CONTAMINATION CONTROL OF THE SPACE SHUTTLE ORBITER CREW COMPARTMENT

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ABSTRACT

The crew compartment of the Space Shuttle Orbiter is a unique environment where contamination control is critical to the performance of orbiter systems and astronauts alike.

A balance must be established between materials used in the crew compartment (both flight and ground support)/system design/personnel activities and nominal system equipment functioning/crew safety. Materials selected must meet programmatic requirements such as flammability, non-shedding and chemmical off-gasing specifications. A "debris-filtering" system consisting of screens for electronic equipment and conditioning breathing air for life support must be in top performance at all times. Another very important aspect for the achievement and maintenance of strict cleanliness levels in the crew compartment is the development and effective practice of contamination control procedures by both astronauts and ground personnel.

With the advent of the Space Shuttle Transportation System and the ensuing reality of the Space Station, a compatible environment for personnel and sophisticated equipment must be further enhanced and fine tuned to state-of-the-art standards.

To facilitate the accomplishment of this goal, several studies in contamination control science involving the crew compartment are in progress. These studies include:

1) Ground Processing contamination control improvements,

2) Analysis and source identification of crew compartment debris,

3) Screen design effectiveness and air flow patterns,

4) Air ionization techniques and

5) Proposal improvements for flight materials, system operations and personnel activities/dress.

An effective ground processing contamination control program is an essential building block to a successful shuttle mission. Personnel are required to don cleanroom-grade clothing ensembles before entering the crew compartment and follow cleanroom rules and regulations. Prior to crew compartment entry, materials and equipment must be checked by an orbiter integrity clerk stationed outside the white-room entrance for compliance to program requirements.

Facility ground processing equipment (GSE) improvements have recently been made to upgrade crew compartment cleanliness. A totally new designed white room entry-way for crew compartment access was built. This

improvement allowed personnel and GSE cleaner access conditions to the crew compartment. A positive pressure gradient from the crew compartment to the whiteroom to the facility ambient environment was achieved.

Other improvements are forth coming as a direct result of contamination control studies (described herein) and SPC/NASA concern for the ''cleanest'' zero-G environment possible.

Analysis and source identification of crew compartment debris studies have been on-going for approximately 2 years. The objective of these studies is to determine and identify particulate generating materials and activities in the crew compartment. Visual inspections are performed and samples of debris are collected for analysis. The results show a wide spectrum of many different types of materials; food particles, hair, paint products, aluminum, etc. The contaminants are studied closely as to probable identity and source. Analysis results are then compared to a list of approved flight and GSE materials. When a source identification is made, corrective action is implemented to minimize or curtail further contaminant generation.

Another very critical area for nominal orbiter system functioning and life support systems are the equipment screens installed in the avionics, computer, air recirculation, etc., units in the crew compartment. The overall effectiveness and in-flight ease-of-maintenance of this ''air-flow filtering'' system is an area where further improvements and modifications would provide a ''cleaner'', more trouble-free environment for flight. A dilemma exists in the design of the equipment screens and air flow system; adequate air flow rates vs. effective contaminant capture where co-existence is necessary for system balance and operation.

A fourth category of study is effective air ionization techniques to allow dissipation of charged particles deposited on surfaces in the crew compartment. Preliminary investigations involving this technique to determine effectiveness and applicability is introductory. Although, studies to date reveal beneficial results.

To summarize, effective contamination control as applied to manned space flight environments is a discipline characterized and controlled by many parameters. This introductory paper on Orbiter Crew Compartment contamination control will present the referenced studies and results to-date. It is the hope of the SPC, by means of investigative/analysis and system enhancement to upgrade the cleanliness level of the crew compartment to the best extent technologically possible.