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# LIMITED DURATION OF CANDIDATE MATERIALS EXPOSURE EXPERIMENT (LDCE): A COMPLEX AUTONOMOUS PAYLOAD (CAP) USING A GET AWAY SPECIAL (GAS) CANISTER

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**ABSTRACT**

CMSS has designed, fabricated, qualified and flown the LDCE payload as a cost effective space flight hardware to conduct exposure of materials to the space environment. The hardware has been qualified for 10 missions, utilizing a GAS Canister, supplied by Goddard Space Flight Center. Results of the first series of LDCE experiments have shown that the hardware performed as expected.

## INTRODUCTION

Advanced structural materials are being developed for the next generation of satellites and space stations. These materials have to withstand the harsh environment of space for long duration missions, with little or no maintenance. The major causes for degradation of materials are UV radiation, atomic oxygen, electron and proton radiation and thermal cycling (1). Atomic oxygen and thermal cycling are the critical factors for low Earth orbit (LEO) structures while radiation is critical in higher orbits. The evaluation of structural materials for LEO is done by a combination of ground based simulated exposure and space flight experiments.

The primary objective of this LDCE payload is to introduce developmental organic/inorganic materials and coatings to a flux of atomic oxygen in low earth orbit. The candidate materials will have undergone extensive ground-based testing prior to being attached to reusable space flight hardware designed for multi-mission Space Transportation System (STS) use. Even though small shuttle payload GAS Canisters are used as the carrier, the LDCE experiment has been classified as a Complex Autonomous Payload (CAP) due to specific requirements for altitude, attitude and duration placed on the orbiter.

## HARDWARE DESCRIPTION

The LDCE experiment assembly consists of the experiment disk, sample holders, and the high density center panel plus its attachment bracket. The sample holder assemblies are bolted onto the experiment disk, the attachment bracket bolts onto the high density panel and then onto the experiment disk, refer to Figure 1.

### Sample Holder Assemblies

The LDCE experiment hardware consists of 8 sample holder assemblies to which material specimens are integrated. All 8 holders are designed to insure that no one component exceeds 0.25 lbs. (low release mass). This accounts for the difference in the number of specimens and thickness for each holder. Seven of the sample holders allow for the placement of 0.75" diameter material specimens accommodating different thicknesses of specimens (e.g., 1/32" up to 1/4" thick), refer to Figure 2. One sample holder allows placement of a thin film rectangular sample of 1.00" X 0.50".

In addition, the LDCE experiment disk provides a method for exposing eight 1.0" diameter specimens, these specimens are mounted in a slightly different manner. Instead of using a bolt top-down assembly, these specimens are mounted from the under side of the disk. A retainer plate then bolts to the underneath side of the disk, holding the 1.0" specimen in place, refer to Figure 3. Total weight of the holders, fasteners and samples is approximately 14 lbs.

### High Density Panel Assembly

Located in the center of the support disk is an area termed the "high density panel." The configuration of this area is flexible, allowing each experiment configuration to differ to meet unique custom requirements. Figure 4 shows an example of different configurations. The high density sample holder panel is bolted to the high density support box. The high density box is attached to the support disk via the attachment bracket. The weight of the high density panel averages about 8-9 lbs. with the recent configurations.

All material samples are placed into their prospective holders and supported by spacers and wave springs to insure a positive upward force to seat them against the retainer plate. Sample holder assemblies are then bolted to the experiment disk, followed by the high density panel assembly.

Experiment Support Disk

Each experiment disk is 19.65" diameter with a 15.34" diameter section to which all sample holders, high density panel and bracket are attached, refer to Figure 5. The disk is capable of supporting 150 lbs., being held in place to the end plate of the GAS Can door assembly, using 24 #10 bolts.

Each disk is fabricated from a different aluminum alloy. Alloys selected for the LDCE series are 7075-T651, 7075-T7351, and Aluminum-Lithium alloy 8090-T8771. The first two alloys were selected based on past flight history. All three disks were clear anodized to spec MIL-A-8625 Rev. E., Type II, Class 1.

The Al-Li was selected as an experimental structural material, after extensive ground based evaluation. This is a much lighter alloy with superior mechanical properties. Using it in the fabrication of the LDCE flight hardware will help qualify it for other space related applications (2).

