TIMED GENERAL INSTRUMENT INTERFACE SPECIFICATION

Section 7.0
Integration and Field Test Requirements
Signature Page

TECHNICAL CONTENT APPROVAL (PAGE 1 of 1)

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B					
C					
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Rev #	Date	S. Dion	A. El-Dinary		
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7. INTEGRATION AND FIELD TEST REQUIREMENTS

7.1 INSTRUMENT/SPACECRAFT INTEGRATION

The TIMED Spacecraft Integration Test Plan (7363-9020) addresses, in general terms, all of the integration, calibration, electrical, mechanical and environmental testing that the TIMED Spacecraft will be exposed to from the onset of integration right up to launch. Test plans and test procedures ranging from the subsystem undergoing integration with the spacecraft to the overall spacecraft system are identified in the Plan. Virtually every phase of testing that the spacecraft will be subjected to, including EMC, Functional, Performance, Ground Station Compatibility, Environmental, Software, and Mission Operations Readiness Demonstration (MORD) is covered as is testing at the Range during pre-launch ground processing. In addition, plans and/or procedures associated with essential spacecraft support activities, such as range communications, contamination control, safety, handling and security are addressed in sufficient detail to complete the picture.

7.1.1 Test Responsibility

All spacecraft mechanical and electrical integration and testing shall be conducted in accordance with the TIMED Spacecraft Test Plan (7363-9020) and shall be under the direction of the Payload Mechanical Engineer and the Spacecraft Integration and Test Manager. All electrical interfaces must be verified by both the instrument provider and the spacecraft integrator prior to mating of the electrical interface connectors.

Prior to instrument integration onto the spacecraft, an instrument pre-integration readiness review will be conducted under the direction of the Spacecraft Integration and Test Manager.

7.1.2 Test Configuration

A Payload Operations Center (POC) capable of instrument commanding, telemetry display, automated testing and quick-look science data processing will be required for each instrument.

Instrument commands will originate from the instrument POC's, flow through the Mission Operations Center (MOC) and the spacecraft ground station to the spacecraft. Telemetry will flow from the spacecraft through the ground station to the Mission Operations Center to the Mission Data Center (MDC). The MDC archives the telemetry and serves it to the instrument POC. Reference Figure 7.1.2-1 Simplified Test Configuration for a simplified diagram.

Starting with spacecraft-instrument integration, an instrument POC will be required to perform all instrument tests.

