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ACD Thermal Vacuum Test Report

ACD-DATA-000377

Goddard Space Flight Center

Greenbelt, Maryland

ACD Thermal Vacuum Test Report

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1 INTRODUCTION

This report presents the results of the ACD thermal vacuum test. The test was conducted from July 21 through August 5, 2005 at Goddard Space Flight center in Chamber 225 located in Building 7. Four thermal vacuum cycles were successfully completed between qualification environmental levels that included a single hot and cold survival temperature exposure. These test sequences were completed to obtain test data and evaluate the effectiveness of the MMS/MLI mechanical support structures. An additional half cycle (hot) was performed to acquire additional function and performance data. The as run test profile is shown in Appendix H.

2 DOCUMENTATION

2.1 Applicable Documents

The ACD flight unit Thermal Vacuum and Thermal Balance test policies are based on the following documents:

- GEVS (General Environmental Verification Specifications), GSFC-STD-7000
- GSFC Rules for the Design, Development, Verification and Operation of Flight Systems, GSFC-STD-1000
- LAT ACD Subsystem Requirements – Level III Specification, LAT-SS-00016
- LAT ACD Requirements – Level IV Specification, LAT-SS-00352
- LAT Environmental Specification Plan, LAT-SS-00778-02
- LAT ACD Electronics Subsystem Specification, LAT-SS-00448
- LAT ACD Subsystem Specification, LAT-SS-00449
- LAT Performance Assurance Implementation Plan (PAIP), LAT-MD-00039-01
- ACD Quality Plan, ACD-QA-8001
- ACD Verification Plan, ACD-PLAN-000050
- ACD Integration and Test Plan, ACD-PLAN-000350
- ACD Flight Thermal Vacuum Test Plan, ACD-PLAN-000347
- ACD Helium Monitor and Control Plan, ACD-PLAN-000152
- ACD Mechanical Handling Procedure, ACD-PROC-000195
- GLAST LAT ACD Comprehensive Performance Test Procedure, ACD-PROC-000270
- GLAST LAT ACD Comprehensive Margin Performance Test Procedure, ACD-PROC-000352
- GLAST ACD Thermal Vacuum Harness Configuration, GE2071691
- ASSEBMLY Instrumentation Installation, GE-2054615
- ″Determining Vacuum Chamber Environment Using a Cold Finger″, ASTM-E-834-81
- Emergency Chamber Shutdown Operating Procedure, ManTech Document 09PC-WI36

3 SYSTEM LEVEL TEST OBJECTIVES

The ACD flight unit Thermal Vacuum test was performed to accomplish the following objectives:

- Verify the ACD Flight Hardware workmanship
- Verify the functional operations of the flight components at elevated and lower than expected flight temperatures to assure thermal design margins
- Perform one hot and one cold start of the ACD

3.1 Subsystem Level Test Objectives

3.1.1 Mechanical

- Cycle MLI to flight extreme temperatures to induce maximum stresses on MMS/MLI support structure
- Cycle MMS to flight extreme temperatures to induce maximum stresses on MMS/MLI support structure

3.1.2 Thermal

- As a goal, thermally cycle the components four times at the system level between temperatures that are 10 °C beyond operating limits (but not exceeding the red temperature limit for any component). As a general rule temperature extremes will be at qualification levels, if achievable. The goal is that levels will be at a minimum to acceptance levels
- Verify that all flight thermistors (TMs) operate (and correlate data, where possible, with test thermocouples)

3.1.3 Electrical

- Check the basic functions of the ACD at expected flight like conditions

3.1.4 Contamination

- Meet the LAT level contamination requirements

4 ACD FLIGHT ARTICLE

4.1 ACD Thermal Control Design

The thermal design of the ACD is passive control with no heaters or dedicated radiator area. The ACD covers all five external sides of the LAT instrument and is fully blanketed by a 14 layer blanket on these five sides with an external MLI blanket layer of 3-mil Germanium Black Kapton. The high emittance LAT tracker exterior surfaces provide the radiative path between the ACD shell interior and the LAT. The BEA is mounted to the LAT Grid via the 4 corners and at the center of each side at the mid-span connectors, while also being radiatively coupled to the LAT Grid.

4.2 ACD Structure

The ACD flight unit consists of 89 scintillator tile detectors and 8 ribbon detectors that are mounted on the Tile Shell Assembly support structure via 368 composite tile flexures. The TSA is mounted to the Base Frame Assembly support structure via 4 titanium corner flexures and 4 titanium mid-span flexures. The BFA houses the ACD electronics in 8 separate compartments and once combined the BFA and electronics become the Base Electronics assembly. The Tile Shell Assembly consists of 5 honeycomb panels fabricated with low thermal conductive composite material, namely M46J facesheets, and aluminum core. The BFA is composed of 4 identical machined aluminum parts bolted together.

4.3 ACD Electrical

The ACD consists of 8 Electrical Chassis consisting of High Voltage Bias Supplies, FREE Cards, and PMTs, which are connected to the tile and ribbon detectors via Clear Fiber Cables. The ACD is electrically connected to and controlled by the GASU. The GASU is a flight like electronics box provided by Stanford Linear Accelerator Center (SLAC).

Additionally the ACD has a flight Instrumentation system for thermal monitoring. GSFC developed a PC based Thermal monitoring instrument that monitored and recorded all readouts from the Flight Instrumentation Harness. The Thermistors and PRTs associated with this are described in Appendix B table B-1.

5 TEST CONFIGURATION AND SET-UP

ACD performed only a TV test on the hardware, no thermal balance was performed to correlate the model or correlate the emissivity of the MLI. Table 5-1 compares the differences between Flight and Test configurations.

Table 5-1 Differences Between Flight and Test

Flight	Test
Sun, Albedo, and Earth IR on sides of ACD	Heat is input radiatively via 1 heater panel on +X side of ACD, chamber provides effective sink temperatures to all other sides
Radiative coupling to TSA via the LAT Tracker	There will be a LAT Tracker simulator but it will be smaller in size compared to the flight LAT design
Radiative and conductive coupling via the LAT Grid	Solely a Radiative coupling to the ACD via the Belly Band (Grid Simulator)
No thermocouples	Thermocouples and associated cabling
MLI flight configuration	Additional pieces of MLI to close-out around test harness, mounting locations and GSE

No test MLI	Closeouts as described in appendix H

A large 2-inch mounting plate placed on the payload cart to provide mechanical stability for all the GSE listed below. The 2-inch plate comes assembled with 4 mid span posts which are used to support the belly band. The 2-inch plate also will have 4 corner posts which are used to support the ACD structure. These 8 posts are all isolated from the 2-inch plate via G-10 spacers. The 2-inch plate is roughly 70" x 70".