Internal GAS Can Experiments

CMSS has developed a method of utilizing the internal portions of GAS Cans for experiments that do not require atomic oxygen exposure. The protrusion on the under side of the experiment disk from the high density box provides a surface area with a bolt pattern for experiments to be attached, refer to Figure 6.

Summary and Conclusions

The CMSS experiment demonstrates that LDCE type experiments are a cost effective method of using the GAS Canisters for controlled exposure of materials to the space environment. The internal portion of the canister is dedicated to launch survivability studies that do not require atomic oxygen exposure.

Part of the flight hardware is fabricated of a developmental Al-Li alloy, thus supporting the flight qualification of this material.

All the objectives were accomplished on STS-46, July 1992, minimizing the utilization of the shuttle small payload accommodation capabilities. Results were reported at the 2nd Annual Materials in Space Symposium (3), May 1993 at CMSS.

## FUTURE WORK

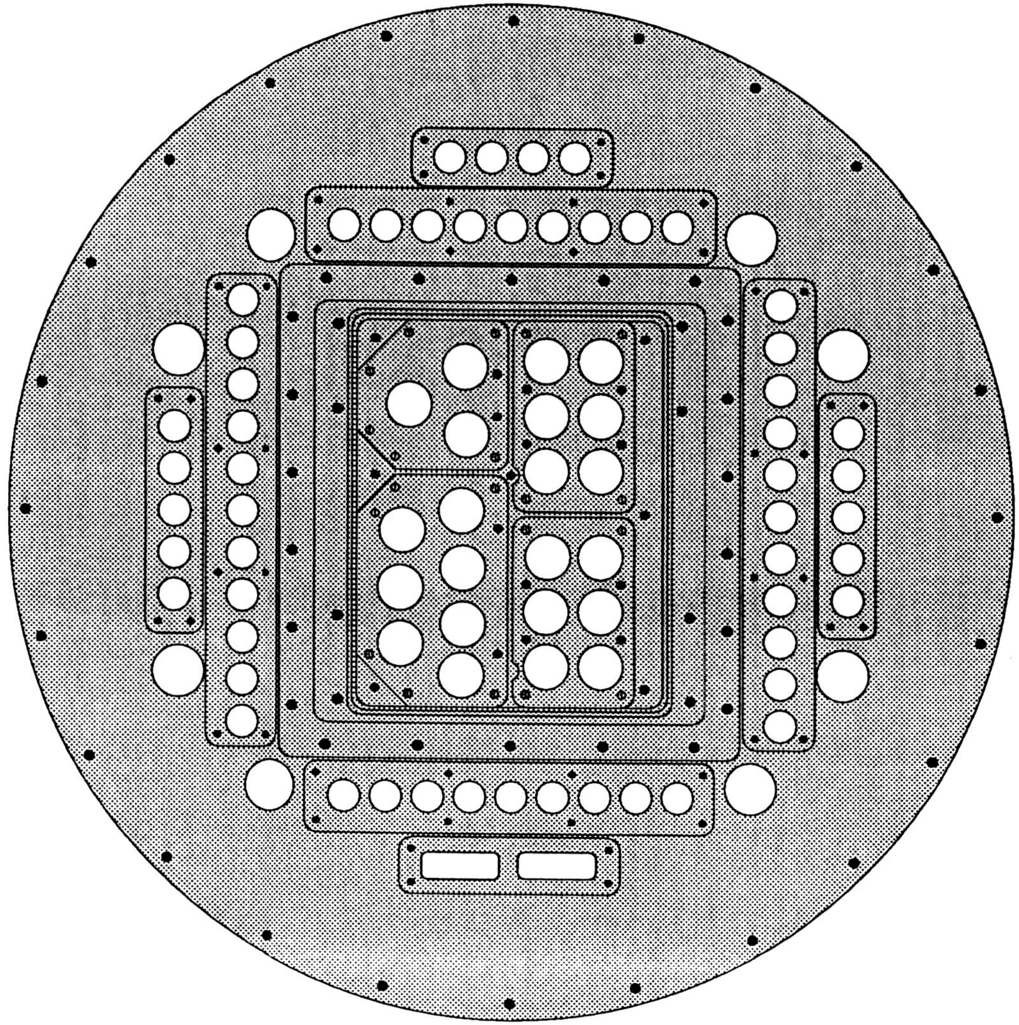
At the time of this writing, the second in a series of LDCE experiments are awaiting the launch of STS-51. Upon the return of the LDCE hardware, re-testing of the disks and re-integration will occur for the third experiment in the LDCE series. LDCE 6-7-8 will be launched on STS-62, February 1994. Results will be reported at the 3rd Annual Materials in Space Symposium, May 1994.