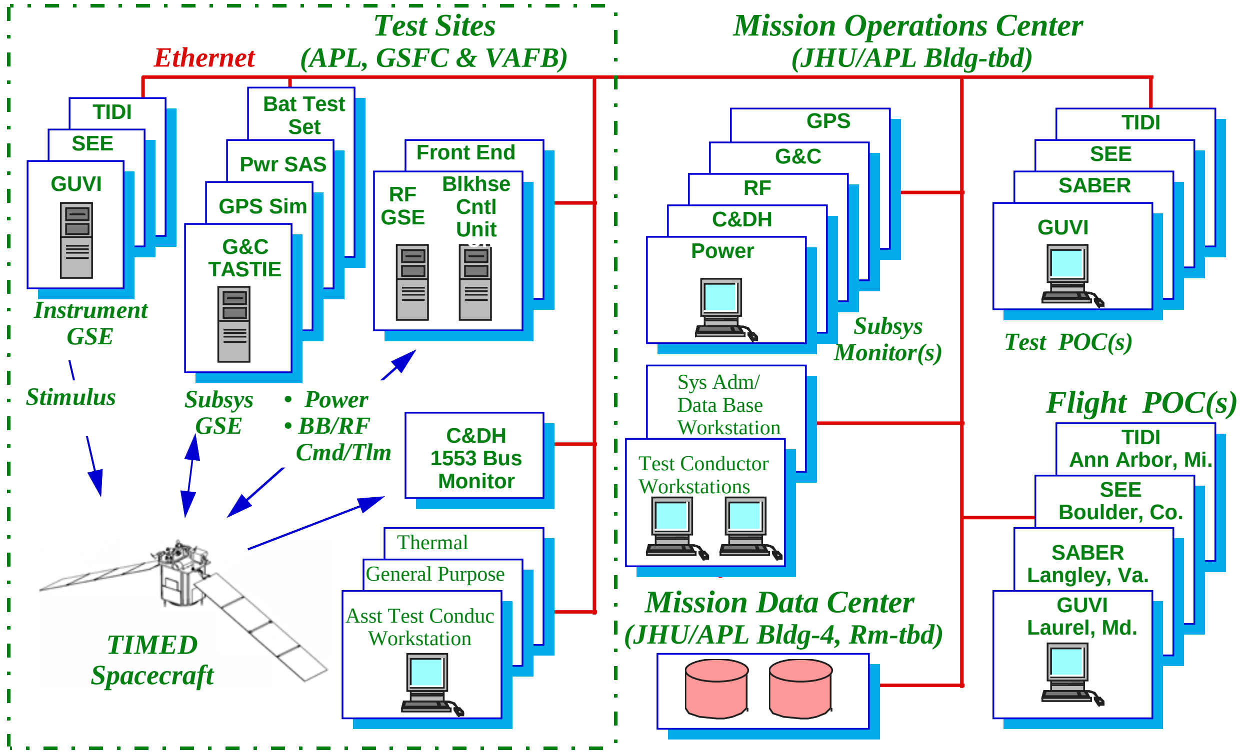

Figure 7.1.2-1 Simplified Test Configuration

7.2 INSTRUMENT GROUND SUPPORT EQUIPMENT (GSE)

7.2.1 Electrical GSE

7.2.1.1 Stand Alone Instrument GSE

Instrument GSE shall be supplied to enable, at a minimum, verification of the stand-alone test of the instrument prior to spacecraft integration or at any time it is deemed necessary to support a stand-alone test of the instrument on the spacecraft. This instrument stand alone GSE must be available to be physically relocated with the spacecraft at remote test facilities such as NASA-Goddard Space Flight Center (GSFC) and Vandenberg Air Force Base (VAFB). Instrument-level testing will be carried out using each instrument's GSE, calibrated as defined in the section on Calibration in section 7.2.1.2.

7.2.1.2 Instrument Specific Ground Support Equipment (GSE)

Instrument specific GSE supporting spacecraft testing will be physically located in the area of the spacecraft and interfaced with the Mission Operations Center (MOC) over the established “priority ethernet” link.

The hand shaking between the Mission Operations Center and the Instrument specific GSE will be checked out using the spacecraft emulator prior to supporting instrument testing on the spacecraft.

The Instrument specific GSE must have the capability of being remotely and independently computer controlled from either the Mission Operations Center (MOC)-Test Payload Operation Center (Test POC) located at APL or the instrument Flight POC located at the respective instrument center. Additional manpower must be provided for GSE support in the field if this requirement is not implemented. This instrument specific GSE must be available to be physically relocated to support initial spacecraft integration at JHU/APL, environmental testing at JHU/APL and at NASA-Goddard Space Flight Center (GSFC) and field testing and launch support at Vandenberg Air Force Base (VAFB).

7.2.1.2.1 Calibration

Instrument equipment that requires calibration must have a valid calibration sticker. The equipment should be calibrated prior to delivery so that it will not require frequent recalibration. A government agency residing at APL, NASA-Goddard, and Vandenberg Air Force Base is responsible for ensuring that all test equipment is properly marked and calibrated if calibration is required.

The government agency has the authority to terminate testing at the described facilities if the calibration date has expired or if the equipment is not properly marked (not needing calibration). Special arrangements may be made for equipment calibration at APL if required.

7.2.1.2.2 Instrument GSE AC Power

All instrument GSE will be powered via the TIMED AC Power Distribution Cart. This power cart requires a manual reset after a power outage.

The input to the TIMED AC Power Distribution Cart is a 208 VAC, three phase, 100 amp circuit. The cart’s output consists of twenty standard 120 VAC, single phase, 20 amp circuits and can be modified to supply any standard voltage and phasing combination with a maximum of 208 VAC, 3 phase, 50 amp.

If an UPS system is required, the instrument personnel will be responsible for providing their own units. The Neutral and GSE Chassis shall be isolated within all GSE. The GSE Chassis shall be tied to Safety Ground (green wire).

Note - The Neutral and Safety Ground shall be tied together at the Facility AC Power Source.

7.2.1.2.3 Instrument GSE Grounds

All instrument GSE chassis shall be grounded to facility ground.

7.2.1.2.4 Test Connectors

Normal and diagnostic modes of the instrument shall produce the appropriate telemetry data to verify proper operation, but troubleshooting through instrument test connectors containing instrument specific signals will be allowed, provided access to these test connectors is available.

