item	Function	Control Method	Verification Method	Verification Status
Structures	USS-02	Primary Structural Path. Composed of closed aluminum beams	Vented, but will be analyzed as if closed and with margins to retained atmosphere.	Structural Analysis	Open.
Avionics	Avionics Crates	Contain avionics	Vented	Venting Analysis	Closed. AMS-02-RP-CGS-005. Nov 12, 2004
Avionics	XPD (Power Distribution) Boxes		Vented	Venting Analysis	Closed. AMS-02-RP-CGS-005. Nov 12, 2004
Avionics	HVB (High Voltage Boxes)	High voltage power sources	Fully Potted No volume to vent		
Avionics	Cryomagnet Avionics Box	Controls charging/discharging of the AMS-02 Superconducting Magnet	Vented	Venting Analysis	Open
UPS	Battery Box	Contains battery and battery control electronics.	Vented	Venting Analysis	Open
MLI	MLI/thermal blankets	Thermal protection	MLI/blanket assembly will use standard means of venting layers and will use standoffs to provide venting across MLI/Blanket areas	Review of Design Inspection of as built hardware	Open
TRD	TRD Octagon Structure	Structure to support TRD sensor proportional tubes	VENTED. Structure is heavily perforated to support sensor tubes. Numerous paths for venting exit	Venting Analysis	Closed. Venting Analysis Complete
TRD	TRD Honeycomb Panels	Secondary Structure	VENTED. Panels are perforated (cover and core) and the panels have holes on the outside of the panels 1mm in diameter to enable venting the interior.	Testing/Analysis of Pressure Retention Potential	Closed. Pull tested completed, showed Margin of Safety of 6.2 with a FoS of 2.0 RWTH Report – Venting of Honeycomb Panels
TRD	Cabling Grid Tubes	Support Cabling runs	VENTED.1 mm holes every 30 cm along length	Inspection of as built hardware	Open
ACC	ACC Connector	Connector for Fiber Optics Connection	VENTED.Filtered (open cell foam) Vents provided	Inspection of as built hardware	Open
ACC	ACC PMT Housing/Box	Covers PMT and Fiber Optics Connections	VENTED.Filtered (open cell foam) Vents provided	Inspection of as built hardware	Open
TOF	TOF paddles	Detector	Venting channel provided, wrapped paddles do not create a hazardous condition if venting blocked	Inspection of as built hardware	Open

Ref	Item	Function	Control Method	Verification Method	Verification Status
TOF	TOF PMT	Detector	Minimum interior free volume for gas, design is not gas tight	Inspection of as built hardware	Open
Tracker	Tracker Volume	Sensor Volume	Vented through 4 bell shaped labyrinths (light tight traps) with nominal section of 20cm^2 to vent the 1.14m^3 volume	Venting Analysis Inspection of as built hardware	Closed. Venting Analysis Complete September 29, 2004, Depressurization and Repressurization Loads on AMS-02 Tracker Structure.
Tracker	Tracker Honeycomb	Secondary Structure	VENTED. Panels are perforated (cover and core) and the panels have holes on the outside of the panels 1mm in diameter to enable venting the interior.	Testing/Analysis of Pressure Retention Potential	Closed. Pull tested completed, showed Margin of Safety of 6.2 with a FoS of 2.0 RWTH Report – Venting of Honeycomb Panels
Star Tracker	Star Tracker Enclosure	Enclosure and Support for Star Tracker Electronics and Optics	Volume vented by 14 fastener access holes	Review of Design Inspection of as built hardware	Open
RICH	Aerogel & NAF Container	Contain particle Cherenkov generating materials	Vented. 0.17 m^3 volume vented (out) through 4 1 psi vent valves and 50 μm filter. Vented (in) through 3 1 psi vent valve	Venting Analysis Inspection of as built design	Open
RICH	RICH Detector	Sensor and reflective surface free volume	Vented. 0.7m^3 vented through eight 15 mm holes.	Venting Analysis Inspection of as built design	Open
RICH	RICH PMT	Detector	Minimum interior free volume for gas, design is not gas tight	Inspection of as built hardware	Open
ECAL	ECAL PMT	Detector	Minimum interior free volume for gas, design is not gas tight	Inspection of as built hardware	Open
ECAL	Backpanels	Support to PMT	Volume vented through 4 labyrinth groves (1mmx 0.5 mm) to vent volume of 0.03 m^2	Review of Design Inspection of as built hardware	Open

