ACE-CT-100-23

# Contamination Control Plan

for the

Advanced Composition Explorer Payload

**California Institute of Technology**

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## 1.0 Introduction and Background

Management of payload development for NASA's Advanced Composition Explorer (ACE) has been assigned to the California Institute of Technology (Caltech) under contract to the Goddard Space Flight Center (GSFC). Caltech is the home institution of Mission Principal Investigator Professor Edward C. Stone. Under terms of its implementation phase contract, the Caltech Payload Management Office (PMO) will establish and maintain a contamination control system appropriate to the development of a payload for the ACE mission.

## 2.0 Purpose and Scope

This document defines the PMO approach to Contamination Control and the scope of the PMO contamination control interactions with the science payload hardware developers (SPHDs). The key contamination control activities are described in this plan and include the following:

a. a listing and description of the SPHD-provided allowable particulate and known volatile contamination thresholds (where available; otherwise contaminates of concern are noted) for each science hardware element;
b. a description of the provisions to be employed at the SPHDs which will ensure that the contamination thresholds are not exceeded;
c. review agenda items that address contamination levels and protective measures;
d. identification of contamination control resources available from PMO; and
e. the applicability of this plan ends at delivery of payload elements to the spacecraft integrator.

## 3.0 Instrument Susceptibility

SPHDs have identified contaminates that are likely to cause performance degradation or failures to the hardware elements they are responsible for. The hardware elements, responsible institution, contaminates, and contamination thresholds are identified in Table 3.0. Avoidance of the contaminates to a sufficient degree (by experience) will be accomplished by the contamination control provisions, below:

## 4.0 Contamination Control Provisions

Provisions will be implemented to control the contaminates identified in Section 3.0. Contamination control provisions to be employed at the fully assembled instrument level are provided in Table 4.0.

**Table 3.0 Contaminates**

| Hardware Element | Responsible Institution | Contaminates | Susceptibility Threshold |
|---|---|---|---|
| Cosmic Ray Isotope Spectrometer (CRIS) | Caltech | Humidity<br>Hydrocarbons<br>Fluorohydrocarbons<br>Ammonia | 35%-50% Allowed<br>Minimize<br>Minimize<br>Minimize |
| Solar Isotope Spectrometer (SIS) | Caltech | Humidity<br>Hydrocarbons<br>Fluorohydrocarbons<br>Ammonia | 35%-50% Allowed<br>Minimize<br>Minimize<br>Minimize |
| Ultra Low Energy Isotope Spectrometer (ULEIS) | JHU/APL | Humidity<br>Ammonia | 35%-50% Allowed<br>Minimize |
| Solar Energetic Particle Ion Charge Analyzer (SEPICA) | UNH | Humidity<br>Hydrocarbons<br>Fluorohydrocarbons<br>Ammonia | 35%-50% Allowed<br>Minimize<br>Minimize<br>Minimize |
| Solar Wind Mass Spectrometer (SWIMS) | UMD | Humidity<br>Hydrocarbons<br>Fluorohydrocarbons<br>Ammonia | 35%-50% Allowed<br>Minimize<br>Minimize<br>Minimize |
| Solar Wind and Composition Spectrometer (SWICS) | UMD | Humidity<br>Hydrocarbons<br>Fluorohydrocarbons<br>Ammonia | 35%-50% Allowed<br>Minimize<br>Minimize<br>Minimize |
| Magnetometer (MAG) | UDEL/BRI | No Unique Susceptibilities | N/A |
| Solar Wind Electron, Proton and Alpha Monitor (SWEPAM) | LANL | Hydrocarbons | Minimize |
| Electron, Proton and Alpha Monitor (EPAM) | JHU/APL | Humidity<br>Ammonia | 35%-50% Allowed<br>Minimize |
| SEPICA/SWIMS/SWICS Data Processing Unit (S/S/SDPU) | UNH | Particles | < Class 300,000 Clean Room |

Notes:
1. The specified environments pertain to the contaminates surrounding a hardware element.
2. The susceptibility thresholds refer to the amount of contaminates that if exceeded may degrade or destroy hardware elements.
3. Minimize is defined as eliminating a substance from the room in which the instrument is located to the greatest extent possible.