7.2.1.2.5 Instrument GSE Interface

All instrument GSE that will be remotely controlled, will be connected to the TIMED network via a standard RJ45 connector. The ethernet hub will be capable of auto detecting 10Base-T or 100Base-T systems.

7.2.1.2.5.1 Faults/Safety

Instrument GSE shall be designed to preclude damage to the spacecraft, spacecraft GSE, and instrument in the event of any single GSE failure.

7.2.1.2.6 Instrument GSE Test Cables

All instrument GSE that will be used for spacecraft thermal vacuum tests will follow the guidelines for cable connectors and cable length shown in the below diagram. The GSE bulkhead connector (30194-TBF-28-21-PS) and the two (2) mating bulkhead connectors (MS3106A-28-21S and 973106A-28-21P) will be furnished by APL so that common cables will be utilized for all instrument testing.

The GSE bulkhead connector (30194-TBF-28-21-PS) should be used for ambient conditions only. For vacuum use, the 30194-TBFH-28-21-PS connector should be used. APL will not supply the 30194-TBFH-28-21-PS connector._

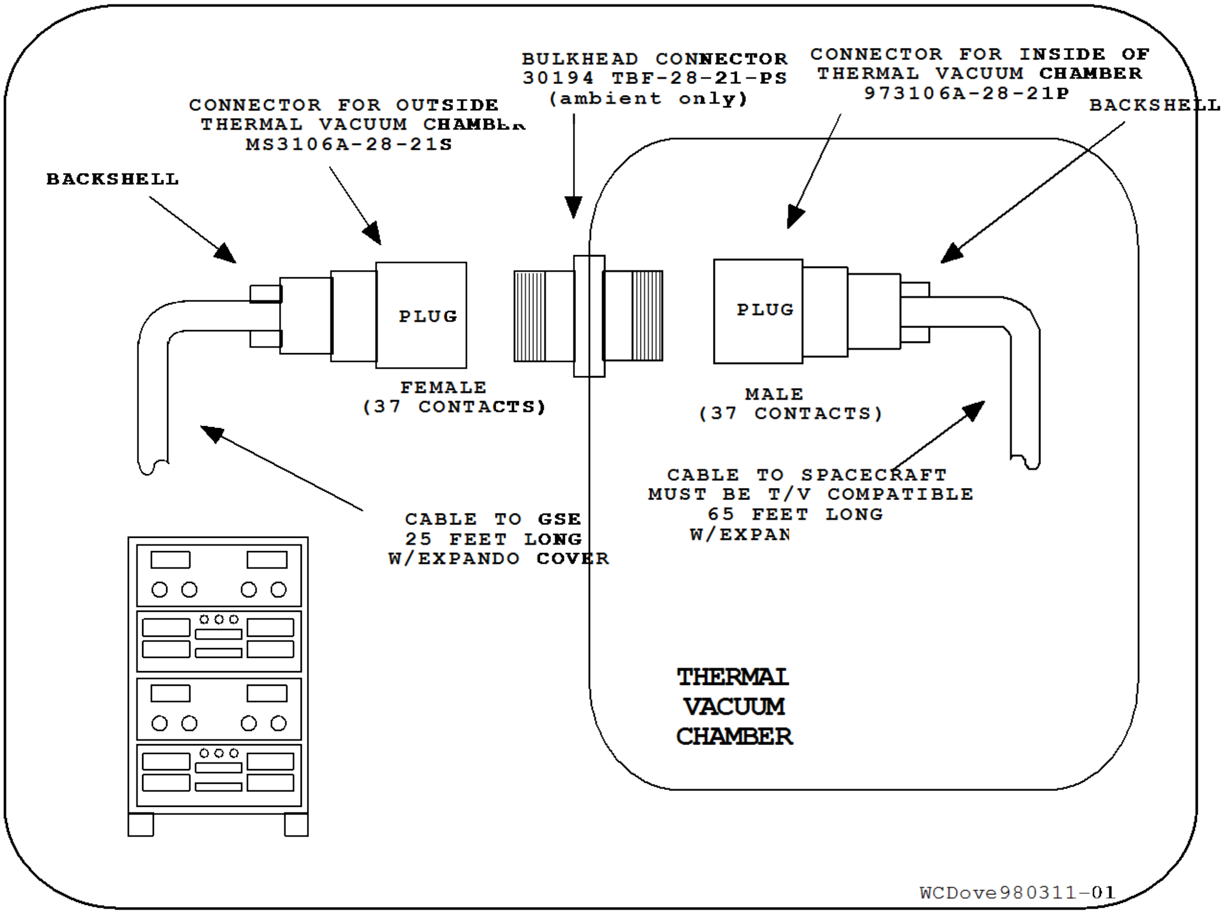

Figure 7.2.1-1 Thermal Vacuum Chamber Feedthrough

7.2.2 Mechanical GSE

Mechanical GSE, required during shipping, installation, calibration, shall meet a subset of requirements listed in the Eastern and Western Range 127-1 Requirements Document. The subset of requirements shall be determined by the TIMED program and will be provided to the instrument teams. The instrument design teams shall provide APL with drawings of the mechanical GSE and handling procedures for their instrument no later than 3 months prior to delivery of their instrument.

7.3 INSTRUMENT PAYLOAD OPERATIONS CENTERS (POC)

7.3.1 Instrument Payload Operations Center Overview

Each instrument organization will be required to maintain a “TEST” and “FLIGHT” Payload Operations Center. Each POC will be capable of instrument and ground support equipment commanding, spacecraft and instrument telemetry display, automated testing and quick-look science data processing. For all instrument tests, the instrument POCs will be required to process on-line, sufficient instrument science data acquired in the Mission Data Center to verify operation of the instrument.

Instrument commands will originate from the instrument POC's, flow through the Mission Operations Center and the spacecraft ground station to the spacecraft. Telemetry will flow from the spacecraft through the ground station to the Mission Operations Center to the Mission Data Center (MDC). The MDC archives the telemetry and serves it to the POC's.

Starting with spacecraft-instrument integration, POC’s will be required to perform all instrument tests. The instrument POC’s will execute pre-reviewed test scripts on their particular command/telemetry terminal.

