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THERMAL TEST PLAN FOR THE EO-1 CARBON-CARBON RADIATOR

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THERMAL TEST PLAN FOR THE EO-1 CARBON-CARBON RADIATOR

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1.0 INTRODUCTION

The Earth Orbitor - 1 (EO-1) is the spacecraft platform for the Advanced Land Imager (ALI) instrument and will fly in a sun-synchronous orbit 705 kilometers above the Earth. The launch date is scheduled for May 1999 aboard a Delta 7320 ELV. Though the ALI is the primary instrument aboard the EO-1, the spacecraft will also be used to test a number of new technologies, one of which is the carbon-carbon radiator. The C-C radiator is made of carbon fibers in a carbon matrix. It is being built by the Carbon-Carbon Spacecraft Radiator Partnership (CSRP) and will undergo environmental testing at GSFC. The testing will consist of two parts. First the radiator will undergo four thermal cycles with four hour soaks at 50°C and -10°C. Second the radiator will undergo thermal balance testing for a variety of conditions.

1.1 Objective

This test is designed to meet the thermal requirements specified in the EO-1 ICD for the C-C radiator and to test the performance of the radiator for a variety of conditions.

1.2 Test Facility

The cryo-pumped Thermal Vacuum Facility located in Building 4, Room 183, of Goddard Space Flight Center will be used for this test.

1.3 Personnel

The following thermal vacuum tests will be conducted by Code 545 personnel.

1.4 Applicable Documents

1. "Operating Procedure for 36" Dynavac Belljar Thermal Vacuum System", April 25, 1994.

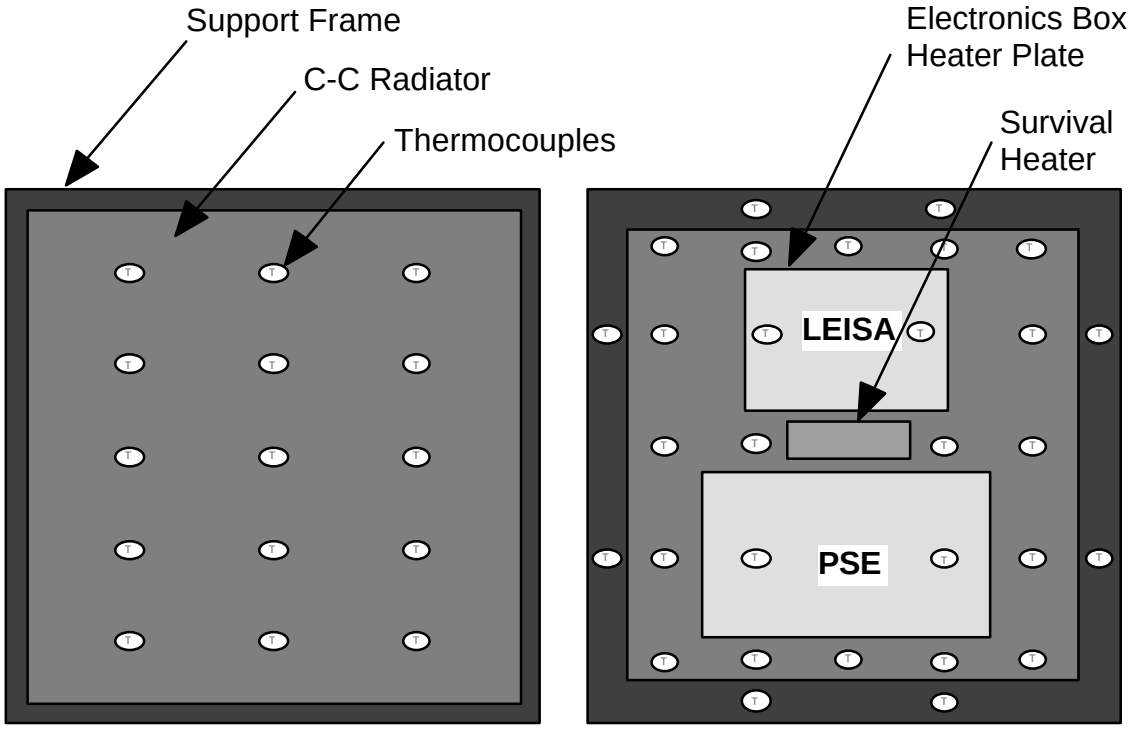
2. "EO-1 Spacecraft to Carbon-Carbon Radiator Interface Control Document (ICD)", SAI-ICD-028, Sept. 2, 1997.