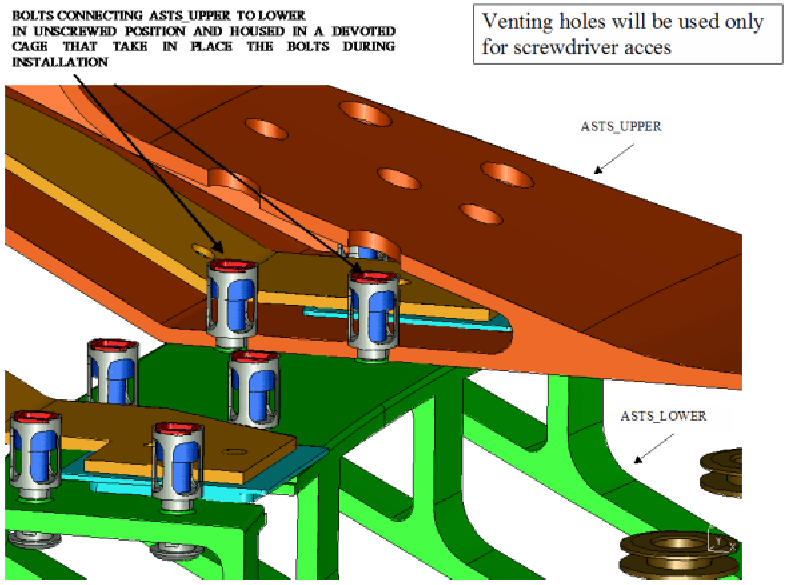
NOTE: All verifications will be tabulated and documented closed in the Chief Engineer's Report on Venting and will be tracked internally within the AMS-02 project, but only single verification will be documented for safety closure, provided by the Chief Engineer.

