

**ACIS Verification Summary Report**

<b>Specification:</b>	ACIS Contract End Item Specification
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<b>Requirement Number/Title:</b>	3.2.4.2 Launch Site Safety (VRSD 3.2.4.2)
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**Requirement Statement:** The ACIS instrument and its ground support equipment for Kennedy Space Center shall be designed to comply with KHB 1700.7 and GP-1098.

<b>Verification Method:</b>	Inspection
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**Procedure Number:**

**Configuration:**

**Cycle Time:**

**Verification Discussion/Results:**

Safety issues were addressed in the design of ACIS ground support equipment as evidenced by the submission of Hazard reports. Refer to SCDP MIT 36-01402 REV-A

  
 ACIS Cognizant Engineer

May 30 1997  
 Date

**AXAF-I CCD Imaging Spectrometer  
(ACIS)**

**Verification Assessment Report  
-Power and Thermal-Control Structure-  
-Phase III Ground Hazard Report-**

**G4**

**Ignition Sources for Flammable Vapors/Liquids  
ACIS Vacuum GSE**

Contract # NAS8-37716

March 19, 1998

Submitted to:  
Massachusetts Institute of Technology  
Center for Space Research  
77 Massachusetts Avenue  
Cambridge, MA 02139

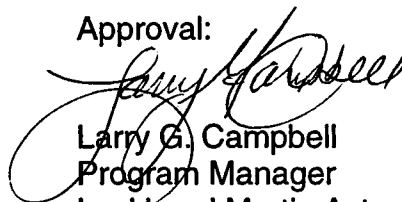
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**CHANGE/REVISION RECORD**

Number	Date	Description	Page	
			Rev.	Added
New	3-11-98	Initial Release	All	

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Appendix A ACIS Vacuum GSE Nitrogen Purge Ports A-1

## **1. INTRODUCTION**

### **1.1 Scope**

This document provides a collection of information which results from the implementation of the AXAF-I Payload Hazard Report. It is intended to show that the delivered ground support equipment meets a specific set of hazard controls from the AXAF-I Ground Hazard Report, 52100.400.007C.

In particular, this report provides the data to support the verification of specific PTS ground support equipment for usage at Kennedy Space Center (KSC). The method selected in the verification of each specific requirement is the method which provides the assurance to the program that the requirements have been verified.

The Verification information contained in the Ground Hazard Report shows how each contractual requirement will be verified. The requirements documented herein have been designated to be verified by analysis and/or a combination of other verification methods.

### **1.2 Applicable Documents**

#### **AXAF-I Project Documents**

52100.400.007	Report G4	AXAF Ground Hazard Report (TRW)
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## **2. METHODOLOGY**

### **2.1 Requirements & Specifications**

Verification methods to be used are defined in the Ground Hazard Report G4, 52100.400.007. This document records when tests and review of records were performed.

### **3. ASSESSMENT**

#### **3.1 Assessment Discussion**

1 CAUSE: *Electrical equipment generates a spark while in the hazardous atmospheric area.*

1.2 CONTROL: All EGSE operated in the vicinity of AXAF after the completion of propellant loading operations will be connected to a manned, single point shut-off while energized (ref. KHB 1700.7B, para 4.4.2.4.2).

DISCUSSION: The ACIS vacuum GSE consists of two powered boxes, the VCU and the Chiller circulator, each of which is outfitted with a single kill switch. The VCU shall have provisions for case purging with nitrogen to prevent an ignition source inside the VCU (e.g. UPS supplied systems) from propagating outside the VCU case in hazardous shutdown situations. Review of procedures will verify that VCU case purge gas is active prior to power application to the ACIS vacuum GSE. Appendix A contains the drawings showing the purge and vent ports.