The test conductor will not be able to command the instrument other than to send the instrument relay commands (e.g., Instrument and Operational Heater Power “On/Off” and Survival Heater Power “On/Off”) and to enable or disable the individual instrument Payload Operations Center ground command link to the Mission Operations Center.

Descriptions of alarms, etc. are provided in Section 8, Ground System and Payload Operations Centers (POC’s) Interface, of this document.

7.3.2 Instrument TEST Payload Operations Center (TEST POC)

Initial spacecraft integration will be performed at JHU/APL Building 23 Clean Room. To support instrument integration the respective Instrument TEST POC will be physically located in the general area of the spacecraft in JHU/APL Building 23 Clean Room. After the spacecraft is fully integrated and prior to the start of the spacecraft baseline performance test, the TEST POC would be relocated to the area within JHU/APL to be designated as the Mission Operations Center.

7.3.3 Instrument FLIGHT Payload Operations Center (FLIGHT POC)

Instrument personnel will be responsible for maintaining a “Flight POC” located at the respective instrument facility. During spacecraft testing, specific test periods will be defined, whereby, a particular instrument Flight POC will take control from the instrument Test POC and perform that particular test. Confidence in the Flight POC command and housekeeping telemetry processing capability, science data processing and voice communication link checkouts will be increased.

7.4 SPACECRAFT INSTRUMENT TROUBLESHOOTING

Each spacecraft instrument problem will be treated on a case-by-case basis. If it is deemed necessary to troubleshoot an instrument to its board level on the spacecraft, the Technical Review Board will evaluate the impact to all concerned.

7.4.1 Instrument "Repeatable Problem" Troubleshooting

If an instrument problem on the spacecraft is repeatable, the following steps will be initiated by the integration and test team to further define and correct the problem:

1.) A Problem Failure Report will be generated and sufficient time allocated to understand the problem with the instrument and the spacecraft bus interfaces connected (power and C&DH 1553 bus).

2.) With the spacecraft bus interfaces connected and the problem repeatable and points to the instrument, the next logical step would be to physically disconnect the spacecraft bus interfaces and have the instrument personnel connect their stand-alone GSE to the instrument and try to repeat the instrument problem. Prior to demating any of the spacecraft/instrument bus interface harness connectors, a visual inspection will be made to verify a good mate. After these connectors are demated, a visual inspection will be made for contamination or bent pins on the box and harness connectors.

It should be noted that the stand-alone instrument GSE will be physically located approximately 10 feet from the spacecraft and that instrument GSE interface cables need to be at least 20 feet in length to troubleshoot in this configuration.