3. "General Environmental Verification Specifications for STS and ELV Payloads, Subsytems, and Components", GEVS-SE, Jan. 1990.

1.4 Test Fixture

Two aluminum plates will be bolted to the radiator to simulate the LEISA and PSE electronics boxes that will be there during the flight. A CHOTHERM thermal interface

will be placed between the plates and the radiator. The bolts will be torqued to the recommended flight values and re-torqued after 24 hours. The PSE plate will have attached heaters capable of generating at least 50 Watts of power, and the LEISA plate heaters will have at least 30 W of power capacity. The heaters will be attached by two-sided adhesive tape. The power to the two heaters should be capable of being adjusted independently. The radiator will also have a support frame which bolts to the radiator at the spacecraft attachment points. The purpose of the support frame is to simulate the spacecraft interface during environmental testing. The bolts which attach the radiator to the support frame shall be torqued to the recommended flight values. There will be no heaters on this frame, but Swles will supply a survival heater to be placed on the radiator. The approximate location of the thermocouples and survival heater are shown in the following diagram. The exact location of each of the thermocouples and heater will be measured once they are installed. The radiator will be suspended vertically in the chamber by stainless steel wire. During the thermal balance test, MLI will be used to insulate the side with the heaters (see figure on the setup).



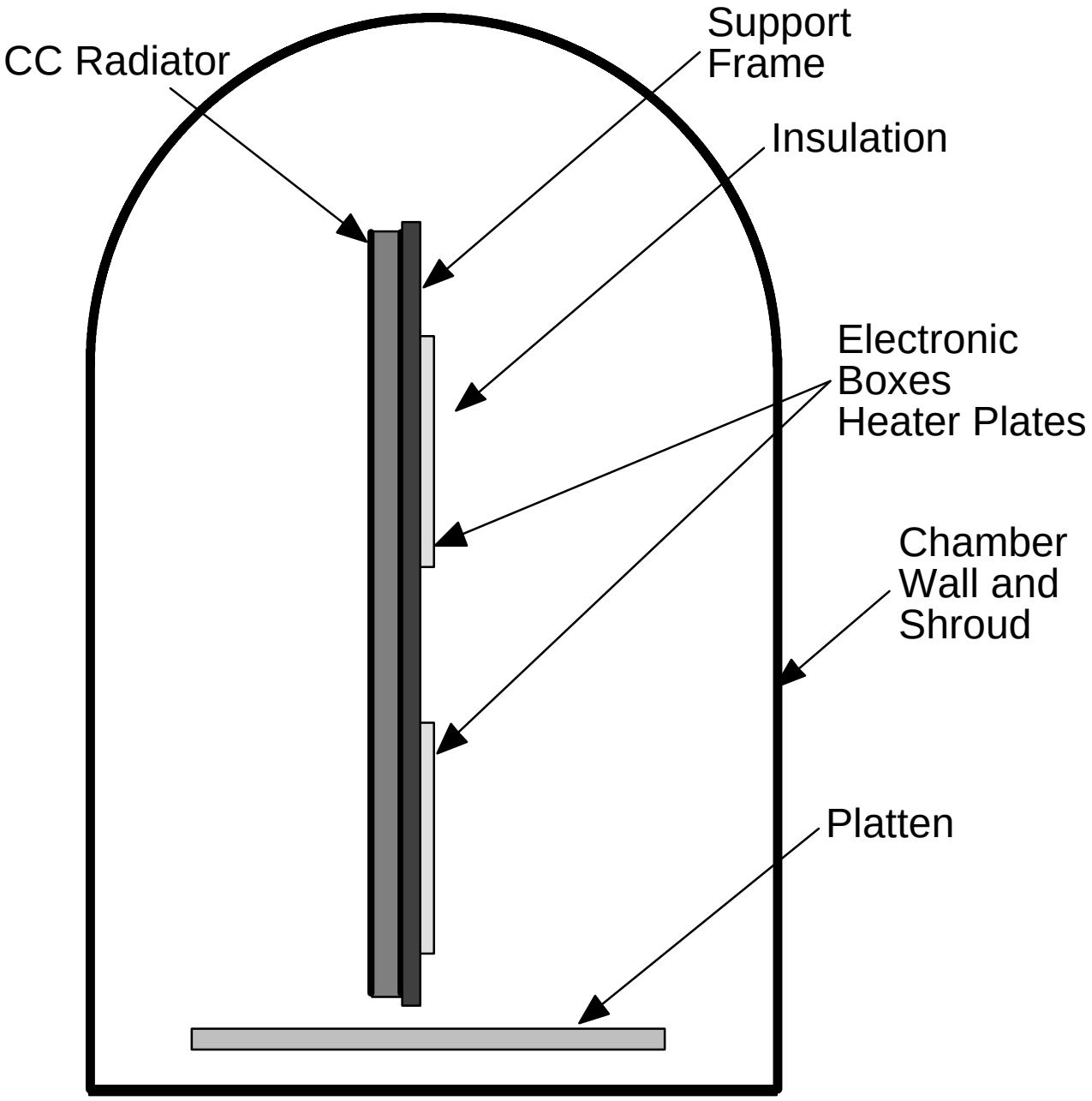
Thermocouple Locations for C-C Radiator Thermal Vacuum Test