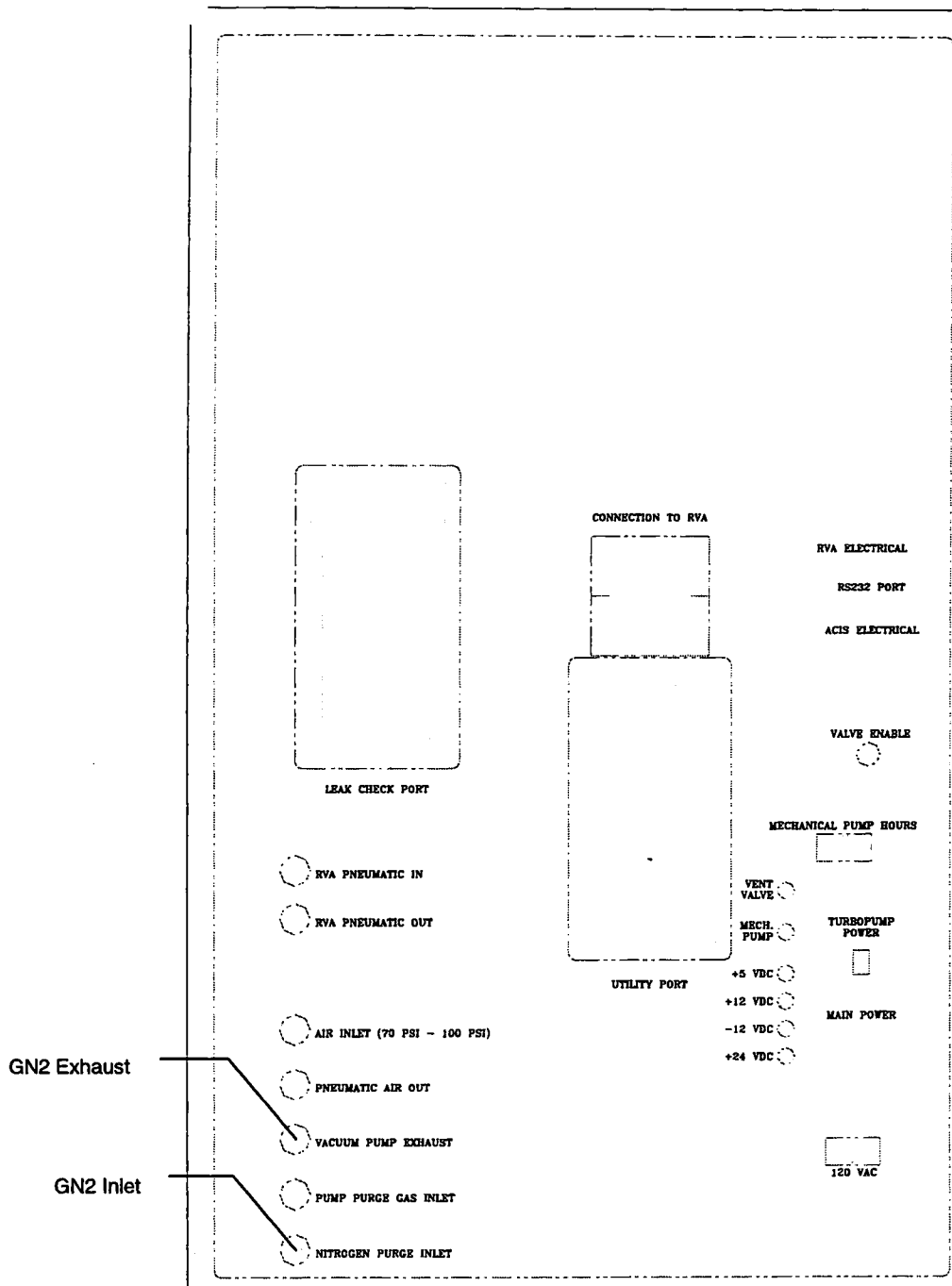
An uninterruptable power supply (UPS) inside of the vacuum control unit (VCU) is used to prevent damage to the GSE during power failures. This UPS remains on for 60 seconds after removal of power from the vacuum GSE. The VGSE may be purged with GN2 when operated in a hazardous environment.

1.2.2 VERIFICATION: This requirement has been verified by review of the ACIS VGSE build documentation. Specifically, 849AC711000, reviewed on 3-24-97. Relevant details of this drawing are included in Appendix A.

Purge shall be verified during operation and is performed as stated in the ACIS VGSE operating manual, ACIS-711-47-01.

This verifies compliance with the Ground Hazard Report - G4, no further action is required.

**Appendix A**  
**ACIS Vacuum GSE Nitrogen Purge Ports**



ACIS Vacuum GSE Back Panel



36-01510.081

**AXAF-I CCD Imaging Spectrometer  
(ACIS)**

**Verification Assessment Report  
-Power and Thermal-Control Structure-  
-Phase II Ground Hazard Report-**

**G16**

**Leakage or Rupture of ACIS Vacuum GSE**

Contract # NAS8-37716

March 13, 1998

Submitted to:  
Massachusetts Institute of Technology  
Center for Space Research  
77 Massachusetts Avenue  
Cambridge, MA 02139

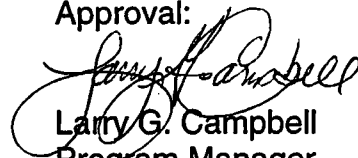
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Appendix A ACIS Vacuum GSE Components Information Table A-1

## **1. INTRODUCTION**

### **1.1 Scope**

This document provides a collection of information which results from the implementation of the AXAF-I Payload Hazard Report. It is intended to show that the delivered ground support equipment meets a specific set of hazard controls from the AXAF-I Ground Hazard Report, 52100.400.007C.