If the problem was repeatable using instrument stand-alone GSE, a Technical Review Board will be convened and a decision made to remove the instrument from the spacecraft. Since the problem is repeatable using instrument GSE, there is no benefit at this time in allowing instrument personnel to do any card level troubleshooting on the spacecraft. The decision will be made to remove the instrument from the spacecraft and troubleshoot the instrument on the bench. The required fix shall be approved by the Technical Review Board and the retest of the instrument addressed.

7.4.2 Instrument "Random Problem" Troubleshooting

If an instrument problem on the spacecraft is random, the following steps would be initiated by the integration and test team to further define and correct the problem:

1.) A Problem Failure Report will be generated and sufficient time allocated to duplicate and understand the problem with the instrument and the spacecraft bus interfaces connected (power and C&DH 1553 bus).

2.) With the spacecraft bus interfaces connected and the instrument problem is random but points to the instrument, a Technical Review Board will be convened and a decision made as to troubleshoot the instrument problem to the card level on the spacecraft or physically disconnecting the spacecraft/instrument bus interfaces and connect the instrument stand-alone GSE. One of the areas of concern should be by performing either of the above could cause the problem to disappear.

Of concern with troubleshooting to the board level on the spacecraft is the possibility of inadvertently stressing additional components within the instrument. Only under extreme problem situations will troubleshooting to the board level on the spacecraft be approved.

Before any instrument box cover is removed and any board is tested, a step-by-step procedure detailing the troubleshooting steps will be required to be generated by the instrument personnel and approved by the Technical Review Board. This troubleshooting procedure would then be part of the Problem Failure Report.

The required fix would need to be approved by the Failure Review Board and the retest of the instrument addressed.

7.5 PURGE REQUIREMENTS

A purging system will provide contamination-sensitive instruments with a nitrogen purge gas flow during integration, testing, and transportation of the spacecraft up to launch. The purge gas shall be generated using the boil-off of liquid nitrogen to provide ultra high purity (99.999%) nitrogen or better. Gas purity and flow will be continuously monitored using in-line analyzers, and an alarm will be activated if contamination exceeds preprogrammed levels. An alarm condition will be corrected within four hours of the onset of the problem. The purge gas will be supplied by individual restrictors and lines branching off a spacecraft manifold, and it will continue up to launch via flyaway fittings at the launch site.

7.5.1 Purge Gas Purity

Fractional distillation of liquid nitrogen will provide an ultra high purity nitrogen purge gas. Residual contaminants include water vapor (< 1 ppm), oxygen (< 5 ppm), and THC (< 0.5 ppm). The permeation of water vapor and oxygen through the purge gas distribution system causes the contamination to rise to 10 ppm at the spacecraft instruments. Therefore the purity of the purge gas delivered to the instruments will be guaranteed at the ultra high purity (99.999% nitrogen) level.

7.5.2 Purge Gas Filtering

A Pall 0.01 micron teflon membrane filter is installed within the Purge Gas Monitor suitcase GSE. This filter is located in-line, adjacent to the outlet valve of the suitcase, and all purge gas must pass through it. Additional last-chance filters are located in the purge lines, at the entrance to the suitcase GSE and the purge gas inlet(s) on the spacecraft, to catch any particles generated by the lines or quick-disconnect fittings.

7.5.3 Purge Gas Monitoring

A Panametrics electronic hygrometer is installed within the PGM suitcase to provide real-time analysis of the purge gas quality. Sensors within the gas flow lines detect the residual amounts of water vapor and oxygen, as well as the pressure and temperature of the purge gas. These parameters are displayed on the hygrometer screen, and two can be selected as the high and low alarm parameters. The hygrometer can be programmed from the front panel to set alarm limits. A series of reed relays are ganged together to provide electrical continuity whenever no alarm is present and when 110 V. and 24 V. power are available. By setting close limits and by monitoring the continuity of the circuit, the purge gas can be monitored real-time for acceptable quality. While at APL, Plant Facilities monitors this circuit on their 24 hour monitoring system in building 1. If the alarm is triggered, they telephone the cognizant personnel on a list, at least one of whom has a pager so they can be reached. Personnel must also perform a check of the system every working day, with a paper log book filled out listing system parameters. When in the field, the purge system must be monitored by either personnel on duty or a guard, or it could be connected to an autodialer to report an alarm. Since the system is being operated off liquid nitrogen dewars when in the field, the log book shall be filled out twice daily; and the weight of the dewars shall be monitored to verify that enough LN2 is remaining to provide an uninterrupted purge gas supply. The time to correct any problem from its occurrence will be less than four hours, with nominal response times of less than two hours.

