Document No: SU P0147 Rev. A **File:** C:/../Clean/GP-B Plan.doc

October 1998

Stanford University

Contract No. : NAS8-39925 and follows

Gravity Probe B Relativity Mission

Contamination Control Plan, Master

G. Keiser _____ B.Taller _____
Cleanliness Committee Quality Engineer

D. Bardas _____ B. Schultz _____
Integration & Tests Chief System Eng.

S. Buchman _____ Prof. J. Turneaure_____
Acting Hardware Manager Acting Program Manager

Table of Contents:

1. Introduction **3**

2. Related Documents **3**

3. Contamination Control Plans **4**

4. Cleaning, inspection and certification methodology and frequency **5**

5. Environment definition and traceability **6**

6. Vacuum **7**

7. Contamination violation reporting and effect assessment **7**

8. Bagging and packaging, criteria and materials **7**

9. Clean room garments, controls and monitoring **7**

10. Sub-Contractors **8**

1. Introduction

The purpose of this document is to describe all the activities, processes and controls to be used in Relativity Mission Program in order to meet all the requirements related to Contamination Control. The plan was written to meet the intent of MSFC- STD-506C, Standard Material and Process Control, Attachment DR-6.

2. Related Documents

These documents are listed for reference only and are to be used to the extent that they are called out by specific procedures. They are not considered to be part of the plan.

2.1 MSFC Documents
2.1.1 Standard Material and Process Control, Attachment DR-6, MSFC- STD-506C, December 1988.

2.2 Stanford 'P' Documents (Procedures).
2.2.1 Probe C Contamination Control Plan, P0059, Rev D, July 1998.
2.2.2 GP-B Clean Room Procedures, P0023, Rev.- 5/23/97.
2.2.3 Clean Room Access Policy, P0034, 5/23/97.
2.2.4 General Conduct Rules within GP-B Clean Room, P0035 Rev. B, 5/23/97.
2.2.5 Approved and Restricted Materials and Actions, P0036 Rev. B, 5/20/97.
2.2.6 Entry/Exit Procedures for GP-B HEPL Clean Room Complex, P0037, Rev. A, 1/5/97.
2.2.7 Clean Room Policy Review Procedure, P0038, 5/23/97.
2.2.8 Procedure for Monitoring Airborne Particulate, P0039, 5/23/97.
2.2.9 Clean Room Janitorial Procedure, P0040, Rev. A, 5/20/97.
2.2.10 Clean Room Safety Course Outline, P0041, 5/20/97.
2.2.11 Standard Cleaning Procedure for Gyroscope Housings, P0001, 11/21/97.
2.2.12 Inspection by Stanford of Finished Quartz Housing, P0012, March 1989.
2.2.13 Clean Room Utility Standards, P0047, 5/23/97.
2.2.14 SU, Science Mission Quality Plan, P0108, 4/19/95.

2.3 LMMS Documents (DCU-Data Control Unit)
2.3.1 LMMS, Science Payload Contamination Control Plan, Spec No. 5835083, Rev. B,DCU
2.3.2 LMMS, Cleaning of the Assembly Payload, GPB5835835, Rev. NC01;02, DCU
2.3.3 LMSC, Probe Solvent Cleaning Procedure, GPB5855411, Rev. NC, DCU
2.3.4 LMSC, General cleaning of Parts and Surfaces, LAC0170
2.3.5 LMSC, Environmental Control, LAC3026
2.3.6 LMSC, Contamination Control, LAC3150
2.4.7 LMMS, GP-B Contamination Control and Precision Cleaning (for Payload) Spec No. 5835033, Rev. B
2.3.8 LMMS, Tape, Polyamide Backing, Pressure-Sensitive
2.3.9 LMMS, Certification of Clean Rooms, Standard 8620-Q002

2.3.10 LMMS, Certification of Automatic Particle Counting System, Standard 8650-Q019
2.3.11 LMMS, Certification of Personnel for Hardware Cleaning and Hardware Cleanliness Verification, 8650-Q026
2.3.12 Science Payload Specification F277277 Paragraphs 3.7.3.4 and 3.7.3.5. Version 4.1 (These requirements were derived from SU document : S0242, "Probe C Vacuum Requirements, March 1995.)
2.3.13 LMSC P086822, Spacecraft Contamination Control Plan, DR# SCSE-19.