In particular, this report provides the data to support the verification of specific PTS ground support equipment for usage at Kennedy Space Center (KSC). The method selected in the verification of each specific requirement is the method which provides the assurance to the program that the requirements have been verified.

The Verification information contained in the Ground Hazard Report shows how each contractual requirement will be verified. The requirements documented herein have been designated to be verified by analysis and/or a combination of other verification methods.

### **1.2 Applicable Documents**

#### **AXAF-I Project Documents**

52100.400.007	Report G16	AXAF Ground Hazard Report (TRW)
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## **2. METHODOLOGY**

### **2.1 Requirements & Specifications**

Verification methods to be used are defined in the Ground Hazard Report G16, 52100.400.007. This document records when tests and review of records were performed.

### **3. ASSESSMENT**

#### **3.1 Assessment Discussion**

##### **1.0 CAUSE:**

Equipment failure causes leak or rupture of cylinders or components of the ACIS vacuum GSE.

##### **1.1 Control:**

Gas cylinders shall be standard DOT rated pressure cylinders . Cylinders shall be depressurized to less than 750 psig.

##### **Verification:**

The gas cylinder will be supplied by KSC. Applicable DOT ratings will be assured by KSC procurement and inspection on site. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

##### **1.2 Control:**

Valves, regulators, gauges, filters, and other ACIS vacuum GSE components have a design burst pressure of 4 times the maximum operating pressure (MOP), except as noted in Attachment B, and are proof tested at 1.5 times MOP (ref. KHB 1700.7B, para. 4.3.3.1.3). The pressure regulator is designed to operate safely at 3000 psig but will be derated to 750 psig MAWP. Bottles used shall be depressurized to this level prior to operation at KSC. The regulator system shall be proof pressure tested to 1.5 times derated MAWP.

External vacuum GSE connections: Hoses, flexlines and connectors designed to operate at pressures in excess of 50 psig shall be commercial products designed to operate at pressures at least 3 times vacuum GSE MAWP and shall be small diameter (~0.5" OD). All hoses, flexlines and connectors operating above 50 psig shall be proof tested to 1.5 times expected MOP and tagged accordingly. External lines, flexhoses, and connectors operating at pressures less than 50 psig shall be designed to operate at 4 times MOP and will be proof tested to 1.5 times MOP. Catastrophic failure of these lines under pressurized conditions will not present a hazard to personnel, GSE, Orbiter, ACIS or KSC facilities because of the low pressure (2 to 10 psig), small size and overpressure relief valves. These systems shall be single fault tolerant.

Internal vacuum GSE. Internal vacuum GSE hoses, flexlines, and connections shall be proof pressure tested to 1.5 times MOP.

Pneumatic air lines shall be proof pressure tested to 1.5 times MOP.

**Verification:**

The gas cylinder shall be depressurized as required to meet the above requirement. A maximum pressure of 750 psig will remain in the cylinder, as specified in the VGSE Operating Manual (ACIS-711-47-02). Appendix A shows the proof test pressures and design pressures for the ACIS VGSE components. Where burst pressure are not available the maximum design operating pressure has been used. The design of the ACIS VGSE was reviewed completely between January 1996 and July 1997. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

**1.3 Control:**

Pressure relief valves are provided downstream of all GSE pressure regulators in the system. Relief valves are set to relieve at pressures less than the MAWP of any system components and are sized such that their relief capacity is equal to or greater than the maximum flow capability of upstream regulators or pressure sources. Relief valves are located in the design such that no other components can be configured to render them inoperative. The valves and their associated plumbing are supported such that their discharge impulse cannot cause structural failure and all lines and other system elements are routed or located to avoid possible impact on other systems or personnel (ref. KHB 1700.7B, para. 4.3.3.1.3).