7.5.4 Purge Gas Distribution

The purge gas is generated by evaporating liquid nitrogen from either the Space Simulation Lab bulk tanks or from dewars which are refilled from bulk tanks. The gas is then passed through the PGM suitcase GSE, where it is regulated, analyzed, and filtered. The total flow rate of purge gas is monitored by viewing a flowmeter on the front panel of the PGM suitcase. The gas is fed to a main spacecraft purge manifold by teflon hose covered with stainless steel braid and a polyolefin overjacket. Self-sealing Symetrics quick-disconnect fittings with 0.03 cc ullage are used at each hose connection. The gas is distributed to the individual instruments and sensors by providing a properly sized restrictor in each line branching off the main spacecraft manifold. Individual instrument purge flow rates will be accommodated by providing choke flow across the restrictor. This will maintain a constant volume rate of flow to each and every instrument, with no instrument able to increase their flow and affect other instrument flow rates. This requires the spacecraft manifold to operate at 14.5 psig. The restrictors are individually measured and tailored to provide the correct flow rate.

7.5.5 Instrument Purge Flow Rates

To prevent the entrance of contaminants into an instrument, the instrument housing shall be sealed well enough so it can maintain a positive internal pressure. The preferred internal pressure is 5 torr (0.1 psid), with an absolute minimum internal pressure of 2 torr (0.4 psid) if contaminants are to be blocked from entering. The purge gas flow rate necessary to provide this internal pressure shall be measured and reported to APL, and the restrictor shall be sized to produce this flow rate. As a general rule, the purge gas flow rate should be sufficient to change the air within the instrument volume in 4 to 5 minutes. If larger amounts of gas are required, the instrument housing is too leaky for a good purge protection. This sealing of the housing will require either vent valves so the instrument can expel its internal volume of gas during launch or acceptable housing rigidity to withstand overpressure during launch.

7.5.6 Purge Connectors

Each instrument shall use the SWAGELOK SS-400-X-X purge fitting.

7.6 ENVIRONMENTAL REQUIREMENTS

The cleanliness specifications for the integration and test, field test facilities, etc. are detailed below. These specifications apply to any area in which the spacecraft will be located from the start of integration until launch, including transits, unless otherwise stated. Details on how these requirements will be met are in the TIMED Contamination Control Plan (7363-9031).

7.6.1 Cleanliness Requirements

The spacecraft will be located in a Class 10,000 or better Clean Room from the start of spacecraft integration until operations on the launch pad. All instrument components and spacecraft components shall meet surface-level 750 requirements from the start of spacecraft integration up to launch.

7.6.2 Hydrocarbon Limits

The spacecraft will be located in an area where the hydrocarbon concentrations will be limited to less than 15 ppm from the start of spacecraft integration until operations on the launch pad.

7.6.3 Facility Temperature Requirements

The spacecraft will be located in an area in which the temperature will be controlled to be between +65° F and +75° C from the start of spacecraft integration until operations on the launch pad.

7.6.4 Facility Humidity Requirements

The spacecraft will be located in an area in which the humidity will be controlled within the range of 40% and 50% from the start of spacecraft integration until operations on the launch pad.

7.6.5 Barometric Pressure

Room Ambient

7.6.6 ESD Control

The integration and test facility shall have controls and equipment to mitigate ESD hazards. (Ref. SOR R&QA Document 8.033)

7.7 SAFETY

7.7.1 Applicable Safety Documentation

All Integration and Test activities at APL, GSFC, and at the launch site shall be conducted according to approved test procedures and in accordance with the TIMED Program Safety Plan (7363-9065).

7.7.2 S/C Safety Hazards

7.7.2.1 Instrument Related Hazards

The following is a list of identified instrument related hazards:

- Pyrotechnic Devices
- Lasers
- High Voltage
- Ionizing Radiation Sources
- Lifting Material Handling
- Purge
- Pressure System
- Electrical Ground Support Equipment (EGSE)
- Hazardous Materials
- Electro-Static Discharge(ESD)

7.7.2.2 Bus Related Hazards

The following is a list of identified Bus related hazards:

- Battery
- RF/EMI
- Purge
- Pyrotechnic Devices
- High Voltage
- Lifting Material Handling
- Electrical Ground Support Equipment (EGSE)
- Hazardous Materials
- Electro-Static Discharge(ESD)

7.7.2.3 Lifting and Handling Flight Hardware

The following restrictions shall apply to the lifting and handling of flight hardware.