**Table 4.0 Instrument Level Contamination Control**

| Hardware Element | Nitrogen Gas Purity Requirements | Storage Locations | Fabrication/ Assembly Locations | Test Locations | Shipping Accom-modations | Cleaning Agents |
|---|---|---|---|---|---|---|
| CRIS | $LN_2$ Boil Off. | Pre-cleaned Shipping Container Under Continuous Purge. | Class 10,000 Flow Bench Located in a Class 300,000 or Better Clean Room. Under Continuous Purge. | Class 300,000 or Better Clean Room or Tented. Under Continuous Purge. | Pre-cleaned Nitrogen Back Filled Shipping Container. | Use of any Solvent in the Vicinity of anySolid State Detectors Must Be Avoided. Ethanol Poses the Least Risk. |
| SIS | $LN_2$ Boil Off. | Pre-cleaned Shipping Container Under Continuous Purge. | Class 10,000 Flow Bench Located in a Class 300,000 or Better Clean Room. Under Continuous Purge. | Class 300,000 or Better Clean Room or Tented. Under Continuous Purge. | Pre-cleaned Nitrogen Back Filled Shipping Container. | Use of any Solvent in the Vicinity of any Solid State Detectors Must Be Avoided. Ethanol Poses the Least Risk. |
| ULEIS | $LN_2$ Boil Off, Purity at Instrument ≥ 99.999%. | Pre-cleaned Shipping Container Backfilled or Under Continuous Purge. | Class 10,000 Flow Bench Located in a Class 100,000 or Better Clean Room. Under Continuous Purge. | Class 100,000 or Better Clean Room. Under Continuous Purge. | Pre-cleaned Nitrogen Back Filled Shipping Container. | Use of any Solvent in the Vicinity of any Solid State Detectors Must Be Avoided. Isopropyl Alcohol Poses the Least Risk. |
| SEPICA | $LN_2$ Boil Off. | Pre-cleaned Shipping Container Under Continuous Purge. | Class 10,000 Flow Bench Located in a Class 100,000 or Better Clean Room. Under Continuous Purge. | Class 100,000 or Better Clean Room or Tented. Under Continuous Purge. | Pre-cleaned Nitrogen Back Filled Shipping Container. | Use of any Solvent in the Vicinity of any Solid State Detectors Must Be Avoided. Ethanol or Isopropyl Alcohol Poses the Least Risk. |
| SWIMS | $LN_2$ Purity at Instrument ≥ 99.995%. $LN_2$ Boil Off on Bare Detectors. | Pre-cleaned Sealed Shipping Container, $LN_2$. Backfilled Every Two Weeks. | Class 10,000 Flow Bench Located in a Class 300,000 or Better Clean Room. Under Continuous Purge. | Flow Bench Located in a Class 300,000 or Better Clean Room. Under Continuous Purge. | Pre-cleaned Nitrogen Back Filled Shipping Container. | Use of any Solvent in the Vicinity of any Solid State Detectors Must Be Avoided. Isopropyl Alcohol Poses the Least Risk. |

