Science and Facility Instruments to



Transport, Observatory and Operational Environments

Interface Control Document

1.9/5.0

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| Approval required by: | |
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Issued By: Project Support Department

Version Control

| REVISION CHART | | | |
| --- | --- | --- | --- |
| Version | Author(s) | Description of Version | Date Completed |
| A | D. Montgomery,  J. Robinson | Initial Version | July 12, 1996 |
| B | D. Montgomery,  J. Robinson | (1) Changed operating specification to -5 C to +20 C as this covers 0% through 98% for Cerro Pachon cumulative distribution and 5% through 100% of MaunaKea cumulative distribution.  (2) Added more complete temperature plots.  (3) Changed temperature rate of change to 0.8 C/hr.  (4) Added median air temperatures. | October 8, 1996 |
| C | M. Close | (1) Moved to new ICD template and retitled according to current ICD format.  (2) Transport updates: combined temperature ranges. Updated vibration spec based on GPI.  (3) Observatory updates: removed mechanical interface, as this is covered in the common requirements document.  (4) Operational updates: adjusted lower altitude limit, to be summit lower altitude (air mass impacts performance). Updated temp rate of change based on more recent data (this was an issue GPI experienced and so for GHOST we researched and updated this). Updated vibration wording to be exactly what is in the recently revised ICD 1.5.3/1.9. Removed handling cart interface as this is covered in the common requirements document. Removed cleanliness as it is in Observatory section and relates to risk of damage. | April 18, 2016  CR 16 2509 |
| D | J. Radwick | (1) Corrected ENV.3.6 Operational Environment Gravity Vectors Z axis gravity component limits to Z axis -1g to 1g, as defined using Optical Support Structure Coordinate System.  (2) Corrected some verification methods to utilize a more rigorous verification approach. | 06 August 2018 |

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1. Description

This document defines the Gemini environmental requirements for instruments and components during transportation, on-site handling and storage, and operations.

The Instrument as it is referred to below, shall include the set of components and ancillary equipment necessary to mount and operate the instrument on the ISS. This includes subsystems, enclosures, frames, weights, coolant, connectors, cabling, etc.

* 1. Acronyms and Abbreviations

DMT Document Management Tool (Gemini’s Docushare-based document repository)

GHOST Gemini High Resolution Optical Spectrograph

GPI Gemini Planet Imager

ISS Instrument Support Structure

PSD Power Spectral Density

1. References

|  |  |
| --- | --- |
| Document Number | Document Name |
| [DMT Link](http://dmt.gemini.edu/docushare/dsweb/Get/Document-414105/GHOST%20Memo%20-%20Dome%20Temp%20Rate%20of%20Change.docx) | GHOST Memo – Dome Temp Rate of Change |
| [DMT Link](http://dmt.gemini.edu/docushare/dsweb/View/Collection-69686) | New Instrument Arrivals (DMT collection) (only has GPI right now) |
| [Wiki Link](http://devgroup.wikis-internal.gemini.edu/index.php/Packing,_Shipping,_Insurance,_Receiving) | Gemini Development Instrument Procurement Manual (Internal Wiki) |
| [DMT Link](http://dmt.gemini.edu/docushare/dsweb/View/Collection-63159) | ISS Vibration Mitigation (DMT collection) |

1. Transport Environment

The instrument builder is responsible for ensuring the packaged instrument is not damaged during transport. It is acceptable for the packaged instrument to be in a disassembled state and for a moderate level of work to be needed at both ends of the shipping process

(disassembly, packing, unpacking, assembly, etc.).

***Shall not be damaged*** means that the instrument performance, functionality, and physical state shall not be altered, after repeated cycles of these conditions.

## Transport Environment Requirements

### Transport Environment Altitude

The packaged instrument shall not be damaged by exposure to altitudes from sea level to 15500m.

Rationale: Project range of altitudes (and corresponding altitudes) that the packaged instrument may be exposed to during transport in unpressurized cargo holds.

Suggested Verification: Analysis

### Transport Environment Temperature

The packaged instrument shall not be damaged by exposure to temperatures from **-33°C to +71°C.**

Rationale: Projected temperature range that could be experienced by packaged instrument during transport.