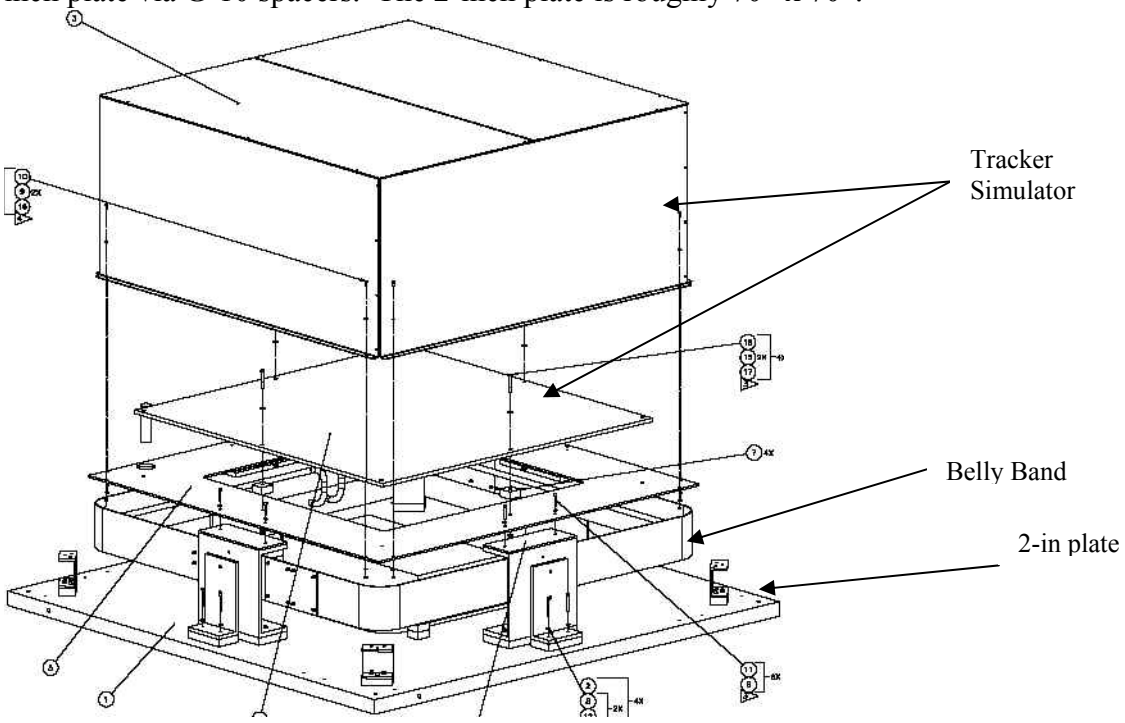


Figure 5-5-1 GSE Test Setup without (+X) Heater Panel shown

The Belly Band is GSE designed to simulate the radiative interface between the ACD BEA and the LAT GRID. A fluid loop is attached to the Belly Band and a thermal conditioning unit (TCU) is utilized to control the temperature of the Belly Band. The Belly Band is mounted to the mid span posts and supported solely by those structures.

The Tracker Simulator is GSE designed to simulate the radiative interface between the ACD TSA and the LAT Tracker Assembly. The Tracker Simulator consists of two components, a 4' x 4' cold plate and a five-sided aluminum box. The five-sided box has a black anodized surface, and contains heaters on each panel; this can be seen in Figure 5-1. The 4' x 4' cold plate is used to radiatively cool the tracker simulator. The Tracker Simulator is supported by the adapter plate. The adapter plate's sole purpose is to interface the Tracker Simulator to the other GSE. The adapter plate is supported by the

mid span posts from which it is also conductively isolated via G-10 spacers.

The GASU is GSE used to simulate the electrical interface between the ACD and the LAT. The GASU is roughly an 18" x 30" aluminum box with roughly 17 W of power being dissipated. The GASU needs to be controlled to 20 °C ± 10C.

A 24" x 36" cold plate, GASU cold plate (GCP) is being used to control the temperature of the GASU. The 24" x 36" cold plate is mounted to the 2-inch plate at the 4 corners and is isolated via G-10 spacers. This cold plate is controlled with a TCU. The GASU is bolted to this cold plate via 8 screws at 8 locations around the periphery of the GASU.

An 83" x 59" heater panel is used to radiatively input heat into the ACD system. This panel is used to simulate the environmental inputs onto 1 side of the ACD were that side directly viewing the sun. The black anodized plate is four inches from the ACD side and has heaters mounted to it. The heater panel has its own mount and does not interface with the ACD GSE.

6 FACILITIES AND EQUIPMENT

6.1 Vacuum Chamber

Chamber 225 was utilized for this TV test. This chamber is in building 7 at the GSFC and is capable of reaching vacuum up to 10^{-7} Torr.

Chamber 225 is a large, horizontal, cylindrical, cryopumped thermal vacuum chamber. Test items are loaded by crane onto a load cart, which is loaded into the chamber on a rail system. Payload weight can be as high as 2268 kg. The shroud is capable of GN_2 mode control (-140°C to +100°C) or LN_2 mode (-190°C). The test volume is 9' dia x 14' length. The standard electrical feedthroughs include 37 pin, 7-pin, 4-pin and RF. It is equipped to monitor up to 126 thermocouples. Standard contamination equipment includes TQCMs, cold finger, and residual gas analyzer (RGA).

6.2 Thermal Test Support Equipment

6.2.1 Thermal Conditioning Units (TCU)

A total of three LN_2 Control TCUs were used for the ACD TV tests.

6.2.2 Cold Plates/Cryopanels

There were 2 cold plates for the ACD TV test: the (1) GASU Cold Plate (GCP) and the 4' x 4' cold plate of the Tracker Simulator. The Belly Band was controlled with a separate LN_2 Thermal Conditioning Unit (TCU).

6.2.3 Heater Control Racks

Two heater control racks were required to perform the test. Heater control rack and heater assignments are listed in tables in Appendix J.

6.2.4 Miscellaneous Support Equipment

- The Thermal Vacuum Data Acquisition System (TVDS) provided by NASA/GSFC Code 549 which is capable of monitoring and recording data from all T/Cs was used for this test. Measurement resolution was 0.1°C, with 2°C accuracy. If the default time scale is not used, TVDS is also capable of providing temperature printouts at 1, 2, 4, 8, 12, or 24-hour intervals, selectable by the user. In addition, the system shall be capable of plotting all or a selected group of T/Cs, see table C - 6 in APPENDIX C, Thermocouple/PTE listing. Each plot can display up to eight (8) data points; each data point can be an individual T/C or an average of T/Cs. The TTD/TTC shall have one dedicated TVDS workstation with a display terminal and hard copy capability.
- Chamber pressure and temperature data was provided. This data was continuously recorded autonomously by TVDS.
- Mechanical mounting of the ACD was devised by the ACD mechanical lead and Code 549, with approval from the lead thermal engineer. The MGSE supporting the ACD was secured in Chamber 225.
- Chamber electrical feedthroughs were done per GLAST ACD Thermal Vacuum Harness Configuration
- TVDS provided date and time tags (in local time) for thermocouple and test heater data.

6.2.5 Mechanical Test Support Equipment

Equipment to provide structural support for the ACD and additional miscellaneous functions was required. All mechanical ground support equipment (MGSE) used to lift, hold, or support ACD and the test fixturing was subjected to a stress and stability analysis. These items are listed in Table 6.2.5.

Table 6.2.5 - Mechanical Ground Support Equipment

ITEM	PURPOSE
2” Plate	To support Belly Band, GASU and GCP, Adapter plate and ACD Flight unit
Adapter Plate	To support Tracker Simulator

6.2.6 Ground System

All test thermocouples were read through the facilities TVDS system. All flight sensors were read through the ACD team’s EGSE system.

6.2.7 Test Blankets

Test blankets are an important part of the ACD instrument test set-up. Test blankets:

- Close out the view from critical surfaces to heater plates
- Minimize GSE heater power requirements and gradients
- Protect cables and aid in Zero Q of cables
- Interface test blankets with flight blankets

Figure G-2 of appendix G shows the GASU/GASU cold plate. These multi-layer blankets cover the GASU as well as the GCP effectively isolating the radiative coupling between the GASU, its GCP and the surrounding environment.

Figure G-3 of appendix G shows the Belly Band. These multi-layer blankets cover the inside surfaces of the belly band where the piping is located. This is done to radiatively isolate the inside of the belly band from the surrounding environment.

Figure G-1 of appendix G shows the 2-inch plate. These multi-layer blankets cover the top surfaces of the 2-inch plate where all the GSE and the ACD mount. This is done to radiatively isolate the 2-inch plate from the GSE and ACD instrument.

The flight blankets have a (Germanium Black Kapton) GBK outer layer. No flight blankets are used during this test.

6.2.8 Thermal Isolation

The MGSE isolation schematic is pictured in figure 6.2.8. Cold plates were isolated from their supports to facilitate individual control and minimize heater power. The ACD was mounted to the GSE at the 8 flight locations. There were G-10 isolators at all 8 points to isolate the ACD from the GSE. All of these isolators have mechanical drawings detailing their size and shape. There were also G-10 spacers between the GASU GSE and the 2-inch plate. There was no isolation between the heater panel and its support structure.