## REFERENCES


1. B.A. Banks, "Atomic Oxygen Interaction with Materials on LDEF. Proc. LDEF Materials Data Analysis Workshop, NASA Conference Pubs. 10046, July 1990.

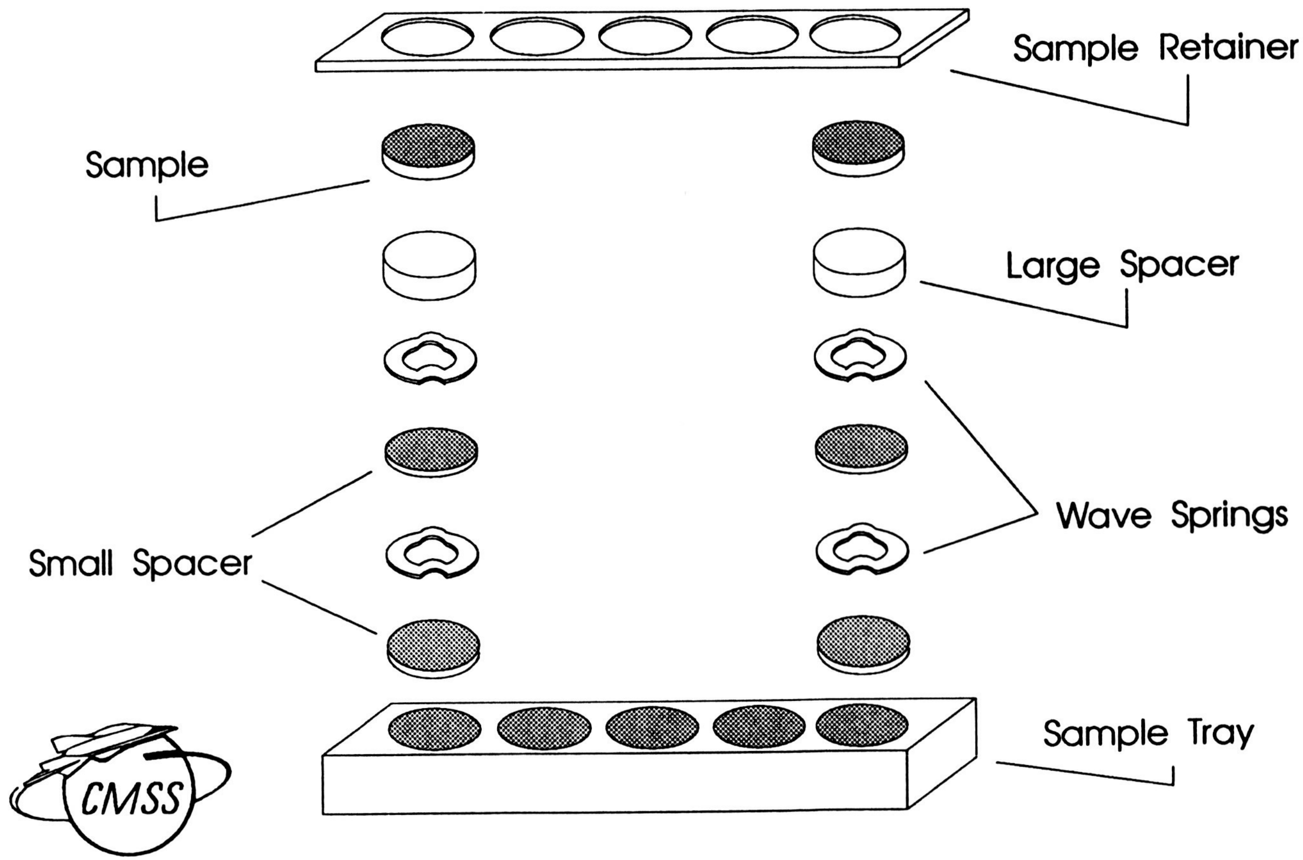
2. S. Zaat, Phd Thesis "The effects of ionized gas exposure on the toughness and fatigue properties of aluminum alloys and composites."