Suggested Verification: Analysis

### Transport Environment Temperature Shock

The packaged instrument shall not be damaged by exposure to temperature shock of **35°C.**

Rationale: Projected maximum temperature shock that could be experienced by packaged instrument during transport.

Suggested Verification: Analysis

### Transport Environment Humidity

The packaged instrument shall not be damaged by exposure to relative humidity from 0 to 100% including condensation.

Rationale: Projected range of humidity that the packaged instrument may be exposed to during transport.

Suggested Verification: Analysis

### Transport Environment Wind Speed

The packaged instrument shall not be damaged by exposure to wind speeds up to **67m/s.**

Rationale: Projected maximum wind speed that the packaged instrument may be exposed during transport, such as when being transported on exposed truck beds.

Suggested Verification: Analysis

### Transport Environment Orientation

The packaged instrument shall not be damaged by exposure to any orientation with respect to gravity.

Rationale: The packaged instrument may be exposed to any orientation during transport.

Suggested Verification: Analysis

### Transport Environment Vibration

The packaged instrument shall not be damaged by exposure to vibrations having PSD 0.15 g2/Hz 10 – 40 Hz.

Rationale: The packaged instrument may be exposed to vibrations during transport. The value given here is the vibrations recorded by GPI transport sensors.

Suggested Verification: Analysis

### Transport Environment Shock

The packaged instrument shall not be damaged by exposure to shocks of peak acceleration of 15g on all axes.

Rationale: The packaged instrument may be exposed to vibrations during transport. The value given here is the vibrations recorded by GPI transport sensors.

Suggested Verification: Analysis

### Transport Environment Cleaniness

The packaged instrument shall not be damaged by exposure to windblown dust, sand and insects.

Rationale: The packaged instrument may be exposed to windblown objects during transport.

Suggested Verification: Test

1. Observatory Storage and Handling Environments

The instrument builder is responsible for ensuring the instrument shall not be damaged due to exposure to the Gemini environments. Possible storage environments include the Engineering Lab at the Base Facility, the Engineering Lab at the summit, the Pier Lab at the summit, the dome floor at the summit and mounted on the Instrument Support Structure (ISS). Possible handling environments include movement related to installation on ISS or removal from ISS, and movement between storage locations.

***Shall not be damaged*** means that the instrument performance, functionality, and physical state shall not be altered, after repeated cycles of these conditions.

## Observatory Environment Requirements

### Storage Environment Altitude

The instrument shall not be damaged by exposure to altitudes from sea level to 4300m.

Rationale: Range of altitude including both sites.

Suggested Verification: Analysis

### Storage Environment Temperature

The instrument shall not be damaged by exposure to temperatures from **-15°C to +25°C.**

Rationale: Range of temperature measured including both sites.

Suggested Verification: Analysis

### Storage Environment Temperature Step

The instrument shall not be damaged by exposure to temperature step of up to **25°C.**

Rationale: Maximum temperature step measured including both sites.

Suggested Verification: Analysis

### Storage Environment Humidity

The instrument shall not be damaged by exposure to relative humidity from 0 to 100% including condensation.

Rationale: Range of humidity measured including both sites.

Suggested Verification: Analysis

### Storage Environment Wind Speed

The instrument shall not be damaged by exposure to wind speeds from **0 to 33m/s.**

Rationale: Range of wind speeds measured including both sites.

Suggested Verification: Analysis

### Storage Environment Orientation

The instrument shall not be damaged by exposure to any orientation with respect to gravity.

Rationale: During handling and storage the instrument may be exposed to any orientation.

Suggested Verification: Analysis

### Storage Environment Vibration

The instrument shall not be damaged by exposure to vibrations having PSD **0.0008g2/Hz @ 20 to 1000Hz in any axis.**

Rationale: Vibration projected to be experienced during handling or storage, with value drawn from IAW MIL-STD-810E, July ‘89 section 514.4-39.

Suggested Verification: Analysis

### Storage Environment Shock

The instrument shall not be damaged by exposure to shocks of peak acceleration of 10g on all axes.

Rationale: Vibration projected to be experienced during handling or storage.

Suggested Verification: Analysis

### Storage Environment Seismic Base Acceleration

**The instrument shall not be damaged by exposure to shocks of peak acceleration of 0.4g @ 0.5Hz to 100Hz in any axis.**

Rationale: Acceleration projected when earthquake occurs and instrument is in storage.