3. Contamination Control Plans

This document is the master contamination control plan for the Gravity Probe B Relativity Mission. Contamination Control on the Gravity Probe B satellite is important for a variety of reasons, perhaps the most important of which is the risk to one of the gyroscopes from particles which could cause a gyroscope's electrostatic control system to lose its control while the gyroscope is spinning at high speed. Another important reason for careful contamination control is the potential degradation of the sensitivity of the cryogenic telescope. Additional considerations possible shorting of electrical components and outgassing of materials on the spacecraft.

Three separate contamination control plans cover various parts of the Gravity Probe B satellite:

1. Gravity Probe B (Stanford University) Document P0059 – Probe C Contamination Control Plan.
2. Lockheed Martin Missile and Space document LMMS P086822 – Gravity Probe B Relativity Mission Spacecraft Contamination Control Plan
3. Lockheed Missile and Space Company document No. 5845083 – Science Payload Contamination Control Plan

In addition contamination control for the proton detector is described in the Product Assurance Control Document (PACD) by Space Technology, Ldt. Contamination controls for various parts of the Gravity Probe B Satellite are specified in each of these documents. The table below shows which contamination control plan covers each component of the satellite and which contamination control zone (defined in P0059) is applicable to each component.

Component	Contamination Control Plan	Zone (s)
Gyroscopes	SU P0059	Zone I, II, III
SQUID sensors	SU P0059	Zone IV
Quartz Block	SU P0059	Zones I,II, III, IV
Telescope	SU P0059	Zone V
Probe	SU P0059	All Zones
Gas Management Assembly (GMA)	SU P0059	Zone VII
	LMSC, No. 5845083	All Zones
Dewar	LMSC, No. 5845083	
Electronics Boxes	LMMS P086822	
Cables	LMMS P086822	
Spacecraft	LMMS P086822	
Proton Detector	LMMS P086822 and	

4. Cleaning, inspection and certification methodology and frequency

Cleaning, inspection and certification methodology are defined for specific procedures in the relevant Stanford P-documents following guidelines in

(1) Document 2.2.1: Probe C Contamination Control Plan, P0059, Rev D, July 1998, which defines contamination zones, cleanliness requirements for each zone, and cleaning procedures, and

(2) Document 2.5.1: Probe C Vacuum Requirements, which define the minimum vacuum requirements.

Two examples of relevant Stanford P-documents are:
2.2.10 Standard Cleaning Procedure for Housings, P0001, April 1990.
2.2.11 Inspection by Stanford of finished Quartz Housing, P0012, March 1989.

4.1 Cleaning

All flight components and parts will have the required level of cleanliness prior to integration in the next higher assembly to ensure their contamination requirements are met. The level of contamination control and the documentation for the cleaning process is specified in the applicable contamination control documents. Each cleaning process is recorded in the Traveler by the operator's signature with additional details recorded in laboratory notebooks.

4.2 Verification of Cleaning Procedure

Verification of the cleanliness status will be done by the System Effectiveness Manager (SEM) or his designate prior to integration into the next higher level of assembly to ensure that the proper cleanliness status and appropriate checks on the cleaning process have been done.

4.3 Facility Certification

Certification of the areas designed to maintain the cleanliness of the flight parts at Stanford shall be done on a regular basis using methods specified in the P-documents. In the absence of any specified method, certification shall be done by one of the following methods:

1. An approved outside vendor will be utilized to certify facilities in accordance with FED-STD-209E.
2. An internal certification will be performed by the System Effectiveness Manager (SEM) or his designate in accordance with FED-STD-209E. It will include as a minimum:
    a. Airborne Particle Count Test
    b. HEPA Filter Leak Test
    c. HEPA Filter Air Flow Velocity Test
    d. Temperature and Relative Humidity Test

e. Room Pressurization Test

A list of all cleanrooms at Stanford will be maintained by the SEM. Test results to prove certification will be documented and kept on file by the SEM for government review. Facilities will be recertified on a 12 month interval unless abnormal events require the re-certification to be performed earlier. Cleanroom certification will be tracked by the SEM or his designate to ensure a recertification is scheduled prior to its expiration date.