**Verification:**

This requirements has been verified by review of the ACIS VGSE build documentation. Specifically, 849AC711000, reviewed on 3-24-97 and 849AC711240 reviewed on 1-10-97. Proper functioning of these safety systems has been verified and documented in the "VGSE Functional Test" (ACIS-711-41-01) and the "VGSE Performance Test" (ACIS-711-46-01) contained in the delivery verification documentation. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

**1.4 Control:**

Pressure gauges are provided downstream of all GSE pressure regulators in the system and on the gas storage cylinders. Pressure gauges have been selected such that the normal operating pressure is not over 75% of full scale. They are designed of one piece, solid front construction with blowout backs, and an optically clear shatterproof window wherever possible. The gauges are provided for reference only and will not be calibrated because of contamination concerns. Operating pressure ranges are defined to allow for normal errors in gauging. Accidental overpressurization / underpressurization is detected by the vacuum GSE which will not operate unless safe conditions are met and will notify the operator of errors. Pressure relief valves are provided to prevent damage

to GSE hardware in the event of accidental overpressure (ref. KHB 1700.7B, para. 4.3.3.1.3).

**Verification:**

This requirements has been verified by review of the ACIS VGSE build documentation. Specifically, 849AC711135 , reviewed on 3-28-97 and 849AC711240 reviewed on 1-10-97. Proper functioning of these safety systems has been verified and documented in the "VGSE Functional Test" (ACIS-711-41-01) and the "VGSE Performance Test" (ACIS-711-46-01) contained in the delivery verification documentation. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

**1.5 Control:**

The system is designed so that pressure cannot be trapped in any part of the system without bleed capability. Check valves are provided where backflow could create a hazard. (ref. KHB 1700.7B, para. 4.3.3.1.3).

**Verification:**

This requirements has been verified by review of the ACIS VGSE build documentation. Specifically, 849AC711000, reviewed on 3-24-97, 849AC711240 reviewed on 1-10-97, 849AC711135 reviewed on 3-28-97, and 849AC711100 reviewed on 5-7-96. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

**1.6 Control:**

Isolation valves used in the system are designed to permit flow or isolation in either direction at the MAWP of the valve. (ref. KHB 1700.7B, para. 4.3.3.1.3).

**Verification:**

This requirements has been verified by review of the ACIS VGSE build documentation. Specifically, 849AC711000, reviewed on 3-24-97, 849AC711240 reviewed on 1-10-97, 849AC711135 reviewed on 3-28-97, and 849AC711100 reviewed on 5-7-96. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

**1.7 Control:**

A shutoff valve is provided in the system at the supply cylinder. Manually operated valves and regulators will be selected such that over-torquing the valve stem or adjustment of the regulator cannot lead to soft seat failure. Valves or regulators with uncontained seats are not used in the system (ref. KHB 1700.7B, para. 4.3.3.1.3).

**Verification:**

This requirements has been verified by review of the ACIS VGSE build documentation. Specifically, 849AC711135 reviewed on 3-28-97. This

verifies compliance with the Ground Hazard Report - G16, no further action is required.

1.8 Control:

System components that are not intended to be reversible will be designed or marked to preclude attachment in a reverse mode (ref. KHB 1700.7B, para. 4.3.3.1.3). All external connections to the vacuum GSE, components or vacuum GSE to ACIS are designed to be reversible and non-interchangeable

Verification:

This requirements has been verified by review of the ACIS VGSE build documentation. Specifically, 849AC711000, reviewed on 3-24-97, 849AC711029 reviewed on 3-26-97. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

1.9 Control:

The VCU for the ACIS vacuum GSE is provided with instrumentation to allow monitoring of pressure levels and confirmation of initiated actions. The control station is designed so that the operator does not need to leave the station to monitor hazard levels (ref. KHB 1700.7B, para. 4.3.3.1.3).

Verification:

This requirements has been verified by review of the ACIS VGSE build documentation. Specifically, 849AC711000, reviewed on 3-24-97, 849AC711240 reviewed on 1-10-97, 849AC711151 reviewed on 3-14-97, 849AC711161 reviewed on 3-14-97, 849AC711171 reviewed on 3-14-97, 849AC711181 reviewed on 3-20-96, 849AC711191 reviewed on 8-15-96, 849AC711201 reviewed on 3/18/97 and 849AC711101 reviewed on 8-11-96. Proper functioning of these safety systems has been verified and documented in the "VGSE Functional Test" (ACIS-711-41-01) and the "VGSE Performance Test" (ACIS-711-46-01) contained in the delivery verification documentation. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

1.10 Control:

Flexible hoses used in the system will be used and maintained according to the manufacturer's specifications. Flex hoses are installed so that they do not carry any external mechanical load and are not subjected to tension, torsion, or overheating (ref. KHB 1700.7B, para. 4.3.3.1.5).