Suggested Verification: Analysis

### Storage Environment Acceleration at Cassegrain Rotator

**The instrument shall not be damaged by exposure to shocks of peak acceleration of 2.0g @ 0.5Hz to 100Hz in any axis.**

Rationale: Acceleration projected when earthquake occurs and instrument is mounted on ISS.

Suggested Verification: Analysis, Test

### Storage Environment Cleanliness

**The instrument shall not be damaged by exposure to wind-blown dust, sand and insects.**

Rationale: The instrument may be exposed to windblown objects during storage and handling.

Suggested Verification: Test

### Storage Environment Ambient Light

The instrument shall not be damaged by exposure to **light conditions ranging from total darkness (night time observing conditions) to laboratory lighting conditions.**

Rationale: The instrument may experience a wide range of lighting conditions during storage.

Suggested Verification: Analysis

1. Gemini Operational Environment

The instrument builder is responsible for ensuring the ISS-mounted instrument shall perform to specification in the full range of operational environment conditions within the Gemini dome.

***Performing to specification*** is defined as meeting the instrument science and other performance requirements, during and after repeated cycles of these conditions.

## Operational Environment Requirements

### Operational Environment Altitude

The instrument shall perform to specification at altitudes from 2700m to 4200m.

Rationale: Altitudes of the summits of each site.

Suggested Verification: Analysis, Test

### Operational Environment Temperature

The instrument shall perform to specification at temperatures from **-15°C to +25°C.**

Rationale: Range of temperature measured including both sites.

Suggested Verification: Analysis, Test

### Operational Environment Temperature Rate of Change

The instrument shall perform to specification at temperature rate of change up **to +/-1.3°C/hr.**

Rationale: Maximum rate of change measured, to 95th percentile, including both sites.

Suggested Verification: Analysis, Test

### Operational Environment Humidity

The instrument shall perform to specification at relative humidity from 0 to 90% including condensation.

Rationale: Range of humidity measured including both sites. Condensation has been recorded at Gemini South during summer months.

Suggested Verification: Analysis

### Operational Environment Wind Speed

The instrument shall perform to specification at wind speeds from **0 to 5m/s.**

Rationale: Range of wind speeds measured including both sites.

Suggested Verification: Analysis

### Operational Environment Gravity Vectors

The instrument shall perform to specification through the range of possible gravity vectors:

|  |  |
| --- | --- |
| **Gravity component limits**  **using Optical Support Structure Coordinate System**  **(components vary continuously and in discrete steps)** | X axis +/-1g |
| Y axis +/-1g |
| Z axis -1g to 1g |

Rationale: The instrument shall be exposed to a range of orientations and gravity vectors during telescope operations.

Suggested Verification: Analysis, Test

### Operational Environment Vibration

The instrument **shall perform to specification** within a vibration environment to be defined during the early Design Phase.

Rationale: The Gemini telescopes are not a vibration free environment. It is a complex problem to directly quantify the range of vibrations that an instrument may experience. To address vibration issues, during the early design stages of ISS-mounted instruments, Gemini mechanical engineers will work closely with the instrument build team to provide information and access to Gemini vibration and FEA data, analysis and reports. The end goal will be to determine the vibration constraints for the instrument.

Suggested Verification: Test

## Environmental Sensors

### Transport Sensors

**The instrument shall have sensors sufficient to characterize and monitor the transport environment experienced. These may include orientation and vibration sensors as deemed necessary.**

Rationale: Upon delivery, the instrument sensor data will be reviewed to see if any out of tolerance conditions were experienced, and to perform additional actions if warranted.

Suggested Verification: Analysis

### Instrument Environmental Sensors

**The instrument shall have sensors sufficient to characterize and monitor the instrument internal environment. These may include temperature, pressure, humidity, vibration as deemed necessary.**

Rationale: Continuous awareness of the instrument internal environment is important for instrument safety.

Suggested Verification: Inspection, Test

### Instrument Service Sensors

**The instrument shall have sensors sufficient to monitor instrument systems services and perform diagnostics. These may include temperature, pressure, leaks, and flow rate sensors as deemed necessary.**

Rationale: Continuous awareness of the instrument service usage is important for instrument safety.

Suggested Verification: Inspection, Test

Appendix A: Original Ambient Air Temperature Data from 1990’s