3. Proceedings 2nd Annual Materials is Space Symposium, May 1993.



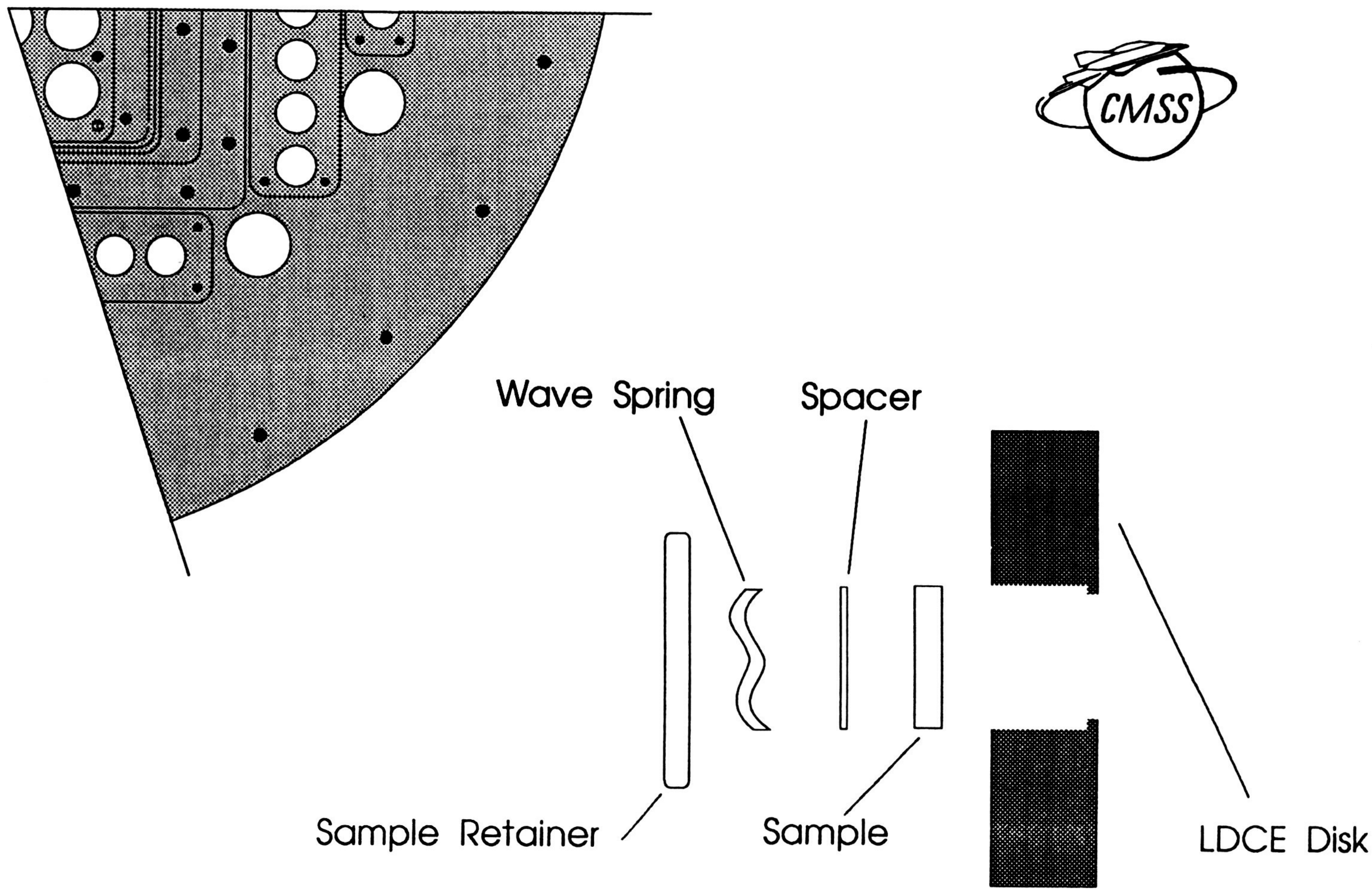
Limited Duration of Candidate materials exposure Experiment (LDCE) Assembly

