PROJECT EXPLORER: GET AWAY SPECIAL #007

by

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INTRODUCTION

PROJECT EXPLORER is a program that will fly student-developed experiments onboard the Space Shuttle in one of NASA's "Get-Away Special" (GAS) containers designated as G #007. The program is co-sponsored by the Alabama Space and Rocket Center, the Alabama-Mississippi Section of the American Institute of Aeronautics and Astronautics, Alabama A&M University and requires extensive support by the University of Alabama in Huntsville. Project Explorer is tentatively scheduled to fly on October 5, 1984, on STS-17 (41G). A unique feature of this GAS mission will demonstrate amateur radio transmissions to global ground stations in the English language.

In 1978, the co-sponsoring agencies undertook this project to encourage high school students to become involved in space-oriented engineering efforts. A brochure was distributed nationwide to high schools throughout the United States soliciting proposals by high school students. The captivating brochure read: "Students, Can You See Your Ideas in Space (?)". Over 150 proposals were submitted and thirteen students were selected. Only two of the original thirteen students remain. One additional student P.I. has been added on since the loss of the others in 1981.

The concept of the project is to design, develop, and fly selected student experiments on the Space Shuttle and to obtain scientific data on the unique conditions of space flight, especially in the area of low-gravity conditions.

Experiments No. 1, 2, and 3 use the micro-gravity of space flight to study the solidification of lead-antimony and aluminum-copper alloys, the germination of radish seeds, and the growth of potassium-tetracyanoplatinate hydrate crystals in an aqueous solution. Flight results will be compared with earth-based data.

Experiment No. 4 (the Marshall Amateur Radio Club Experiment - MARCE) features radio transmissions and will also provide timing for the start of all other experiments. A microprocessor will obtain real-time data from all experiments as well as temperature and pressure measurements within the GAS canister. These data will be transmitted on previously announced amateur radio frequencies after they have been converted into the "English language" by a digitalker for general reception.

OPERATIONAL SCENARIO

The G #007 Payload will require a duration of five (5) full days and a "turn-on" of the experimental package as early in the Space Shuttle mission as possible. Experiment No. 1: The Solidification of Alloys experiment will be started at a time when about 8 hours of very low "g" operations can be expected, such as during a sleep period for the crew. At that time, a signal from the GAS Operations Panel within the crew compartment will trigger the operation of this experiment. Subsequent operations will be started by built-in controls and do not need additional signals. Another period of low-gravity operations for a second solidification will occur about a day later.

Experiment No. 2: The Radish Seed Germination and Growth experiment must be initiated as soon as feasible, i.e., at about the time when the Shuttle reaches its orbit to obtain the longest possible growth period for the seeds. An orbital operation of at least five (5) days is needed for meaningful results. Operational control will be provided by MARCE: Upon the initial G #007 power-up, a relay will activate pump "A" to supply the water/fertilizer solution to the seeds. Upon power-down, approximately 120 hours later, another relay will activate pump "B" and freeze any further seed development by the application of buffered formaldehyde to the seeds.

Experiment No. 3: The Crystal Growth experiment will be activated when micro-gravity conditions exist. At the beginning of the first available low-g period lasting 4 hours or more, MARCE will power-up the electrolysis cell by a 1.3 V DC power supply, and crystals will start to form on the anode. A 35 mm camera and its electronic flash will have been activated at the same time, and will take a picture every 40 minutes. This experiment requires 24 hours for completion.

Experiment No. 4: The Marshall Amateru Radio CIub Experiment (MARCE) will control all other experiments in accordance with individual requirements. The "ORBITER's ATONOMOUS PAYLOAD CONTROLLER (APC) provides AFT-Flight Deck control for experiments "turn-on" and "turn-off" and can also terminate all GAS operations if SAFETY NEEDS require such premature cessation of experimentation.

Three transmission cycles of 8 hours each are planned. A transmission cycle consists of a 30 second transmission every 4 minutes. When experiment #1 is active, transmissions will last about 45 seconds. The first 8-hour cycle will be activated at G #007 "turn-on". Second and third cycles will be started during the two experiment #1 operations.

DESCRIPTION

ALL experiment packages and/or their components are mounted on a rectangular mounting plate, which is in turn bolted to the rib of a round plate which is bolted directly to the GAS canister top lid.

Experiment No. 1 will solidify two alloy samples (Lead-Antimony and Aluminum-Copper) inside of an internally insulated aluminum cylinder (15" long and 6" diameter). It will house two small cylinders that will encompass two miniature furnaces 4½" H and 3/4" Diameter. (see Figure 1). The wall thickness of the cylinders are 1/16" thick. The melting furnaces are made of lava cores and are wrapped with Nichrome wire (spring coils). The alloy samples are centrally located in the middle of each furnace core and can be heated to temperatures of up to 700°C. The heat is generated by a 28 VDC electric current from a central power supply. Moreover, while the inner part of the small can is 700°C, the outer surface is only around 60°C.