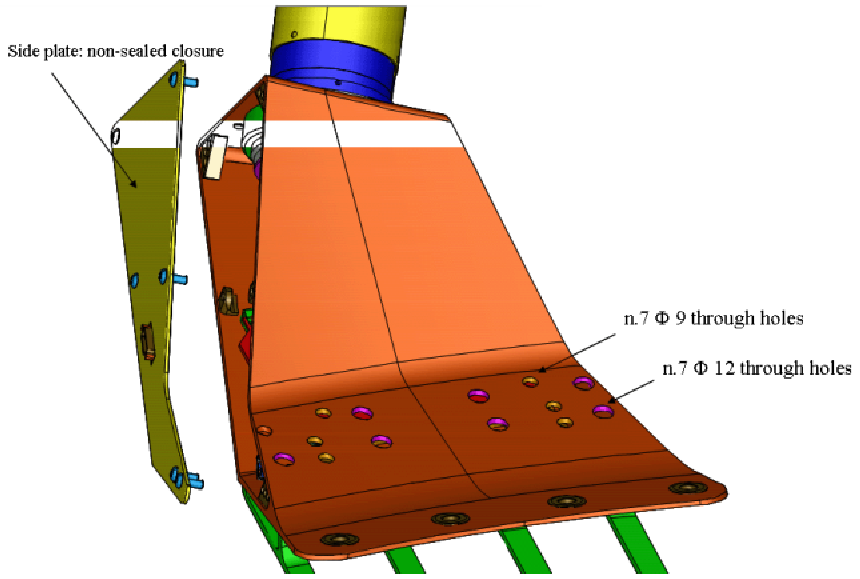




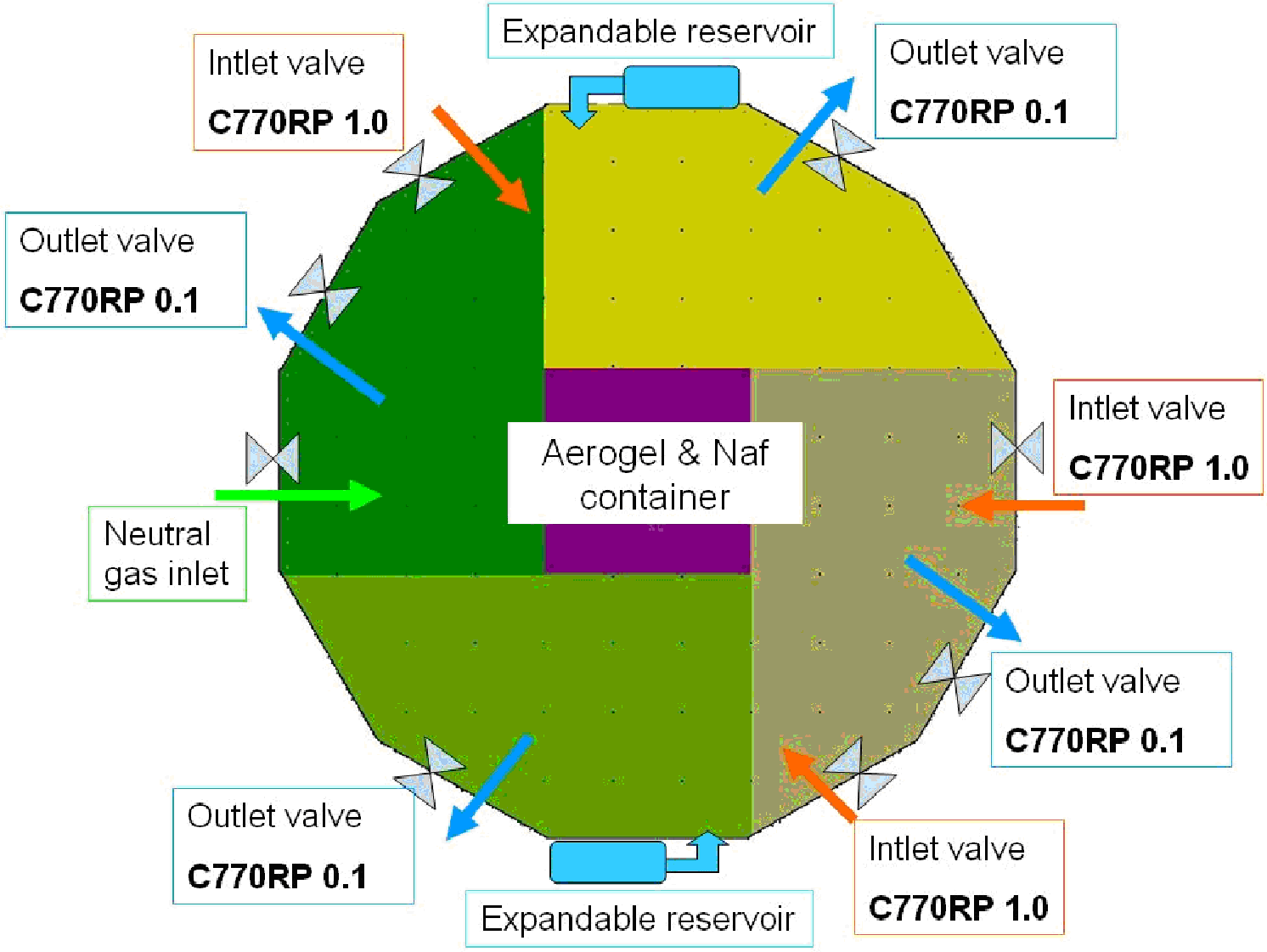
AMS-02 Largest Vented Volume is the Silicon Tracker.

Tracker Vent Design





Star Tracker Enclosure Venting



RICH Functional Venting Design

IGNITION SOURCES DURING ASCENT/DESCENT

DURING ASCENT THE FOLLOWING ITEMS ARE POWERED

- Cryogenic Vent Valve (operates at baroswitch command or Shuttle computer command when exterior pressure is 5 mbar (0.04 psia)
- Baroswitch for operating Cryogenic Vent Valve (operates at 5 mbar (0.04 psia)
- Uninterruptible Power Supply Battery and Battery Circuit. Battery is operational at all times. No charging occurs.

Item	Issue	Compliance Method	Verification	Status
Cryogenic Vent Valve	Arcing/Sparking Potential	Sealed Electromechanical Components within Valve	Review of Design, manufacturer's specifications	Open
Cryogenic Vent Valve Operating Baroswitch	Arcing/Sparking Potential	Sealed electronics	Review of Design, manufacturer's specifications	Open
Cryogenic Vent Valve Drive Circuitry	Arcing/Sparking Potential	No arcing/sparking components. Low Temperature Surfaces	Review of Design. Functional Testing	Open
Uninterruptible Power Supply Battery and Battery Circuit	Arcing/Sparking Potential	No arcing/sparking components. Low Temperature Surfaces	Review of Design. Thermal Analysis/Functional Testing	Open
AMS-02 (Integrated)	Excessively high temperature	Low Temperature Surfaces	AMS-02 Thermal Analysis	Open

Note: Individual verifications of the preceding table will be tabulated and documented in unified verification closures documented on the 1230 Form.

ROTATING EQUIPMENT

System	Rotating Equipment	Rotational Speed	Diameter	Control/Fracture Classification	Verification
TRD	Gas pumps (2) KNF NMP830	240 RPM	(15 gram rotating mass, small diameter)	Contained within Box C Vessel, Low Energy	Review of Design Fracture Control Assessment
TTCS	Pumps (4)	9000 RPM Maximum	0.5 inch	Contained, Low Energy	Review of Design Fracture Control Assessment
Cryosystem	Pump (vacuum pump)	~~1500 RPM Maximum, 500-1500 RPM Operational Ground Operations Only~~TBD	~~90 mm, 0.512 Kg~~TBD	~~Contained, Low Energy~~TBD	~~Review of Design Fracture Control Assessment~~TBD

Note: Individual verifications of the ~~preceeding~~preceding table will be tabulated and documented in unified verification closures documented on the 1230 Form.