Figure 1



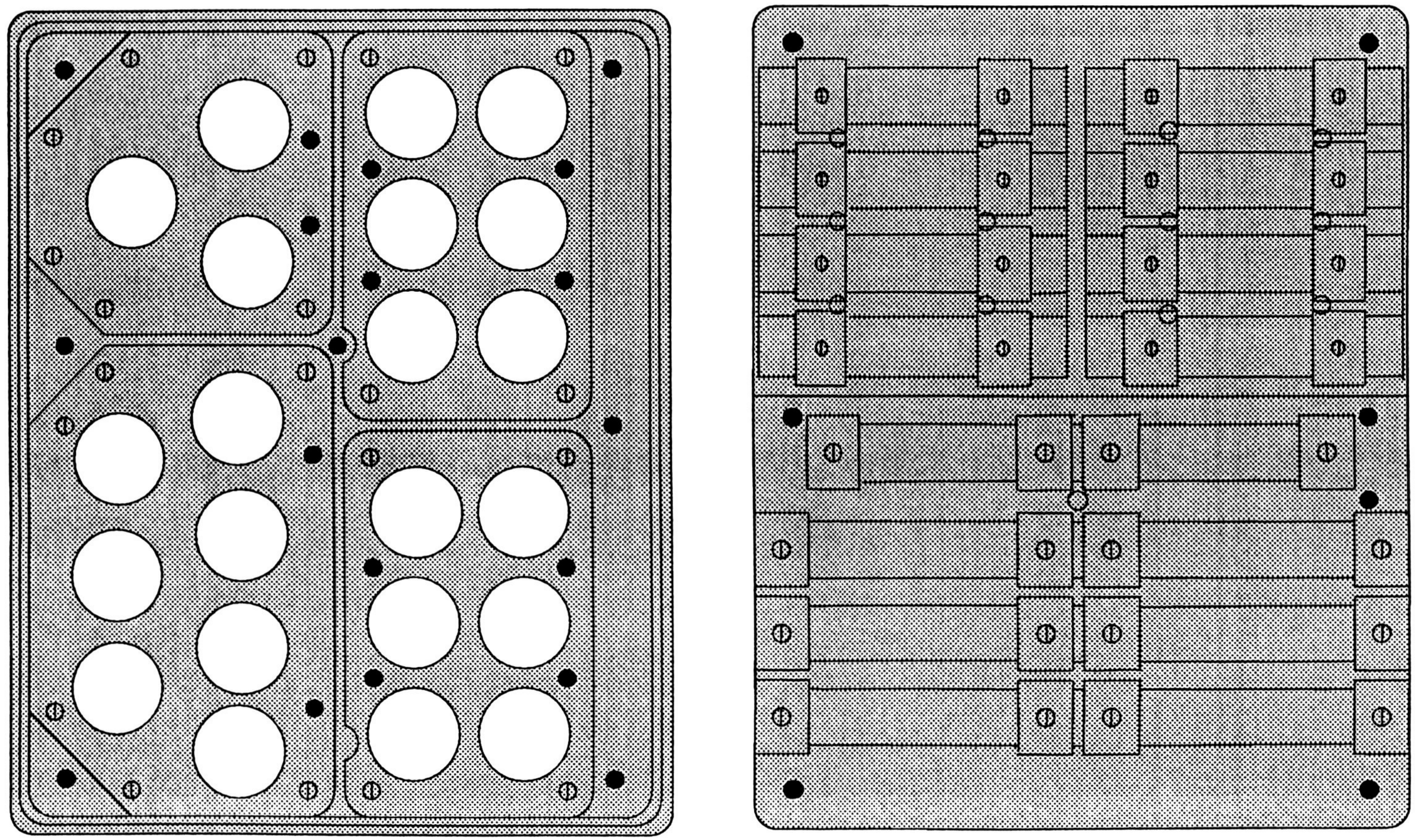

LDCE Sample Holder Assembly Illustration

Figure 2




Method of Mounting 1.0" Specimens to LDCE Experiment Disk