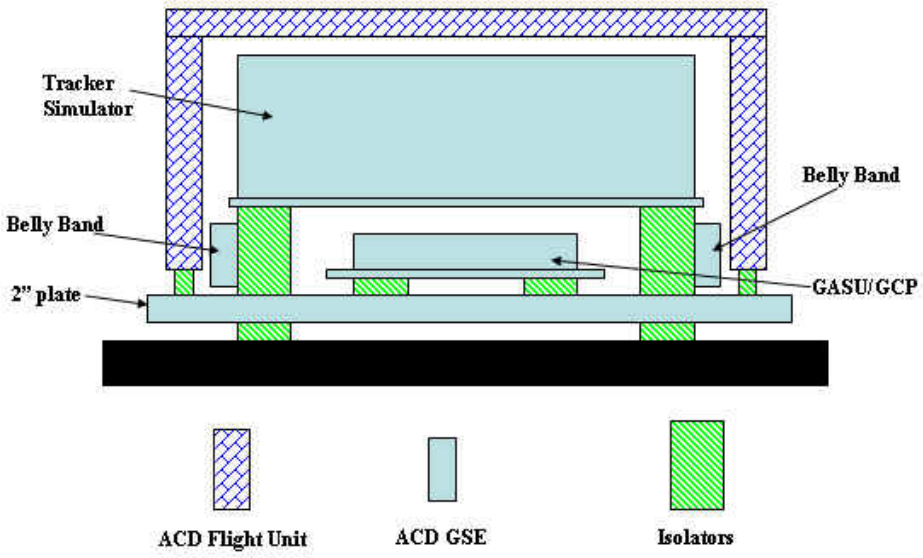
6.3 Electrical GSE:

The ACD is electrically connected to and controlled by the GASU. The GASU is a flight like electronics box provided by Stanford Linear Accelerator Center (SLAC). The Ground Test System used to generate Commands process telemetry is the PC based G3 system also provided by SLAC. Test Scripts utilized in the Thermal-Vacuum test of the ACD were generated by GSFC and posted on the CVS Repository at SLAC. Test cables between the ACD and GASU, utilized in the ACD test, were built by GSFC based on the SLAC flight drawings and were electrically similar to the flight design . A diagram of the Electrical test configuration is in appendix L.

Additionally the ACD has a flight Instrumentation system for thermal monitoring. GSFC developed a PC based Thermal monitoring instrument that monitored and recorded all

readouts from the Flight Instrumentation Harness. The Thermistors and PRTs associated with this are described in Appendix B table B-1.

Figure 6.2.8 ACD MGSE Isolation Schematic



7 INSTRUMENTATION

7.1 Temperature Sensors

All critical flight and test sensors (defined by Code 545) must have well defined red and yellow temperature limits for the operational and non-operational modes (Appendix D Table D-1, and Table C-6 of Appendix C). The red limits are those temperatures beyond which the thermal sensors must not go. (The red limit is defined as the most extreme temperatures that the component has ever seen in its test program.) Action must be taken so that the red limit is not exceeded. The yellow limits are defined as temperatures that are inside of the red limits. (Ideally, the limits conform to the following flow: first comes the expected or operational test temperature; next at the upper and lower limits of the design range comes the yellow limit; and finally, at a temperature 10 ºC above and below the design range is the red limit. However, there may be a few specific exceptions whereby the red limits are less than 10 °C beyond the operational temperatures.) When the yellow limits are attained, test personnel are alerted that extra caution must now be exercised so that the red limits are not exceeded. The thermal sensor readings (both flight and test) shall be alarmed (visually and/or audibly) to aid the test personnel in identifying when the yellow limits have been reached. The red and yellow limits are identified for each thermal sensor in Tables B-1, C-6, and D-1.

7.1.1 Thermocouples

Thermocouples were installed on the ACD instrument and GSE as listed in Appendix C, and as shown in the mechanical drawings and sketches shown in Appendix C. All thermocouples were installed and laced out prior to installation in the chamber. The

proper performance of each T/C was verified prior to ACD test thermal blanket installation and fly-away instrumentation prior to MMS installation.

Some test sensors were located next to flight thermal sensors to "calibrate" those sensors through the telemetry system. Each test heater had a thermocouple for a control sensor. Zero Q heater circuits had two thermocouples for control. All test thermocouples were reviewed for criticality so that all critical sensors had redundant sensors installed on ACD. Thus the loss of a critical sensor wouldn't have compromise the test. The figures in Appendix C show the locations of all the test sensors for the GSE and instrument.

7.1.2 Thermistors

All thermistors are flight units. There are 44 total instrument flight thermistors and fly-away temperature sensors. Details of the thermistors are provided in Appendix B. Thermistor read-out data was provided by the cognizant Functional Test Conductor and recorded by the Thermal Test Conductor. The instrument thermistor data and test thermocouple data was displayed and recorded simultaneously. Limits for flight thermistors are given in table B-1**.**

7.2 Test Heaters

Appendix J contains the heater listing and rack assignments that were used for the test. Appendix C, figure C-5 shows the locations. The types of test heaters and their applications are as follows:

7.2.1 Temperature controlled heaters

Temperature controlled heaters use a temperature sensor near the heater to allow the controller to maintain a desired temperature by switching the heater on and off. The power supplied to the heater can also be controlled as for the flux-controlled heaters or proportionally controlled heaters. They are used when it is desirable to maintain a piece of equipment at a known temperature. These heaters are used to help achieve thermal balance, achieve thermal vacuum soak goals, thermally protect hardware and to speed-up hot transitions.

8 SUMMARY AND RECOMMENDATIONS

8.1 Thermal Summary:

The ACD subsystem has been tested to the specified and pre-determined levels through the 4.5 thermal vacuum cycles to hot and cold temperature extremes. The hot and cold soak parameters as well as the ACD flight hardware temperature transition rates were monitored during the test via the 100+ thermocouples and 44 flight and fly-away temperature sensors. All soak times were a minimum of 4 hours. Less than 5% of the test telemetry failed during the test, none of which was identified as a critical sensor for

testing purposes. These failed sensors are listed in Table C-6 in appendix C, thermocouple/PTE listing. 8 hour temperature plots were printed for the length of the test, as well as a snapshot of temperatures when soak was declared.
The flight telemetry data during the test was correlated on numerous occasions with corresponding test sensors. This data correlated within 2 °C during soaks, plateaus and functional testing.
There was one flight sensor anomaly during the ACD thermal vacuum test. The sensor read out bad temperature data during the early stages of the test. The sensor seemed to correct itself as testing went on, and didn't show another bad reading for the remainder of the test. The sensor was identified as a non-critical sensor due to the fact that a redundant temperature sensor exists and soon after the bad reading the sensor returned to a correct temperature reading. The sensor has been examined post test but there is no corrective action to take. This sensor is identified in appendix B, table B-1 ACD Flight Temperature sensors.

8.2 Electrical Summary:

During the ACD Thermal Vacuum Test several procedures were ran at different plateaus of the test. There were 5 hot soaks at 35 degrees C, 4 cold soaks at -25 degrees C, 2 nominal operational soaks at 0 degrees C, 2 ambient soaks at 23 degrees C, 1 cold survival at -30 degrees C, and 2 hot survivals at 40 degrees C. These tests were performed using the thermal vacuum WOA, ACD-INT-02334.

One or more of the following procedures were run during the beginning or ending of each soak: GLAST LAT ACD Comprehensive Performance Test Procedure (ACD-Proc-000270), GLAST LAT ACD Comprehensive Margin Performance Test Procedure (ACD-Proc-000352), ACD-Monitor Operational Test Procedure (ACD-Proc-000346) and additional Triggered Ops runs as required by scientist. From the ACD-Plan-00347, when the ACD TV Test Profile specified functional test, the CPT 270 procedure was performed with a re-run of AcdHldCal script. Also, when the CPT was specified in the profile, CPT 270 with a re-run of AcdHldCal script and Margin CPT 352 were performed.

There were no tests required at hot soak 1. At hot soaks 2 and 3 the CPT procedure 270 was performed. At hot soak 4 the CPT procedure 270 and 352 were performed. The free cal version was modified prior to re-run of hot soak 5 testing which updated 3.6V, 40 degrees C data. At hot soak 5 there was a re-run of CPT 270 section 6.0, Triggered Op and CPT 352 section 5.2, 3.6 margin test. At cold soaks 1, 2 and 3 the CPT procedure 270 was performed. At cold soak 4 the CPT procedures 270 and 352 were performed. CPT 270 was performed at both operational and ambient soaks. After the cold survival the init current script was used to turn on the ACD at -25 degrees C. There was no power on performed after hot survival. During thermal transitions starting after hot soak 2, the Procedure 346 was ran to monitor the rates. For specific details refer to the thermal vacuum WOA.