4.4 Facility Maintenance

To maintain a cleanroom's integrity post certification, the following will be implemented:

1. A cleanroom facility coordinator will be designated for each cleanroom by the SEM. This person will be responsible for maintaining each cleanroom's integrity.
2. The SEM or his designate will periodically monitor cleanrooms for their compliance with this plan. He/she will also ensure access is limited (i.e. locks, security system, etc.) and proper signs are in place to ensure only authorized personnel enter.
3. The janitor will be notified of the proper process for cleaning each cleanroom per P0040, Clean Room Janitor Procedure or a specific procedure for that clean room.
4. All remaining used garments in the gowning area will be thrown away on Fridays unless a more stringent procedure is followed.

4.5 Personnel Certification

All personnel who enter a cleanroom (except visitors who are accompanied by a trained individual) will be certified by attending a training course per P0042, Clean Room Course Outline. This course will require a written test that will be kept on file for government review. Recertification is required on a 12 month interval. This training is generic in nature for class 10,000 cleanrooms. Areas requiring cleanliness levels stricter than class 10,000 will be augmented by additional procedures to ensure contamination control.

4.6 Transportation Controls

Transportation controls for parts interior to the probe are specified in P0059, the Probe C Contamination Control Document. Transportation controls for the dewar and probe are specified in the Science Payload Contamination Control Plan. Transportation controls for the electronics boxes and cables are specified in the Gravity Probe B Spacecraft Contamination Control Plan.

5. Environment definition and traceability

Clean Rooms environment definition, monitoring and recording are described in the relevant Stanford P-documents following guidelines outlined in Document 2.2.1: Probe C Contamination Control Plan, P0059, Rev D, July 1998. When applicable, these procedures

refer to document 2.2.7, Procedure for Monitoring Airborne Particulate, P0039, September 1989.

6. Vacuum

Vacuum requirements are covered in document 2.3.13 Science Payload Specification F277277 Paragraphs 3.7.3.4 and 3.7.3.5. (These requirements were derived from SU document: S0242, “Probe C Vacuum Requirements", March 1995.)

Procedures for evacuating, maintaining vacuum, and venting vacuum systems are defined in the relevant Stanford P-documents using guidelines in S0242, “Probe C Vacuum Requirements", March 1995.

Since these procedures may affect the cleanliness of the surfaces within the probe, they must also follow guidelines contained in Document 2.2.1: Probe C Contamination Control Plan, P0059, Rev D, July 1998

7. Contamination violation reporting and effect assessment

All Contamination violation shall be reported in Discrepancy Report (DR) including Analysis, Disposition and Corrective Action, as described in 2.2.13, SU, Science Mission Quality Plan.

8. Bagging and packaging, criteria and materials

Bagging and packaging, materials for items requiring cleanliness control are described in relevant Stanford P-documents following guidelines described in 2.2.3, Approved and Restricted Materials and Actions, P0036, September 1992.

9. Clean room garments, controls and monitoring

Clean room garments, controls and monitoring are defined in 2.2.5, Entry/Exit Procedures for GP-B HEPL Clean Room Complex, P0037, September 1989.

10. Sub-Contractors

Contamination Control Requirements and Implementation at LMMS for the payload are described in 2.3.1, LMMS, Science Payload Contamination Control Plan, Spec No. 5835083, Rev B. Cleaning of specific Parts/Assemblies shall be described in written procedures.

Cleanliness verification and testing are described in 2.3.4 LMMS, Probe Cleanliness Verification Procedure. Clean Rooms control and certification are defined in:

2.3.10 LMSC, Certification of Clean Rooms, Standard 8620-Q002

2.3.11 LMSC, Certification of Automatic Particle Counting System, Standard 8650-Q019

2.3.12 LMSC, Certification of Personnel for Hardware Cleaning and Hardware Cleanliness Verification, Standard 8650-Q026

Contamination Control Requirements and Implementation at LMMS for the spacecraft are described in LMMS P086822, Spacecraft Contamination Control Plan, DR# SCSE-19 and in LMMS System Effectiveness Plan, LMMS-P086904, 7/30/96 Paragraph 5.4.

Contamination Control Requirements and Implementation at Space Technology Ltd., which is the manufacturer of the Proton Detector, are described in their Product Assurance Control Document (dated April 7, 1997).