Verification:

This requirements has been verified by review of the ACIS VGSE build documentation. Specifically, 849AC711000, reviewed on 3-24-97. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

- 1.11 Control:  
External flexible hoses used in the system have a design burst pressure equal to or greater than 4 times their MAWP and are pressure tested to 1.5 times their MAWP. (ref. KHB 1700.7B, para. 4.3.3.1.5).

Verification:

This requirements has been verified by review of the ACIS VGSE build documentation. Specifically, 849AC711000, reviewed on 3-24-97 and Manufacturing Process Plan (MPP) 849AC711000A010. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

- 1.12 Control:  
Periodic inspection and retest of flexible hoses is performed according to an established program. All hoses will be inspected prior to use at KSC, at which time any hoses showing signs of physical damage will be replaced. Flexible hoses will be marked with a metal tag detailing date of proof test, dedicated fluid service, MAWP, and a unique identifier. This tag will be replaced after each pressure test recertification (ref. KHB 1700.7B, para. 4.3.3.1.5).

Verification:

This requirements has been verified by review of the ACIS VGSE build documentation. Specifically, 849AC711000, reviewed on 3-24-97 and associated manufacturing process plans. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

- 1.13 Control  
CONTROL: Flex hoses with operating pressures above 150 psig are provided with attachments for restraining devices (ref. KHB 1700.7B, para. 4.3.3.1.3).

Verification:

This requirement has been verified by review of the ACIS VGSE build documentation which shows that there are no flex lines operating above 100 psig. Specifically, 849AC711000, reviewed on 3-24-97 and ACIS-711-47-01 (ACIS VGSE operating manual) reviewed on 9-26-97. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

2.0 CAUSE: Operator error causes overpressurization of components of the ACIS vacuum GSE vacuum-backfill system.

- 2.1 Control:  
A single operator error (e.g., mis-setting the regulator) will not result in system overpressurization, since flow orifices and relief valves will limit the system pressure (ref. KHB 1700.7B, para. 4.1.1).



**Verification:**

This requirements has been verified by review of the ACIS VGSE build documentation. Specifically, 849AC711000, reviewed on 3-24-97, 849AC711135 reviewed on 3-28-97 and ACIS-711-47-01 (ACIS VGSE operating manual) reviewed on 9-26-97. Proper functioning of these safety systems has been verified and documented in the "VGSE Functional Test" (ACIS-711-41-01) and the "VGSE Performance Test" (ACIS-711-46-01) contained in the delivery verification documentation. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

**2.2 Control:**

ACIS vacuum-backfill operations are controlled by a safety-approved procedure (ref. KHB 1700.7B, para. 4.1.3)

**Verification:**

This requirement has been verified by review of ACIS-711-47-01 (ACIS VGSE operating manual) reviewed on 9-26-97. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

**2.3 Control:**

All personnel involved in ACIS vacuum GSE operations shall be trained and certified to operate the ACIS vacuum equipment. A list will be provided of all personnel authorized to participate in hazardous operations certifying each individual's training and qualification by system to perform a hazardous operation (ref. KHB 1700.7B, para. 4.1.2.1, 4.1.2.2).

**Verification:**

Review of operations personnel list at time and place of VGSE operation will verify that all ACIS vacuum GSE vacuum-backfill system operators are trained and certified in its operation. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

**3.0 CAUSE:** Use of ACIS vacuum GSE vacuum-backfill system in confined space creates an oxygen-deficient environment.

**3.1 Control:**

The ACIS vacuum GSE will not be used in a confined or poorly ventilated space (ref. KHB 1700.7B, para. 4.4.2).

**Verification:**

Procedural review will verify that a step is in the procedures to verify, prior to operations with gaseous nitrogen, that the area has adequate ventilation to preclude the buildup of gaseous nitrogen. If any area is found to be unacceptable, oxygen content monitors will be used. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

4.0 CAUSE: Inadvertent evacuation of normally pressurized components results in component failure.

4.1 Control:

All components in the ACIS vacuum GSE, including those used for pressurized operations, are designed to withstand vacuum pressures.

Verification:

This requirements has been verified by review of the ACIS VGSE build documentation. Specifically, 849AC711000, reviewed on 3-24-97, 849AC711240 reviewed on 1-10-97, 849AC711135 reviewed on 3-28-97, and 849AC711100 reviewed on 5-7-96. This verifies compliance with the Ground Hazard Report - G16, no further action is required.

## **Appendix A**

### **ACIS Vacuum GSE Components Information Table**

+ Design burst pressure is not available from the manufacturer for these components. These are standard industrial pneumatic components and are protected by overpressure relief valves. All of these components are small and positioned to minimize risk in the event of failure.