The following scripts failed during thermal vacuum testing: AcdInitPower, AcdHldCal, AcdTciHighRange, AcdTciRegRange, AcdVetoHitmapPha, AcdGafeNoise, and AcdVetoCal. All Problem Reports were closed except the following: AcdVetoHitmap and AcdHldCal. For specific details refer to the NASA GPRs problem reporting system.

All thermal vacuum testing was completed on August 3, 2005. The tests procedures 270, 352 and 346 were performed when specified. After scientific evaluation of the data, the thermal vacuum testing was declared a success.

8.3 Contamination Summary:

8.3.1 TQCM Data

The TQCM data was the primary contamination requirement for the bakeout/certification portion of the ACD thermal vacuum test. Two TQCMs were used in the thermal vacuum chamber to characterize the outgassing of the ACD materials. One TQCM was place within the enclosure of the ACD(TQCM #2) while the other TQCM was place outside the ACD with ACD completely filling the field of view of the TQCM(TQCM #1). The final day of the TQCM raw data is included in the appendix of this report.

TQCM #1 was the primary TQCM for this test. The external outgassing of the ACD was the driving requirement as this outgassing could contaminate other observatory contamination sensitive surfaces. The certification requirement for this TQCM was 610 Hz/hr for five consecutive hours. As the raw data indicates, this TQCM met this requirement by more than an order of magnitude. The final accumulation rate was 38 Hz/hr. This meets the certification requirements for this test.

TQCM #2 was a secondary TQCM placed inside the ACD enclosure for contamination information purposes. As this TQCM was a 10 MHz rather than the 15 MHz TQCM used as #1, the certification requirement is different. This requirement was 270 Hz/hr on this TQCM. This rate was not successfully met during this test. It was necessary to place this TQCM blindly within the enclosure due to the setup of the hardware and blanketing. It was determined after the test that this TQCM was placed within a small enclosed space inside the enclosure and then sealed in this space. This did not allow the contaminants within this space to adequately vent to the chamber.

When the TQCM rate is calculated, it assumes free flow of molecular contaminants within the chamber. This sealed enclosure causes the accumulation rate to be much higher than expected for the given outgassing rate. Since outgassing rate is the real data we are trying to collect, the test setup makes the data for this TQCM not a good measure of this rate. As this TQCM was for information purposes only and was not adequately measuring the desired test data, the information from this TQCM was not used to evaluate bakeout success criteria.

8.3.2 Cold Finger and Scavenger Plate

A cold finger and scavenger plate were used to monitor the condensable contamination species present during the thermal vacuum test. The cold finger collects material at the end of the test(post bakeout) for eight hours only. The scavenger plate collects material for the entire duration of the test. After completion of the test the cold finger and scavenger plate are solvent rinsed to accumulate and analyze the collected materials. The analysis report for these two samples is enclosed in the appendix of this report.

The analysis of these samples indicates .72 mg of collected material from the cold finger and 89.73 mg of collected material from the scavenger plate. These rates of accumulation meet the contamination requirements of this test. The species collected are also what would be expected from the materials used in constructing the ACD hardware.

APPENDIX A: ACRONYMS AND ABBREVIATIONS

ACD	Anticoincidence Detector
AR	Anomaly Report
AT	Acceptance Temperature
BEA	Base Electronics Assembly
CC	Contamination Control
CCE	Contamination Control Engineer
EGSE	Electrical Ground Support Equipment
ESD	Electro-Static Discharge
ETU	Engineering Test Unit
FT	Functional Test
GCP	GASU Cold Plate
GLAST	Gamma-ray Large Area Space Telescope
GN2	Gaseous Nitrogen
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HVBS	High Voltage Bias Supply
LAT	Large Area Telescope
LN2	Liquid Nitrogen
MGSE	Mechanical Ground Support Equipment
MLI	Multi-Layer Insulation
MMS	Micro-Meteoroid Shield
N/A	Not applicable
NASA	National Aeronautics and Space Administration
NCR	Non-Compliance Report
PMT	Photomultiplier Tube
QAE	Quality Assurance Engineer
QT	Qualification Temperature
ST	Short Functional Test
TD	Test Director
TE	Test Engineer
TC	Thermocouple
T/C	Thermocouple
TQCM	Thermoelectric Quartz Crystal Microbalance
TRR	Test Readiness Review
TTC	Thermal Test Conductor
TTM	Thermal Test Monitor
TV	Thermal Vacuum
T/V	Thermal Vacuum
TVTE	Thermal Vacuum Test Engineer

APPENDIX B: FLIGHT AND FLY-AWAY TEMPERATURE SENSORS AND LOCATIONS

TABLE B-1 – ACD Flight Temperature Sensors

Sensor Name	Sensor Description	Sensor Type	Pin No.	Temperature Limits				Rate Limit
				Red Lo	Yel Lo	Yel Hi	Red Hi	(C/hr)
XM_PMT_1L_P			1					
XM_PMT_1L_P_RET	-X PMT Rail, Left, Primary	Thermistor	2	-30	-25	40	45	10
XM_PMT_1L_S			3					
XM_PMT_1L_S_RET	-X PMT Rail, Left, Secondary	Thermistor	4	-30	-25	40	45	10
YM_PMT_2L_P			5					
YM_PMT_2L_P_RET	-Y PMT Rail, Left, Primary	Thermistor	6	-30	-25	40	45	10
YM_PMT_2L_S			7					
YM_PMT_2L_S_RET	-Y PMT Rail, Left, Secondary	Thermistor	8	-30	-25	40	45	10
XP_PMT_3L_P			9					
XP_PMT_3L_P_RET	+X PMT Rail, Left, Primary	Thermistor	10	-30	-25	40	45	10
XP_PMT_3L_S			11					
XP_PMT_3L_S_RET	+X PMT Rail, Left, Secondary	Thermistor	12	-30	-25	40	45	10
YP_PMT_4L_P			13					
YP_PMT_4L_P_RET	+Y PMT Rail, Left, Primary	Thermistor	14	-30	-25	40	45	10
YP_PMT_4L_S			15					
YP_PMT_4L_S_RET	+Y PMT Rail, Left, Secondary	Thermistor	16	-30	-25	40	45	10
XP_O_SHELL_P			17					
XP_O_SHELL_P_RET	+X, Outside Composite Shell, Primary	PRT	18	-50	-40	45	50	30
XP_O_SHELL_S			19					
XP_O_SHELL_S_RET	+X, Outside Composite Shell, Secondary	PRT	20	-50	-40	45	50	30
XM_O_SHELL_P			21					
XM_O_SHELL_P_RET	-X Outside Composite Shell, Primary	PRT	22	-50	-40	45	50	30
XM_O_SHELL_S			23					
XM_O_SHELL_S_RET	-X Outside Composite Shell, Secondary	PRT	24	-50	-40	45	50	30
YP_GRID_IF_P			25					
YP_GRID_IF_P_RET	+Y, BEA/Grid Interface, Primary	Thermistor	26	-30	-25	40	45	30
YP_GRID_IF_S			27					
YP_GRID_IF_S_RET	+Y, BEA/Grid Interface, Secondary	Thermistor	28	-30	-25	40	45	30
YM_GRID_IF_P			29					
YM_GRID_IF_P_RET	-Y, BEA/Grid Interface, Primary	Thermistor	30	-30	-25	40	45	30
YM_GRID_IF_S			31					
YM_GRID_IF_S_RET	-Y, BEA/Grid Interface, Secondary	Thermistor	32	-30	-25	40	45	30
XP_TILE_P			1					
XP_TILE_P_RET	+X Tile, Primary	PRT	2	-50	-40	45	50	30
XP_TILE_S			4					
XP_TILE_S_RET	+X Tile, Secondary	PRT	5	-50	-40	45	50	30
XM_TILE_P			6					
XM_TILE_P_RET	-X Tile, Primary	PRT	7	-50	-40	45	50	30
XM_TILE_S	-X Tile, Secondary	PRT	8	-50	-40	45	50	30