PACIFIC DESIGN TECHNOLOGIES, INC.

PDT Model 5319-1, Centrifugal Pump, CO_2
Rotating Mass Data

The CO_2 circulation pumps that are to be installed on the AMS2 each contain the following rotating masses:

Rotor Assembly:	**0.034 lbs**	**(0.544 oz)**
Impeller:	**0.004 lbs**	**(0.064 oz)**
Screw:	**0.0004 lbs**	**(0.0064 oz)**
Total:	**0.0384 lbs**	**(0.614 oz)**

The above listed rotating masses are contained in a 304L stainless steel housing that has a minimum wall thickness of 0.118 inches. The housing is designed to withstand an internal burst pressure of 400 BAR, (5800 psig).

The Rotor Assembly, the larger of the rotating masses, is also contained within the motor stator assembly. The motor stator assembly laminations and windings have a thickness of 0.195 inches.

The maximum radius of the rotating mass is 0.250 inches.

The maximum rate of rotation is 9000 rpm.

Following is the outline drawing of the pump and controller assemblies:

For more information please contact:

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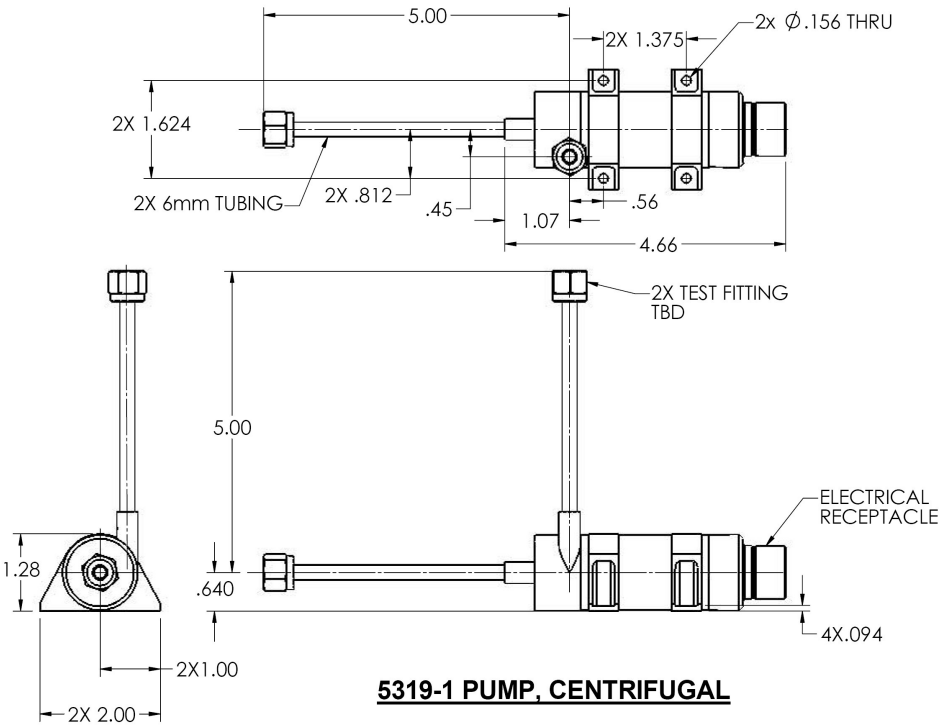
805 961-9110



5319-1 PUMP, CENTRIFUGAL

DESIGN NOTES

1. FLUID: LIQUID CARBON DIOXIDE
2. FLOWRATE:
   MINIMUM: 2 ml/sec AT 150 mBAR dP AT + 25°C
   MAXIMUM: 4 ml/SEC AT 850 mBAR dP AT + 25°C
3. OPERATING VOLTAGE:
   28 VDC ± 4 VDC
4. TEMPERATURE:
   PUMP:
   OPERATING: -50°C TO + 25°C
   AMBIENT STORAGE: -60°C TO +80°C
   CONTROLLER:
   OPERATING: -20°C TO + 55°C
   AMBIENT STORAGE: -40°C TO +80°C
5. PRESSURE
   MAXIMUM OPERATING: 160 BAR (2320 PSIG)
   PROOF: 240 BAR (3480 PSIG)
   BURST: 400 BAR (5800 PSIG)
   PUMP INLET: 10 PSIG ABOVE SATURATED LIQUID PRESSURE
6. INPUT POWER:
   10 WATTS @ NOMINAL FLOW CONDITION AS A GOAL
7. LIFETIME:
   3 YEARS NOMINAL
9. LEAK RATE:
   LESS THAN 1 X 10-8 mBAR *L/S CO2 AT 160 BAR
10. WEIGHT:
    2X 5319-1 PUMP: 2.20 LBS
    5356-2 CONTROLLER: 2.44 LBS
    60908 HARNESS ASSEMBLY: 2.10 LBS
    (HARNESS NOT SHOWN)