1.5 Data Acquisition

The test fixture temperatures will be recorded by a data acquisition system connected to a PC using Labview software. The temperatures will be recorded throughout the entire test. The chamber pressure and the actual heater power will be recorded in the log sheet.

1.6 Thermocouple Measurement

Approximately 45 type “T” thermocouples will be used to monitor test temperatures. See the diagram for rough thermocouple locations on the test assembly. The chamber wall, shroud, and platten temperatures will also be monitored.



Carbon-Carbon Radiator Thermal Vacuum Setup for Thermal Balance Test

[not to scale]

1.7 Heater Power Measurement

Heater power will be monitored continuously by measuring the voltage directly across the heater and by measuring the actual current flowing through the heater. When steady state is reached, the voltage and current will be measured and recorded in the log.

2.0 TEST PROGRAM

The objective of this test is to meet the thermal cycling requirements listed in the ICD and to conduct a thermal balance test on the radiator to measure its performance under different heat loads. The radiator assembly will be suspended vertically in the chamber by non-conducting wires. During the thermal cycle testing, there will be no insulation on the radiator assembly, and the heaters will not be used. During the thermal balance testing, the side of the radiator with the heater plates (interior surface) will be insulated with a minimum of 5-layered MLI. The chamber walls, shroud, and platten will be set to about -40°C during the testing, though this can be changed at the discretion of the test director to accelerate transitions. The heater(s) will then be set to the powers listed in the thermal test plan in Section 3, and the radiator allowed to reach equilibrium. Once equilibrium has been reached, based upon the discretion of the test conductor, the power will be set for the next test. This pattern will be repeated until all the tests have been completed or the testing is ended by order of the C-C Radiator Manager.

2.1 Temperature Limits

For all tests, the maximum temperature that the heater surface can reach cannot be greater than 100°C, nor shall the radiator temperature be less than -20°C. If the temperature of the aluminum plate exceeds 100°C, the heaters are to be turned off until the temperature drops below 80°C.

	Cold, C	Hot, C
Yellow Limit	-15	55
Red Limit	-20	60

2.2 Temperature Stability

During thermal balance testing, the test will be considered complete when the temperatures reach steady state and change less than ± 0.5°C in 30 minutes.

2.3 Sink Temperature

The tests will be run with the chamber walls at temperatures specified in the thermal test plan, ±5°C.

2.4 Heater Power

The tests will be run with the heaters powered at the settings specified in the thermal test plan to provide a variety of differential temperature gradients across the panel.

2.5 Vacuum Requirement

Throughout the Thermal Vacuum Test, the chamber pressure will be at or below 5.0 x 10^{-5} Torr.

3.0 THERMAL TEST PLAN

3.1 Thermal Cycle Test

The C-C radiator will be subjected to four cycles each consisting of a hot soak at 50°C ±2°C for four hours and a cold soak at -10°C ±2°C for four hours (see figure on next page). The chamber wall, shroud, and platten will be controlled to a temperature that will attain and sustain these desired conditions. The start of the hot and cold soaks will be at the discretion of the test conductor in charge at the time.

3.2 Thermal Balance Test

No.	PSE Power(W)	LEISA Power(W)	Platten(C)*	Shroud(C)*
1	10	0	-20	-20
2	30	0	-20	-20
3	50	0	-20	-20
4	0	10	-20	-20
5	0	30	-20	-20
6	20	10	-20	-20
7	40	20	-20	-20
8	50	30	-20	-20

* These temperatures can be set lower at the discretion of the test conductor as long as the radiator temperature does not drop below -40°C.

The test conditions for the survival heater will depend on the type, power, and location of the heater and will be determined at the time of the thermal balance.