XM_TILE_S_RET			9					
YP_TILE_P			10					
YP_TILE_P_RET	+Y Tile, Primary	PRT	11	-50	-40	45	50	30
YP_TILE_S			12					
YP_TILE_S_RET	+Y Tile, Secondary	PRT	13	-50	-40	45	50	30
YM_TILE_P			14					
YM_TILE_P_RET	-Y Tile, Primary	PRT	15	-50	-40	45	50	30
YM_TILE_S			17					
YM_TILE_S_RET	-Y Tile, Secondary	PRT	18	-50	-40	45	50	30
ZP_TILE_P			19					
ZP_TILE_P_RET	+Z Tile, Primary	PRT	20	-50	-40	45	50	30
ZP_TILE_S			21					
ZP_TILE_S_RET	+Z Tile, Secondary	PRT	22	-50	-40	45	50	30
XP_IN_SHELL_P			23					
XP_IN_SHELL_P_RET	+X Inside Composite Shell, Primary	Thermistor	24	-50	-40	45	50	30
XP_SHELL_S			26					
XP_SHELL_S_RET	+X Inside Composite Shell, Secondary	Thermistor	27	-50	-40	45	50	30
XM_IN_SHELL_P			28					
XM_IN_SHELL_P_RET	-X Inside Composite Shell, Primary	Thermistor	29	-50	-40	45	50	30
XM_IN_SHELL_S			30					
XM_IN_SHELL_S_RET	-X Inside Composite Shell, Secondary	Thermistor	31	-50	-40	45	50	30
YP_IN_SHELL_P			32					
YP_IN_SHELL_P_RET	+Y Inside Composite Shell, Primary	Thermistor	33	-50	-40	45	50	30
YP_IN_SHELL_S	+Y Inside Composite Shell, Secondary		34					
YP_IN_SHELL_S_RET		Thermistor	35	-50	-40	45	50	30
YM_IN_SHELL_P			36					
YM_IN_SHELL_P_RET	-Y Inside Composite Shell, Primary	Thermistor	37	-50	-40	45	50	30
YM_IN_SHELL_S			38					
YM_IN_SHELL_S_RET	-Y Inside Composite Shell, Secondary	Thermistor	39	-50	-40	45	50	30
ZP_IN_SHELL_P			40					
ZP_IN_SHELL_P_RET	+Z Inside Composite Shell, Primary	Thermistor	41	-50	-40	45	50	30
ZP_IN_SHELL_S			43					
ZP_IN_SHELL_S_RET	+Z Inside Composite Shell, Secondary	Thermistor	44	-50	-40	45	50	30
XM_PMT_1R_P			45					
XM_PMT_1R_P_RET	-X PMT Rail, Right, Primary	Thermistor	46	-30	-25	40	45	10
XM_PMT_1R_S			47					
XM_PMT_1R_S_RET	-X PMT Rail, Right, Secondary	Thermistor	48	-30	-25	40	45	10
YM_PMT_2R_P			49					
YM_PMT_2R_P_RET	-Y PMT Rail, Right, Primary	Thermistor	50	-30	-25	40	45	10
YM_PMT_2R_S			52					
YM_PMT_2R_S_RET	-Y PMT Rail, Right, Secondary	Thermistor	53	-30	-25	40	45	10
XP_PMT_3R_P			54					
XP_PMT_3R_P_RET	+X PMT Rail, Right, Primary	Thermistor	55	-30	-25	40	45	10

XP_PMT_3R_S			56					
XP_PMT_3R_S_RET	+X PMT Rail, Right, Secondary	Thermistor	57	-30	-25	40	45	10
YP_PMT_4R_P			58					
YP_PMT_4R_P_RET	+Y PMT Rail, Right, Primary	Thermistor	59	-30	-25	40	45	10
YP_PMT_4R_S			60					
YP_PMT_4R_S_RET	+Y PMT Rail, Right, Secondary	Thermistor	61	-30	-25	40	45	10

APPENDIX C: GSE THERMAL INSTRUMENTATION AND ACD TEST TC INSTRUMENTATION

TABLE C-1 - Thermocouples for ACD TV Testing		
Test Article	**TC Locations**	# of TCs
2" Plate	1 TC located on the +Z face of the plate on all 4 sides (+X,-X,+Y,-Y)	4
GASU	2 TCs located centrally on 5 faces (+X,-X,+Y,-Y,+Z)	10
GASU Cold Plate	2 TCs located on the +Z face of the plate on 4 sides around GASU (+X,-X,+Y,-Y)	4
Belly Band	2 TCs located centrally on inside of belly band behind each chassis	8
BEA	2 TCs located on each Chassis Rail	8