The Data Acquisitions and Control Unit (DAQ2-K) exterior is also made of aluminum and it contains the experiment control system which supervises the two separate metallurgical experiments. Its primary functions include measuring temperatures of the experimental vessels, storing measured values for later recall, operating the two furnaces used in the experiment and sending experimental data to external telemetry equipment. The experiment control system has two modes of operation, normal and test. The normal mode is used during flight to run the experiments solely under control of the internal system. The test mode is used in the laboratory to insert and display the experiment's parameters.

During operation of the experiment, data is sent to the external telemetry equipment (located in Expt. #4) once a minute via a TTL serial data port in (Exp. #1). If the system is operating in the test mode, identical data is also routed to the RS232 port. Telemetry data consists of an identification of the mode currently executing the current time as maintained by the system and the measured values from all eight thermocouples. These messages are formatted on a computer as shown below and are terminated by a carriage return and line feed:

AA T=HHMM TC1=RR TC2=RR TC3=RR TC4=RR TC5=RR TC6=RR TC7=RR TC8=RR

Where AA is a two character abbreviation of the current mode, HH is the current hour in 24 hour format, MM is the current minute and RR is the actual reading - all in hexadecimal notation. This experiment will weigh less than 30 lbs.

MARCE will provide the signal to start the melting and solidification process of experiment No. 1 at a time when about 8 hours of very low "g" operations can be expected, such as during a sleep period for the crew. At that time, a signal from the GAS APC within the crew compartment will trigger the operation of this experiment. Subsequent operations are controlled automatically and do not need additional signals from the crew.

Experiment No. 2 will be conducted inside of an aluminum container. The radish seeds will be held in place by filter paper as the growth substrate. Gear-type pumps will initially deliver a water/fertilizer solution to the seeds, and at the end of the mission supply a buffered formeldehde solution to stop any further growth during descent and disassembly after return.

Operational control of the experiment will be provided by the MARCE radio experiment. One hour after initial G #007 power-up, a control relay will be closed for 30 seconds and thus activate pump "A" which supplies the water/fertilizer solution to the seeds. Prior to G #007 power-down (approximately 120 hours later) a second control relay will close for 30 seconds and thus activate pump "B", which supplies the buffered formaldehyde solution.

This experiment will require a temperature of 30°C plus/minus 10°C. Should temperatures inside the growth chamber go below 20°C, a small heater will be activated to maintain required temperatures. There will be no cooling provisions for temperatures above 40°C.

A turn-on signal as early in flight as possible is desired as well as an experiment operations time of 5 full days in orbit. Best available micro-gravity levels are desired, but 10.-3 g's is acceptable. This experiment will weigh less than 15 lbs.

Experiment No. 3 will be conducted in an electrolysis cell of 6 ml volume. The cell is made of plexiglas and fitted with two small platinum electrodes. An optical system consists of a 35 mm NIKON F-2 camera with a 50 mm close-up lens; camera auto-winder MD-3 with camera battery pack MB-1; and a small NIKON SB-E electronic flash. The battery pack holds 10 AA size batteries (15 V DC) and is used to power the camera. The electronic flash holds 4 AAA size (6 F DC) batteries. Operational control of the experiment consists of application of a 1.3 V DC precision reference supply to furnish the potential across the platinum electrodes for nucleation of crystal growth; camera operation will be synchronized with the flash to photograph the crystals at a rate of one exposure per four minutes for 24 hours. A thermistor is attached to the electrolytic cell to monitor the temperature fluctuations of the experiment's environment. The precision reference supply and a control timer will be furnished by MARCE. The experiment will weigh less than 10 lbs.

Experiment No. 4 provides power, control and on-board storage of G #007 experiments environmental data. MARCE will acquire these data for input to analog-to-digital converters through signal lines. A voice synthesizer Digitalker system will convert the experimental data into "ENGLISH LANGUAGE" and will modulate the transmitter

The weight of all MARCE equipment besides the battery will be about 10 pounds. A 25 pound surplus SPAR battery will provide power at 28 V DC and 20 amp-hrs.

SUPPORT STRUCTURE

The support structure for the G #007 experiments consists of two primary plates and four "bumper" assemblies. One of the primary plates is a round plate which mounts to the GAS canister top lid. This round plate has a machined rib along a diameter, to which the second rectangular plate is bolted. This rectangular plate divides the GAS canister volume in two equal halves along the longitudinal axis. The bottom of the rectangular plate, which supports all experiments, is supported by four "bumpers" contacting the inside of the canister. Two of these "bumpers" are mounted on the lower corners of the rectangular plate. The other two "bumpers" are mounted on "T" mounts perpendicular to the faces of the rectangular plate. (See Figures).