TTCS Pump Specifications

Stand alone and backing pump for turbopumps

Pfeiffer Vacuum

Product

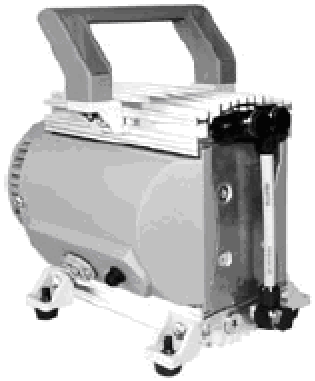
MVP 020-3DC

MVP 020-3DC, Diaphragm pump, 24 V +/- 10 %

Characteristics

Ultimate pressure	< 2 mbar
Mains requirement: voltage (range)	24 V +/- 10 %
Switch	no

Note:
The offered cable, part number:
PM 051 103 -T, corresponds to the connection cable between the power supply TPS 150, 24 V DC and the Diaphragm pump MVP 020-3 DC.



Similar product

- Backing pump and stand alone pump for turbopumps.
- Completely oil free! Very quiet, noise level approx. 48 dB(A). Long service life of diaphragms and valves. Pumping of dry and non corrosive gases. Interval operation and rotation speed control.

Flanges

Flange (in): DN G 1/8" Hose nipple DN 6
Flange (out): DN G 1/8" Silencer

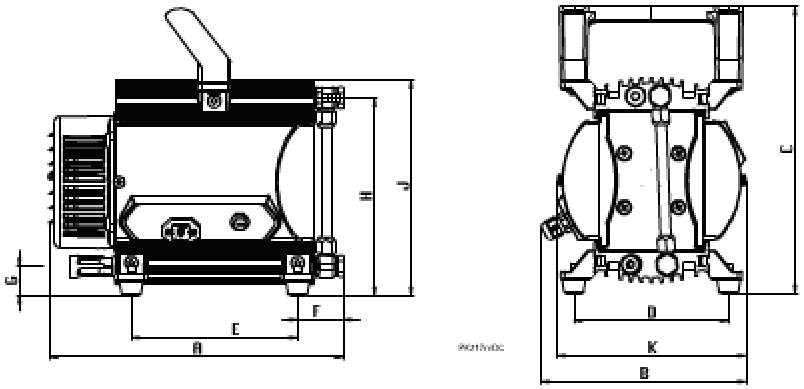
Technical data

Rotational speed max.	1500 rpm
Pumping speed at 1500 min-1	1 m^3/h
Ultimate pressure	< 2 mbar
Exhaust pressure max.	$1{,}1 \cdot 10^3$ mbar
Leak rate	$1 \cdot 10^{-1}$ mbar l/s
Motor rating	64 W
Current max.	3,5 A
Noise level	48 dB (A)
Ambient temperature	12-40°C
Weight	4,1 kg

Note:
The offered cable, part number:
PM 051 103 -T, corresponds to the connection cable between the power supply TPS 150, 24 V DC and the Diaphragm pump MVP 020-3 DC.

Cryomagnet Vent Pump Specifications

Dimensional Diagram



Large view

A: 223 mm B: 155 mm C: 217 mm D: 117 mm

E: 126 mm F: 35 mm G: 22 mm H: 149 mm

J: 163 mm K: 143 mm

From Pfeiffer vacuum, the supplier of the Cryomagnet vent pump.

1. A description of the rotating mass – a round steel housing with 4 mm wall thickness with an annular permanent magnet 82mm X 71.5mm, length 20mm

2. Diameter – the diameter of the motor – 90 mm

3. The rotating mass – 0.512 kg

4. Maximum speed – 1500 rpm

5. Controlled speed – 500 – 1500 rpm (with variable DC input)

6. Compliance assessment to the Fracture Control requirements for rotating equipment – no further precautions are necessary due to the low rotational speed (1500 rpm) and the robust construction (4mm wall thickness)

Cryomagnet Vent Pump Specifications