TC locations on 2” plate

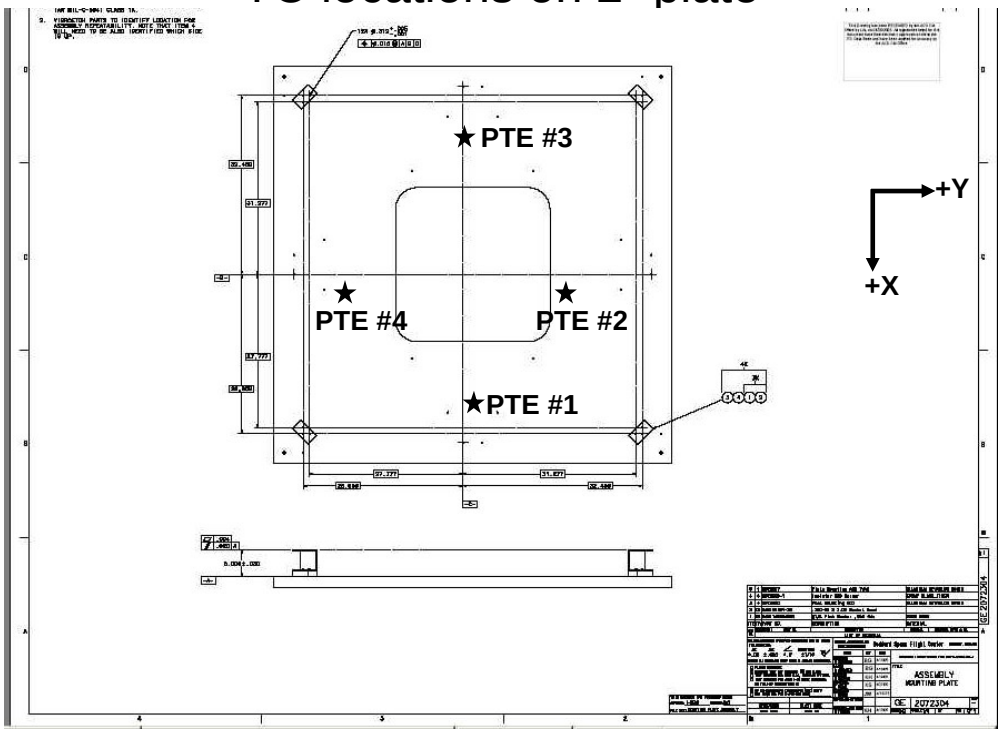


Figure C-2 - 2" Plate Thermocouples

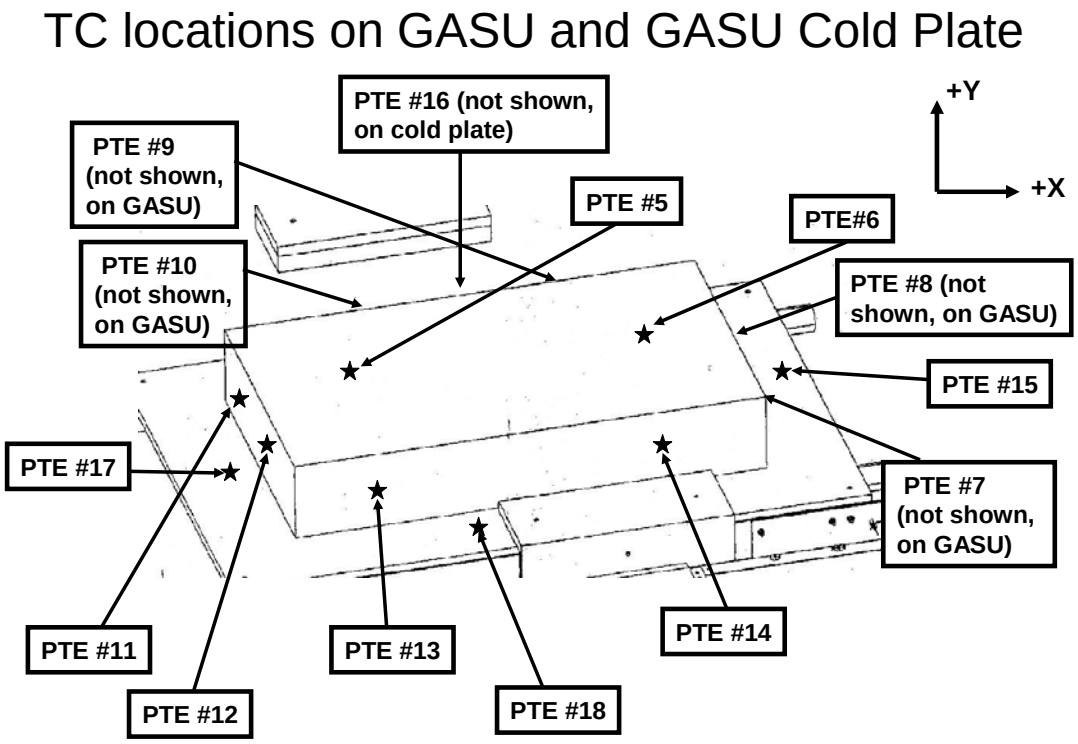


Figure C - 3 GASU and GASU Cold Plate Thermocouples

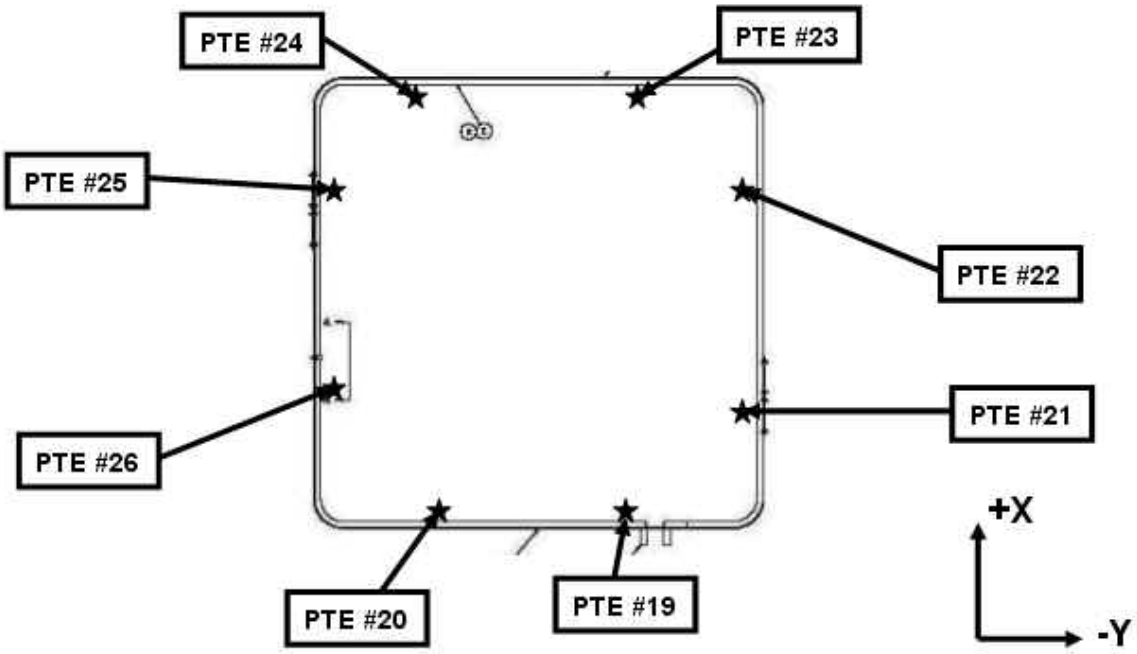


Figure C - 4 Belly Band Thermocouples

	L	Mid	R		L	Mid	R
+X (Zone 1)	PTE 73	PTE 74	PTE 75	**+X (Zone 2)**	PTE 76	PTE 77	PTE 78
+Y (Zone 3)	PTE 79	PTE 80	PTE 81	**+Y (Zone 4)**	PTE 82	PTE 83	PTE 84
-X (Zone 5)	PTE 85	PTE 86	PTE 87	**-X (Zone 6)**	PTE 88	PTE 89	PTE 90
-Y (Zone 7)	PTE 91	PTE 92	PTE 93	**-Y (Zone 8)**	PTE 94	PTE 95	PTE 96
+Z (Zone 9)	PTE 97	PTE 98	PTE 99	**+Z (Zone 10)**	PTE 100	PTE 101	PTE 102

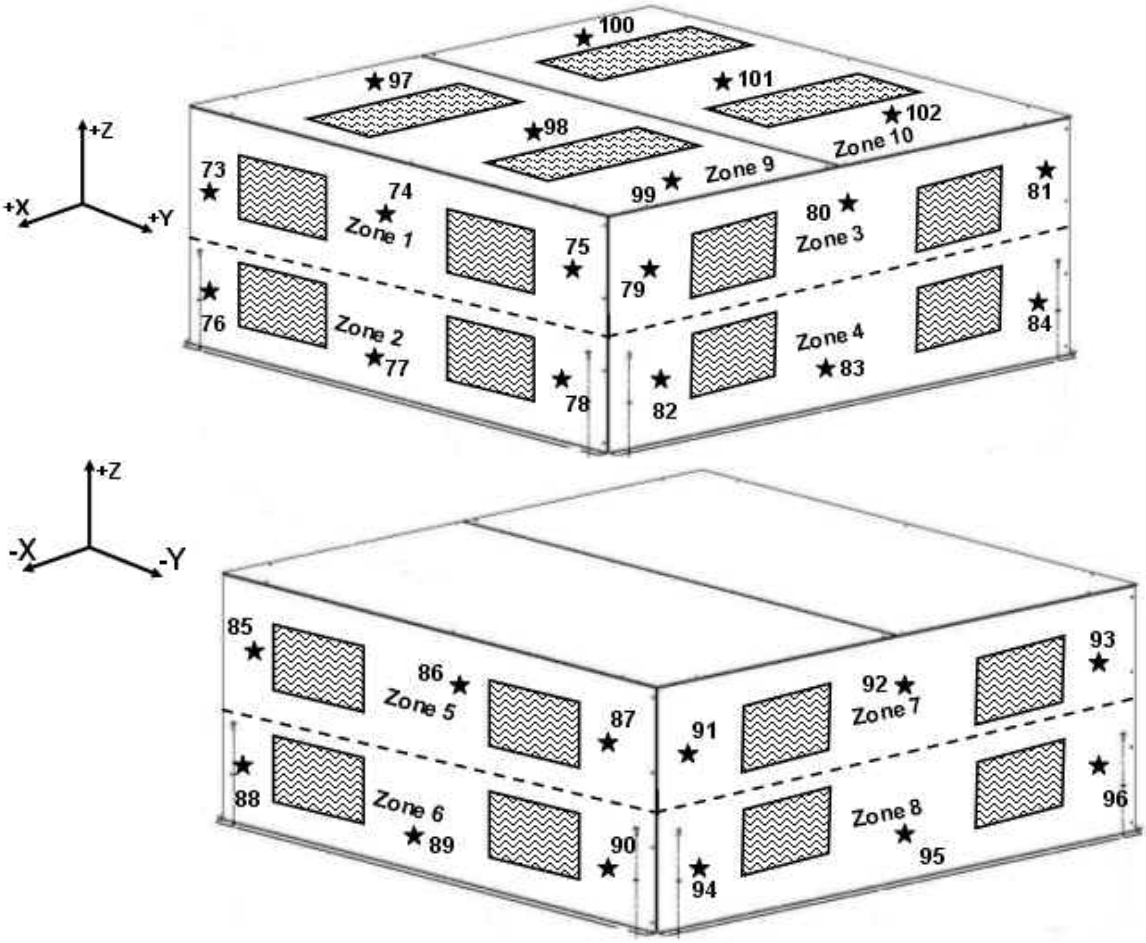
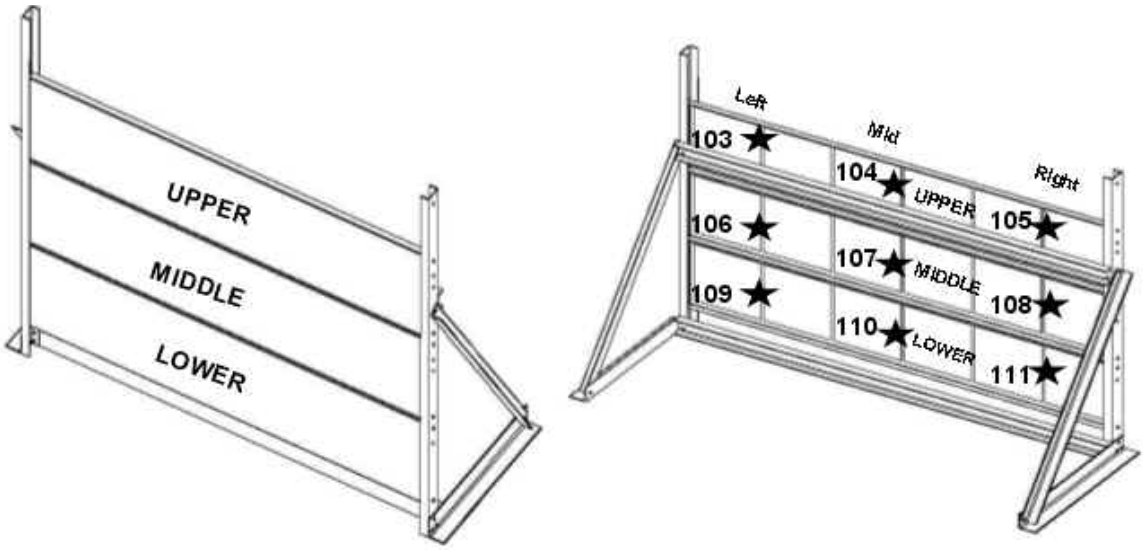