- A sling shall be used for all hardware that exceeds 35 lbs. (~15.75 Kg.)
- The minimum ultimate load to rated load ratio shall be 5:1
- The minimum yield load to rated load shall be 3:1
- Slings shall be proof load tested to 2x the rated load every 12 months and tagged with the date of the most recent test
- All critical welds and single failure points shall be subject to NDI on an annual basis
- Attachment points for flight hardware shall be located above the center of gravity
- Work shall not be permitted under suspended loads

7.7.2.4 Ionizing Radiation

The following requirements shall be applied to prevent exposure to ionizing radiation.

- · Ionizing radiation sources shall be contained/encapsulated
- · Precautions shall be taken to prevent inadvertent exposure to ionizing radiation sources
- · Personnel must receive proper training for handling sources at APL, GSFC, VAFB
- · Documentation shall be fitted out for all sources and users
- · Approved procedures shall be followed at APL, GSFC, and VAFB

7.7.2.5 Lasers

The following requirements shall be applied to prevent exposure to Lasers.

- · Laser beams shall be contained in housings, and housings cannot be opened
- · Laser operation will comply with the requirements of EWR 127-1 Section 3.8.2
- · If housing is opened:
  - Clearance areas and access controls shall be established
  - Eye protection shall be used to control exposure

7.7.2.6 S/C Electrical Safety Hazards

The following requirements shall be applied to prevent injury from exposure to high voltage.

- · All circuitry shall be contained to prevent contact with high voltage
- · All circuitry shall be grounded
- · All high voltage sources shall operate at low current

7.7.2.7 Pyrotechnic Devices

The following restrictions shall apply to the use of pyrotechnic devices:

- · All pyrotechnic devices shall be category B (Non-Hazardous)/Class C
- · Grounding and shielding shall comply with the requirements of EWR 127-1
- · Pyros shall be handled in approved containers with Faraday Caps
- · EED's shall be stored at all times in static free containers
- · EED's shall be handled at ESD free workstations
- · All pyrotechnic devices shall be EMI compatible with other systems

7.7.2.8 Pressurized Systems

The following standards and requirements shall apply to all pressurized systems:

· All flight pressure systems shall meet MIL-STD-1522
· Refrigerant system is designed and tested to MIL-STD-1522
· All GSE pressure systems shall meet ASME, MIL-STD-1522, and/or DOT requirements

7.7.2.9 Electrical GSE

The following restrictions shall apply to Electrical GSE:

· Electrical GSE will be inspected to insure NEC Code Compliance (cutoff switch, fusing, return connected to ground, 3 prong plugs, no exposed voltage
· EGSE used on the pad after the second stage is fueled will be explosion proof (within 100 feet)
· All electrical GSE in the Blockhouse will be remotely controlled

7.7.2.10 Hazardous Materials

The following restrictions shall apply to Hazardous Materials:

· All hazardous materials shall be contained in approved containers
· Cleaning fluids, epoxies, lubricants, and paints shall be applied and discarded properly
· N2 and Ar shall be used only in ventilated areas (oxygen depletion analysis)

7.8 CONTAMINATION CONTROL

The contamination requirements for each payload instrument shall be documented in each instrument's SIIS.

7.8.1 Instrument Cleanliness

Prior to integration, APL shall verify the cleanliness levels of all sensitive surfaces. The test methods shall be agreed to by the experimenter.

The following common chemicals are prohibited in the integration and spacecraft test areas including but not limited to:

a) Aromatic Hydrocarbons

b) Acetone
c) Methyl Ethyl Ketone
d) Propyl Alcohol
e) Xylene
f) Acetylene
g) Vacuum pump oil and oil vapor
h) Ammonia
i) Caustic or acid fumes
j) Mercury
k) Ionic Salts

7.8.2 Materials Outgassing

All nonmetallic materials used in the payload instrument design shall conform to the requirements of the TIMED Contamination Control Plan (7363-9031). Exceptions and/or additions to these outgassing requirements shall be documented in each instrument's SIIS, for approval by JHU/APL.