TECHNICAL LESSONS LEARNED

Even from the simplest of experimental ideas, there is much, much more than meets the eye. The main lesson learned was the complexity involved in preparing a simple GAS payload - in addition to the tons and tons of paper work. From the initial ideas, to the design and fabrication of all experiments, as well as integrating the four experiments into one functional package made the whole endeavor invaluable.

For experiment No. 1, the major problem was finding a way to monitor and store the experimental parameters during operation. This problem prompted the development of the DAQ2-K.

For experiment Nos. 2 and 3, the main problem was maintaining a constant temperature for an extended period of time. Miniature heaters were designed to facilitate this problem. In addition, for experiment No. 3, recording the crystal's growth was questionable until a modified 35 mm camera was acquired to compensate this essential requirement.

Experiment No. 4's major hurdle was obtaining approval to mount an external antenna on the outside of the GAS canister. Also, this problem was overcome.

Overall, PROJECT EXPLORER has come a long way from its initial beginning and has accomplished 90% of its original objectives.

ACKNOWLEDGEMENT

G #007 could not have been completed without the dedication and total commitment of the student P.I.'s and MARCE P.I. who all made gallant achievements in preparing their individual experiments. Also, thanks and appreciation go to the co-Directors, Project Manager, the Integration Team, and countless others who have contributed immensely in making this payload a huge success.