Figure C-5 - Tracker Simulator



Upper 1	PTE 103	**Upper 2**	PTE 104	**Upper 3**	PTE 105
Middle 1	PTE 106	**Middle 2**	PTE 107	**Middle 3**	PTE 108
Lower 1	PTE 109	**Lower 2**	PTE 110	**Lower 3**	PTE 111

Figure C - 6 (+X) Heater Panel

IN TABLE C-6 PTE#'S 55-69 ARE FLY-AWAY SENSORS.

Table C - 6 Thermocouple/PTE listing

PTE No.	Conn No.	Sensor Type	Location Description	Operating Limits				Non-Operating Limits				Rate Limit
				Red Lo	Yel Lo	Yel Hi	Red Hi	Red Lo	Yel Lo	Yel Hi	Red Hi	(C/hr)
1	1	TC	NEG X 2 INCH PLATE	-50	-40	45	50	-50	-40	45	50	30
2	1	TC	NEG Y 2 INCH PLATE	-50	-40	45	50	-50	-40	45	50	30
3	1	TC	POS X 2 INCH PLATE	-50	-40	45	50	-50	-40	45	50	30
4	1	TC	POS Y 2 INCH PLATE	-50	-40	45	50	-50	-40	45	50	30
5	1	TC	POS Z GASU #1	10	15	30	35	10	15	30	35	30
6	1	TC	POS Z GASU #2	10	15	30	35	10	15	30	35	30
7	1	TC	NEG X GASU #1	10	15	30	35	10	15	30	35	30
8	1	TC	NEG X GASU #2	10	15	30	35	10	15	30	35	30
9	1	TC	NEG Y GASU #1	10	15	30	35	10	15	30	35	30
10	1	TC	NEG Y GASU #2 **(Failed during test, non critical)**	10	15	30	35	10	15	30	35	30
11	1	TC	POS X GASU #1	10	15	30	35	10	15	30	35	30
12	1	TC	POS X GASU #2	10	15	30	35	10	15	30	35	30
13	1	TC	POS Y GASU #1	10	15	30	35	10	15	30	35	30
14	1	TC	POS Y GASU #2	10	15	30	35	10	15	30	35	30
15	1	TC	NEG X GASU COLD PLATE	0	10	40	50	0	10	40	50	30
16	1	TC	NEG Y GASU COLD PLATE	0	10	40	50	0	10	40	50	30
17	1	TC	POS X GASU COLD PLATE	0	10	40	50	0	10	40	50	30
18	1	TC	POS Y GASU COLD PLATE	0	10	40	50	0	10	40	50	30
19	2	TC	NEG X, NEG Y BELLY BAND	NA	NA	NA	NA	NA	NA	NA	NA	NA
20	2	TC	NEG X, POS Y BELLY BAND	NA	NA	NA	NA	NA	NA	NA	NA	NA
21	2	TC	NEG Y, NEG X BELLY BAND	NA	NA	NA	NA	NA	NA	NA	NA	NA
22	2	TC	NEG Y, POS X BELLY BAND	NA	NA	NA	NA	NA	NA	NA	NA	NA
23	2	TC	POS X, NEG Y BELLY BAND	NA	NA	NA	NA	NA	NA	NA	NA	NA
24	2	TC	POS X, POS Y BELLY BAND	NA	NA	NA	NA	NA	NA	NA	NA	NA
25	2	TC	POS Y, POS X BELLY BAND	NA	NA	NA	NA	NA	NA	NA	NA	NA
26	2	TC	POS Y, NEG X BELLY BAND	NA	NA	NA	NA	NA	NA	NA	NA	NA
27	2	TC	POS X 4x4 COLDPLATE	NA	NA	NA	NA	NA	NA	NA	NA	NA

28	2	TC	NEG X 4x4 COLDPLATE	NA	NA	NA	NA	NA	NA	NA	NA	NA
29	2	TC	POS Y 4x4 COLDPLATE	NA	NA	NA	NA	NA	NA	NA	NA	NA
30	2	TC	NEG Y 4x4 COLDPLATE	NA	NA	NA	NA	NA	NA	NA	NA	NA
31	2	TC	POS Z INSIDE TSA	-50	-40	45	50	-50	-40	45	50	30
32	2	TC	POS X INSIDE TSA	-50	-40	45	50	-50	-40	45	50	30
33	2	TC	POS Y INSIDE TSA	-50	-40	45	50	-50	-40	45	50	30
34	2	TC	NEG X INSIDE TSA	-50	-40	45	50	-50	-40	45	50	30
35	2	TC	NEG Y INSIDE TSA	-50	-40	45	50	-50	-40	45	50	30
36	2	TC										
37	3	TC	POS X CHASIS 3L #1	-35	-30	40	45	-35	-30	40	45	10
38	3	TC	POS X CHASIS 3L #2	-35	-30	40	45	-35	-30	40	45	10
39	3	TC	POS X CHASIS 3R #1	-35	-30	40	45	-35	-30	40	45	10
40	3	TC	POS X CHASIS 3R #2	-35	-30	40	45	-35	-30	40	45	10
41	3	TC	POS Y CHASIS 4L #1	-35	-30	40	45	-35	-30	40	45	10
42	3	TC	POS Y CHASIS 4L #2	-35	-30	40	45	-35	-30	40	45	10
43	3	TC	POS Y CHASIS 4R #1	-35	-30	40	45	-35	-30	40	45	10
44	3	TC	POS Y CHASIS 4R #2	-35	-30	40	45	-35	-30	40	45	10
45	3	TC	NEG X CHASIS 1L #1	-35	-30	40	45	-35	-30	40	45	10
46	3	TC	NEG X CHASIS 1L #2	-35	-30	40	45	-35	-30	40	45	10
47	3	TC	NEG X CHASIS 1R #1	-35	-30	40	45	-35	-30	40	45	10
48	3	TC	NEG X CHASIS 1R #2	-35	-30	40	45	-35	-30	40	45	10
49	3	TC	NEG Y CHASIS 2L #1	-35	-30	40	45	-35	-30	40	45	10
50	3	TC	NEG Y CHASIS 2L #2	-35	-30	40	45	-35	-30	40	45	10
51	3	TC	**(moved to 53)**									
52	3	TC	NEG Y CHASIS 2R #2	-35	-30	40	45	-35	-30	40	45	10
53	3	TC	NEG Y CHASIS 2R #1	-35	-30	40	45	-35	-30	40	45	10
54	3	TC										
55	***4***	***TC***	***POS Z CENTER TILE(022)***	***-50***	***-40***	***45***	***50***	***-50***	***-40***	***45***	***50***	***30***
56	***4***	***TC***	***POS X CENTER TILE (312)***	***-50***	***-40***	***45***	***50***	***-50***	***-40***	***45***	***50***	***30***
57	***4***	***TC***	***POS Y CENTER TILE (412)***	***-50***	***-40***	***45***	***50***	***-50***	***-40***	***45***	***50***	***30***