**Table 4.0 Instrument Level Contamination Control (Continued)**

| Hardware Element | Nitrogen Gas Purity Requirements | Storage Locations | Fabrication/ Assembly Locations | Test Locations | Shipping Accom-modations | Cleaning Agents |
|---|---|---|---|---|---|---|
| SWICS | $LN_2$ Purity at Instrument ≥ 99.995%. $LN_2$ Boil Off on Bare Detectors. | Pre-cleaned Sealed Shipping Container, $LN_2$. Backfilled Every Two Weeks. | Class 10,000 Flow Bench Located in a Class 300,000 or Better Clean Room. Under Continuous Purge. | Flow Bench Located in a Class 300,000 or Better Clean Room. Under Continuous Purge. | Pre-cleaned Nitrogen Back Filled Shipping Container. | Use of any Solvent in the Vicinity of any Solid State Detectors Must Be Avoided. Isopropyl Alcohol Poses the Least Risk. |
| MAG | Not Applicable. | Pre-cleaned Shipping Container. | Laboratory Environment | Laboratory Environment | Pre-cleaned Shipping Container. | Ethanol or Isopropyl Alcohol |
| SWEPAM | TBD | Pre-cleaned Shipping Container Under Continuous Purge or in a Sealed Tent that has been Purged. | Detector Cavity is Hermetically Sealed. | Detector Cavity is Hermetically Sealed until just before Launch, then purge is applied. Before T/V Pump Down the Hermetic Seal Must be Relieved and the Inlet Air Filtered Through a Charcoal Filter. | Pre-cleaned Nitrogen Back Filled Shipping Container. | Use of any Solvent in the Vicinity of any Solid State Detectors Must Be Avoided. Ethanol or Isopropyl Alcohol Poses the Least Risk. |
| EPAM | $LN_2$ Boil Off, Purity at Instrument ≥ 99.999%. | Pre-cleaned Shipping Container Backfilled or Under Continuous Purge. | Class 10,000 Flow Bench Located in a Class 100,000 or Better Clean Room. Under Continuous Purge. | Class 100,000 or Better Clean Room. Under Continuous Purge. | Pre-cleaned Nitrogen Back Filled Shipping Container. | Use of any Solvent in the Vicinity of anySolid State Detectors Must Be Avoided. Ethanol Poses the Least Risk. |
| S/S/SDPU | Not Applicable. | Pre-cleaned Shipping Container. | Laboratory Environment | Laboratory Environment | Pre-cleaned Shipping Container. | Ethanol or Isopropyl Alcohol |

## 5.0 Testing

Vacuum ($\leq 10^{-5}$ torr) bakeouts should be performed on all cable harnesses until the outgas rate from the cable harnesses, at the flight acceptance hot temperature level, is less than 3 ng/cm$^2$ per hour at 30 cm. PMO will be informed of cable harness outgas rates that exceed 3 ng/cm$^2$ per hour at 30 cm. PMO and the hardware developer will determine if outgas rates in excess of 3 ng/cm$^2$ per hour can be tolerated by the instrument system. When necessary, PMO will work with hardware developers to define low outgassing cable harness modifications. The measurement of the outgas rates should be performed by a TQCM at the flight acceptance cold operating temperature of the most sensitive flight instrument surface. It is recommended that a TQCM also be used to measure the outgas rate in instrument T/V tests. Witness plates should be placed in environmental test setups (e.g. vibration, acoustic). The use of witness plates will help determine the amount of contamination exposure and criterion for recleaning hardware.

## 6.0 Review Program

Contamination control provisions will be presented at each formal review At the inheritance, preliminary design, and critical design reviews the emphasis of the presentations will be on contamination control while the hardware is under the SPHD's control. At the preshipment review the emphasis will be upon reviewing the adequacy the spacecraft integrator's contamination control plans. The current integrator's contamination control plans are contained in APL Document Number 7345-9102, "ACE/Advanced Composition Explorer Contamination Control Plan."

## 7.0 PMO Contamination Control Resources

Upon request, the Caltech PMO will provide SPHDs with contamination control assistance. The assistance will include the planning and design of contamination control systems, evaluation of materials, analysis of contamination witness samples from thermal/vacuum tests. Additional aid will be provided whenever it is appropriate and PMO resources are available.

# APPENDIX A

## Applicable Documents

| Document Number | Document Identification |
|---|---|
| ACE-CT-100-20 | "Caltech Payload Assurance Implementation Plan, " Dated: December 1, 1993. |
| ACE-CT-100-031 | "Configuration Management Plan for the Advanced Composition Explorer Payload," Dated: October 6, 1993. |
| 7345-9102 | APL Document, "ACE/Advanced Composition Explorer Contamination Control Plan," Dated: June 1993. |

# APPENDIX B

## Acronyms

| Acronyms | Definition |
|---|---|
| ACE | Advanced Composition Explorer |
| APL | The Johns Hopkins University Applied Physics Laboratory |
| Caltech | California Institute of Technology |
| CT | California Institute of Technology |
| GSFC | Goddard Space Flight Center |
| JPL | Jet Propulsion Laboratory |
| NASA | National Aeronautics and Space Administration |
| ng | Nanogram |
| PAIP | Performance Assurance Implementation Plan |
| PMO | Payload Management Office |
| SPHD | Science Payload Hardware Developer |
| TQCM | Temperature-Controlled Quartz Crystal Microbalance |
| T/V | Thermal Vacuum |