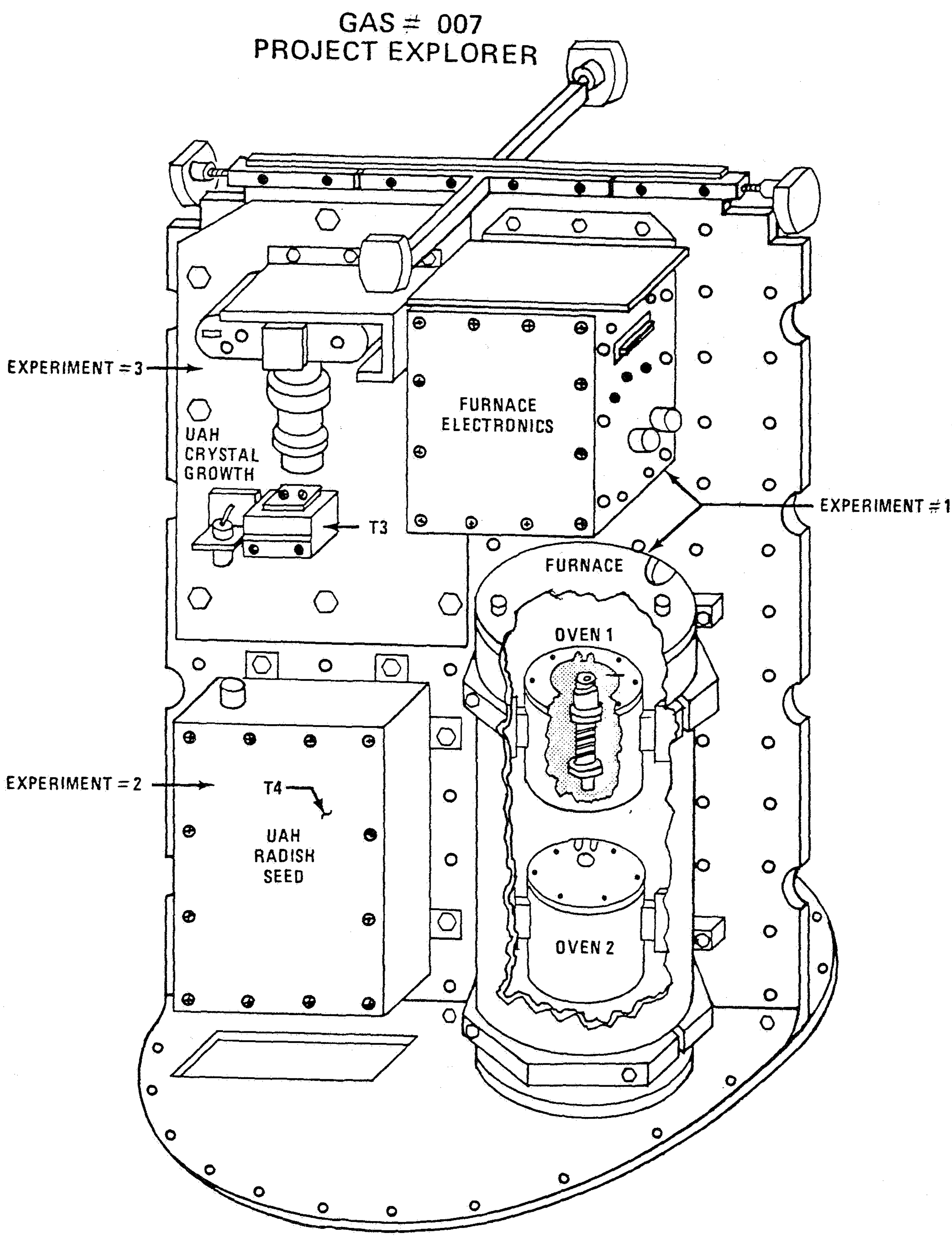
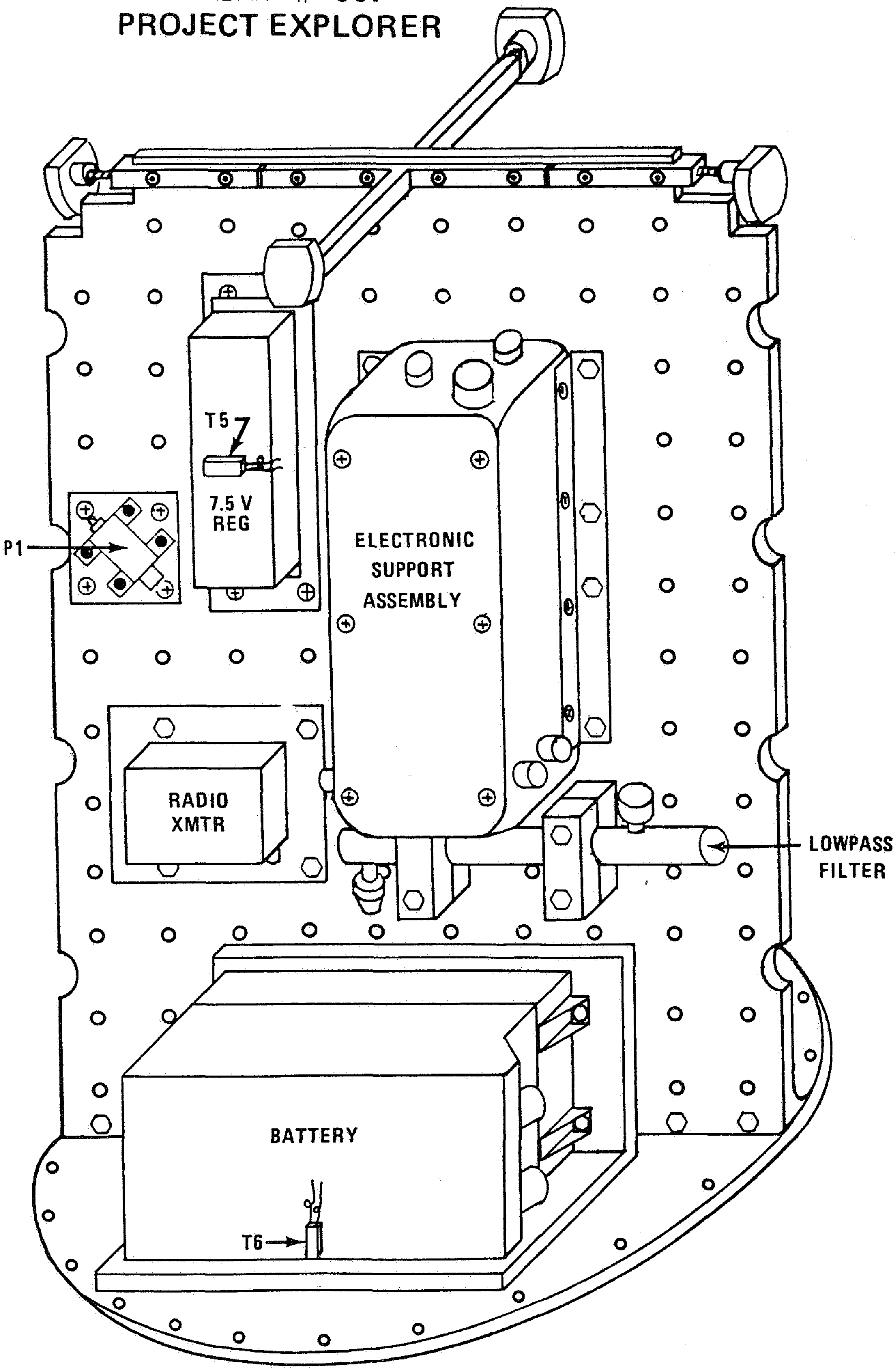

GAS ≠ 007
PROJECT EXPLORER
EXPERIMENT = 3
UAH
CRYSTAL
GROWTH
T3
FURNACE
ELECTRONICS
EXPERIMENT ≠ 1
FURNACE
OVEN 1
OVEN 2
EXPERIMENT = 2
T4
UAH
RADISH
SEED

FIGURE 1

GAS # 007
PROJECT EXPLORER



EXPERIMENT #4 FIGURE 2