Figure 3



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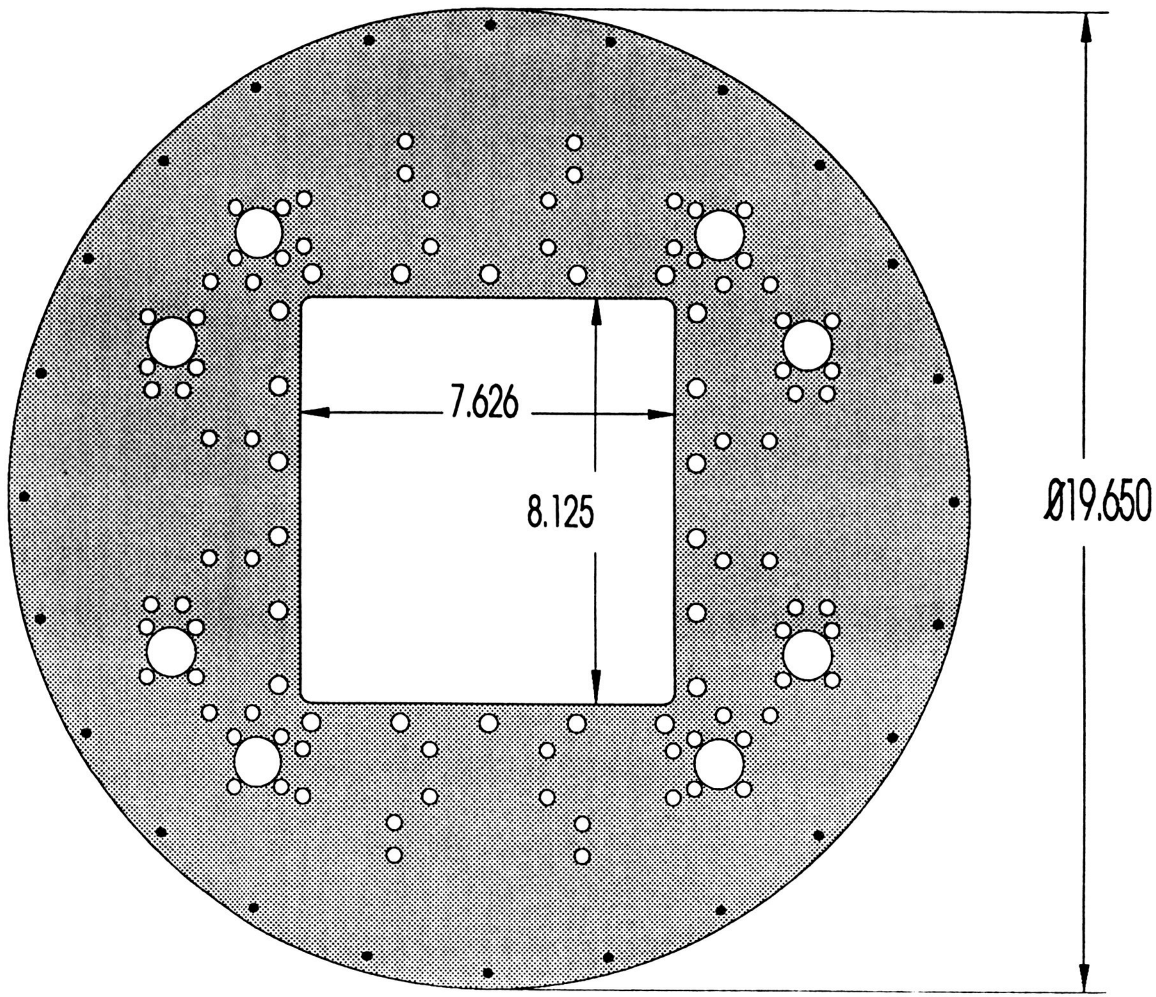
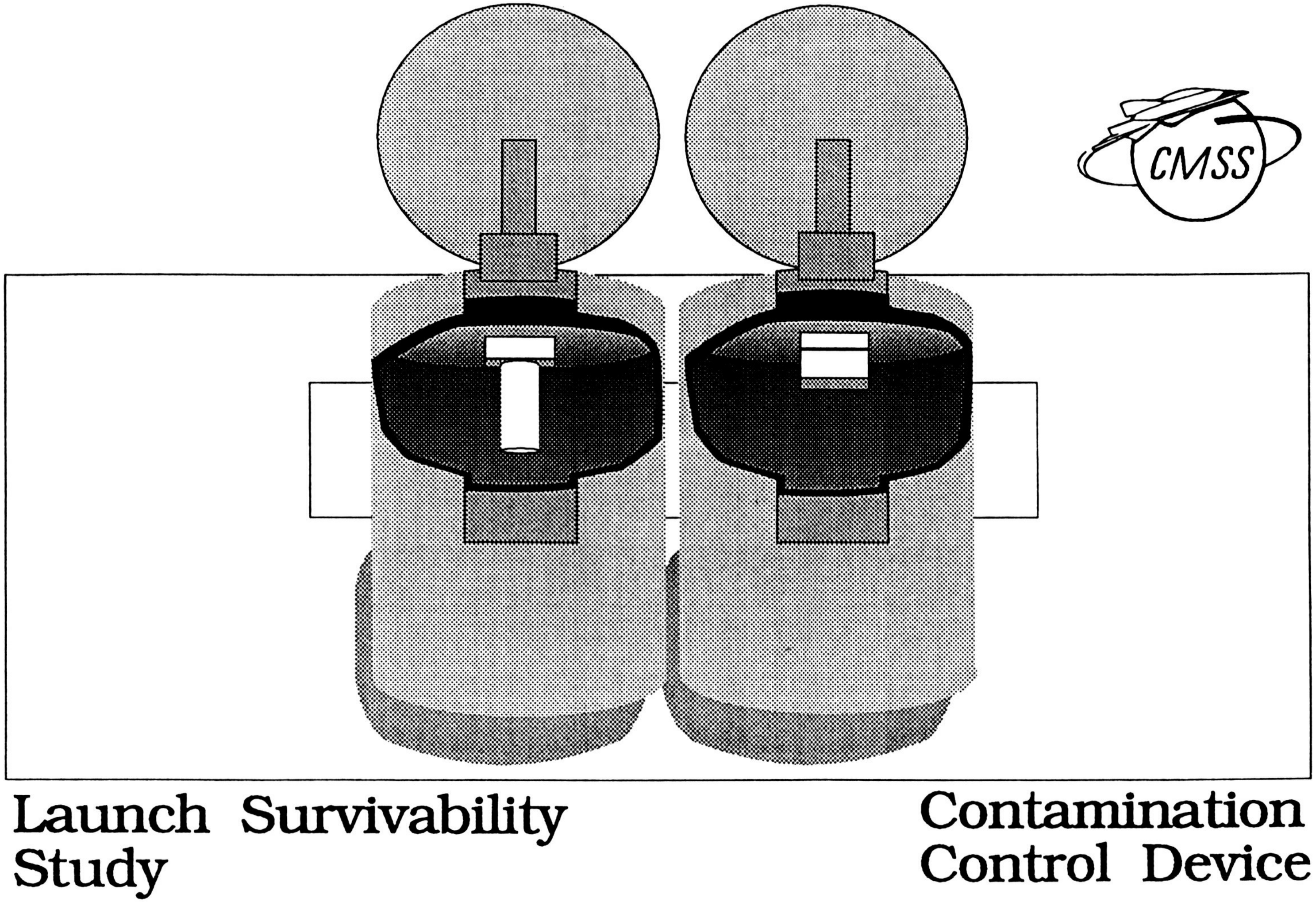
High Density Panel Assemblies used on LDCE 4 & 5

Figure 4




LDCE Experiment Support Disk

Figure 5




Internal GAS Can Experiments Mounted to the LDCE Experiment Disk

Figure 6