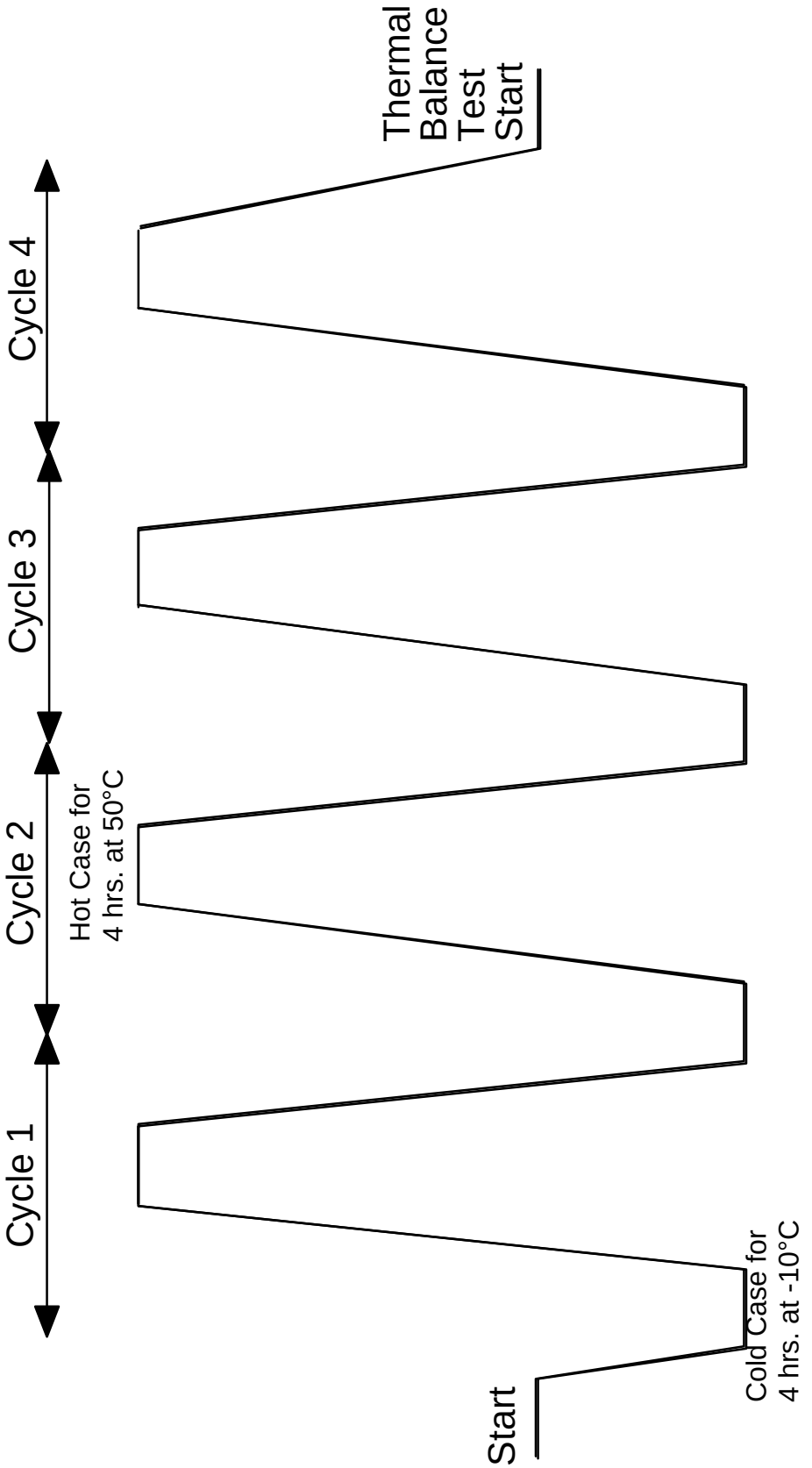
3.3 Thermal Balance Test - Survival

No.	Heater Voltage	Platten(C)*	Shroud(C)*
1	21	-20	-20
2	26	-20	-20
3	30	-20	-20
4	35	-20	-20

* These temperatures can be set lower at the discretion of the test conductor as long as the radiator temperature does not drop below -40°C.

4.0 QUALITY REQUIREMENT

This test will be monitored by EO-1 Quality Assurance. Prior to execution of this test, Quality Assurance shall verify the test configuration, test equipment calibration, facilities, and documentation. After this initial verification, testing shall commence. If anomalies are encountered during test execution, the C-C Radiator Manager and Quality Assurance shall be notified. The execution of this test procedure along with any anomalies shall be logged in the C-C Radiator Certification Log/Problem Record.



Thermal Test Cycles for EO-1 C-C Radiator