SECTION 2.7

CONTAMINATION CONTROL

2.7 CONTAMINATION CONTROL PROGRAM

The objective of the contamination control program is to decrease the likelihood that the performance of payloads will be unacceptably degraded by contaminants. Since contamination control programs are dependent on the specific mission goals, instrument designs, planned operating scenarios, etc. it is necessary for each program to provide an allowable contamination budget and a Contamination Control Plan (CCP) which defines the complete contamination control program to be implemented for the mission. The specific verification plans and requirements must be defined in the CCP. The procedures that follow provide an organized approach to the attainment of the objective so that the allowable contamination limit is not violated.

2.7.1 Applicability

The contamination control program is applicable to all payloads, subsystems, instruments, and components during all mission phases (fabrication, assembly, integration, testing, transport, storage, launch site, launch, and on-orbit). In the cases of payloads which are not sensitive to contamination, this program may still be required due to cross-contamination potentials to other payloads and/or orbiter systems.

2.7.2 Summary of Verification Process

The following are performed in order:
a. Determination of contamination sensitivity;
b. Determination of a contamination allowance;
c. Determination of a contamination budget;
d. Development and implementation of a contamination control plan.

Each of the above activities shall be documented and submitted to the project manager for concurrence/approval.

2.7.3 Contamination Sensitivity

An assessment shall be made early in the program to determine whether the possibility exists that the item will be unacceptably degraded by molecular or particulate contaminants, or is a source of contaminants. The assessment shall take into account all the various factors during the entire development program and flight including identification of materials (including quantity and location), manufacturing processes, integration, test, packing and packaging, transportation, and mission operations including launch and return to earth, if applicable. In addition, the assessment should identify the types of substances that may contaminate and cause unacceptable degradation of the test item.

If the assessment indicates a likelihood that contamination will degrade performance, a contamination control program should be instituted. The degree of effort applied shall be in accordance with the importance of the item's function to mission success, its sensitivity to contamination, and the likelihood of its being contaminated.

2.7.4 Contamination Allowance

The amount of degradation of science performance that is allowed for critical, contamination-sensitive items shall be established, usually by the Project Scientist. From this limit, the amount of contamination that can be tolerated, the contamination allowance, will be established. The rationale for such determination and the ways in which contaminants will cause degradation shall be described in the contamination control plan (2.7.7) The allowable degradation should also be included in a contamination budget.

2.7.5 Contamination Budget

A contamination budget shall be developed for each critical item. It shall describe the quantity of contaminant and the degradation that may be expected during the various phases in the lifetime of the item. The phases shall include the mission itself. The budget should be stated in terms (or units) that can be measured during testing. The measure of contamination shall be monitored as the program progresses to include the contamination and degradation experienced. The budget shall be monitored to ensure that, given the actual contamination, the mission performance will remain acceptable. In the event that contamination build-up predictions are not borne out, corrective action shall be taken.

A contamination-sensitive item may be cleaned periodically to reestablish a budget baseline. Contamination avoidance methods, such as cleanrooms and instrument covers, will affect the budget and a general description of their usage should be included. The contamination budget shall be negotiated among the cognizant parties (e.g., the Project Scientist, the instrument contractor and the payload integration contractor). Each contractor shall be responsible for staying within their portion of the budget; however, the budget may be redistributed, with the concurrence of the project manager, in order to improve the approach.

2.7.6 Contamination Control Plan

A contamination control plan shall be prepared that describes the procedures that will be followed to control contamination. It shall establish the implementation and describe the methods that will be used to measure and maintain the levels of cleanliness required during each of the various phases of the item's lifetime. The plan shall specifically address outgassing requirements for the flight items, test chamber, and test support equipment.

2.7.7 Other Considerations

The effects of the payload on other payloads in the orbiter cargo bay shall also be considered and addressed in the Contamination Plan. The formation or transfer of payload effluents that could jeopardize the performance of orbiter systems (e.g., radiators, windows, optics, etc.) or other payloads manifested on the same flight shall be restricted. All non-metallic materials shall be selected for low outgassing characteristics. Material selection criteria shall be consistent with those stipulated in JSC 07700 Vol. XIV. and NASA Reference Publication 1124.

Bake-outs of solar arrays, major wiring harnesses, and thermal blankets are required unless it can be satisfactorily demonstrated to the GSFC project that the contamination allowance can be met without bake-outs. Bake-outs of other components with large amounts of non-metallic material, such as batteries, electronic boxes, and painted surfaces may also be necessary.

Because they can be a source of contamination themselves, special consideration shall also be given to materials and equipment used in cleaning, handling, packaging, and purging flight hardware.

Contamination

The contamination program requirements be followed closely during the environmental test program. Non-flight materials near the flight hardware may damage or contaminate it. For example:

- Non-flight GSE wiring and connector materials can contaminate the flight hardware during thermal testing.
- Packaging material (plastic films and flexible foams) can contaminate hardware or cause corrosion during shipping and storage.
- Plastic bags without anti-static properties can allow electrostatic discharges to damage electronic components on circuit boards.
- Tygon tubing (or other non-flight tubing) used in purge systems can contaminate hardware when gasses or liquids extract plasticizers from the tubing.
- Paints, sealants, and cleaning materials used to maintain clean rooms can contaminate or corrode flight hardware.

To protect flight hardware, non-flight hardware that will be exposed to thermal vacuum testing with flight hardware (items such as cables, electronics, fixtures, etc.) should be fabricated from flight quality materials. Packaging materials should be tested to verify that they are non-corrosive, non-contaminating, and provide electrostatic protection, if required. All materials used in purge systems should be tested for cleanliness and compatibility with flight materials.