58	***4***	***TC***	***NEG X CENTER TILE (112)***	***-50***	***-40***	***45***	***50***	***-50***	***-40***	***45***	***50***	***30***
59	***4***	***TC***	***NEG Y CENTER TILE (212)***	***-50***	***-40***	***45***	***50***	***-50***	***-40***	***45***	***50***	***30***
60	***4***	***TC***	***P X, N Y LC UNDER TILE 320***	***-50***	***-40***	***45***	***50***	***-50***	***-40***	***45***	***50***	***30***
61	***4***	***TC***	***P X, N Y UC UNDER TILE 300***	***-50***	***-40***	***45***	***50***	***-50***	***-40***	***45***	***50***	***30***
62	***4***	***TC***	***P X, P Y UC UNDER TILE 304***	***-50***	***-40***	***45***	***50***	***-50***	***-40***	***45***	***50***	***30***
63	***4***	***TC***	***P Y, P X LC UNDER TILE 424***	***-50***	***-40***	***45***	***50***	***-50***	***-40***	***45***	***50***	***30***
64	***4***	***TC***	***P Y , P X LC TILE 424 FLEXURE***	***-50***	***-40***	***45***	***50***	***-50***	***-40***	***45***	***50***	***30***
65	***4***	***TC***	***N X P Y LC UNDER TILE 124***	***-50***	***-40***	***45***	***50***	***-50***	***-40***	***45***	***50***	***30***
66	***4***	***TC***	***N X, P Y UC UNDER TILE 104***	***-50***	***-40***	***45***	***50***	***-50***	***-40***	***45***	***50***	***30***
67	***4***	***TC***	***N X, N Y UC UNDER TILE 100***	***-50***	***-40***	***45***	***50***	***-50***	***-40***	***45***	***50***	***30***
68	***4***	***TC***	***N Y, N X LC UNDER TILE 220***	***-50***	***-40***	***45***	***50***	***-50***	***-40***	***45***	***50***	***30***
69	***4***	***TC***	***N Y, N X LC 220 TILE FLEXURE***	***-50***	***-40***	***45***	***50***	***-50***	***-40***	***45***	***50***	***30***
70	4	TC										
71	4	TC										
72	4	TC										
73	5	TC	(+X) LAT Simulator - Zone 1 - Left	NA	NA	NA	NA	NA	NA	NA	NA	NA
74	5	TC	(+X) LAT Simulator - Zone 1 - Mid	NA	NA	NA	NA	NA	NA	NA	NA	NA
75	5	TC	(+X) LAT Simulator - Zone 1 - Right	NA	NA	NA	NA	NA	NA	NA	NA	NA
76	5	TC	(+X) LAT Simulator - Zone 2 - Left	NA	NA	NA	NA	NA	NA	NA	NA	NA
77	5	TC	(+X) LAT Simulator - Zone 2 - Mid	NA	NA	NA	NA	NA	NA	NA	NA	NA
78	5	TC	(+X) LAT Simulator - Zone 2 - Right	NA	NA	NA	NA	NA	NA	NA	NA	NA
79	5	TC	(+Y) LAT Simulator - Zone 3 - Left	NA	NA	NA	NA	NA	NA	NA	NA	NA
80	5	TC	**(moved to 112)**									
81	5	TC	**(moved to 113)**									
82	5	TC	(+Y) LAT Simulator - Zone 4 - Left	NA	NA	NA	NA	NA	NA	NA	NA	NA
83	5	TC	(+Y) LAT Simulator - Zone 4 - Mid	NA	NA	NA	NA	NA	NA	NA	NA	NA
84	5	TC	(+Y) LAT Simulator - Zone 4 - Right	NA	NA	NA	NA	NA	NA	NA	NA	NA
85	5	TC	(-X) LAT Simulator - Zone 5 - Left	NA	NA	NA	NA	NA	NA	NA	NA	NA
86	5	TC	(-X) LAT Simulator - Zone 5 - Mid	NA	NA	NA	NA	NA	NA	NA	NA	NA
87	5	TC	(-X) LAT Simulator - Zone 5 - Right	NA	NA	NA	NA	NA	NA	NA	NA	NA

88	5	TC	(-X) LAT Simulator - Zone 6 - Left	NA	NA	NA	NA	NA	NA	NA	NA	NA
89	5	TC	(-X) LAT Simulator - Zone 6 – Mid **(Failed during test, non-critical)**	NA	NA	NA	NA	NA	NA	NA	NA	NA
90	5	TC	(-X) LAT Simulator - Zone 6 - Right	NA	NA	NA	NA	NA	NA	NA	NA	NA
91	6	TC	(-Y) LAT Simulator - Zone 7 - Left	NA	NA	NA	NA	NA	NA	NA	NA	NA
92	6	TC	(-Y) LAT Simulator - Zone 7 - Mid	NA	NA	NA	NA	NA	NA	NA	NA	NA
93	6	TC	(-Y) LAT Simulator - Zone 7 - Right	NA	NA	NA	NA	NA	NA	NA	NA	NA
94	6	TC	(-Y) LAT Simulator - Zone 8 - Left	NA	NA	NA	NA	NA	NA	NA	NA	NA
95	6	TC	(-Y) LAT Simulator - Zone 8 - Mid	NA	NA	NA	NA	NA	NA	NA	NA	NA
96	6	TC	(-Y) LAT Simulator - Zone 8 - Right	NA	NA	NA	NA	NA	NA	NA	NA	NA
97	6	TC	(+Z) LAT Simulator - Zone 9 - Left	NA	NA	NA	NA	NA	NA	NA	NA	NA
98	6	TC	(+Z) LAT Simulator - Zone 9 - Mid	NA	NA	NA	NA	NA	NA	NA	NA	NA
99	6	TC	(+Z) LAT Simulator - Zone 9 - Right	NA	NA	NA	NA	NA	NA	NA	NA	NA
100	6	TC	(+Z) LAT Simulator - Zone 10 - Left	NA	NA	NA	NA	NA	NA	NA	NA	NA
101	6	TC	(+Z) LAT Simulator - Zone 10 - Mid	NA	NA	NA	NA	NA	NA	NA	NA	NA
102	6	TC	(+Z) LAT Simulator - Zone 10 - Right	NA	NA	NA	NA	NA	NA	NA	NA	NA
103	6	TC	Sun Simulator Upper Panel Left	NA	NA	NA	NA	NA	NA	NA	NA	NA
104	6	TC	Sun Simulator Upper Panel Mid	NA	NA	NA	NA	NA	NA	NA	NA	NA
105	6	TC	Sun Simulator Upper Panel Right	NA	NA	NA	NA	NA	NA	NA	NA	NA
106	6	TC	Sun Simulator Middle Panel Left	NA	NA	NA	NA	NA	NA	NA	NA	NA
107	6	TC	Sun Simulator Middle Panel Mid	NA	NA	NA	NA	NA	NA	NA	NA	NA
108	6	TC	Sun Simulator Middle Panel Right **(Failed during test, non critical)**	NA	NA	NA	NA	NA	NA	NA	NA	NA
109	7	TC	Sun Simulator Lower Panel Left	NA	NA	NA	NA	NA	NA	NA	NA	NA
110	7	TC	Sun Simulator Lower Panel Mid	NA	NA	NA	NA	NA	NA	NA	NA	NA
111	7	TC	Sun Simulator Lower Panel Right	NA	NA	NA	NA	NA	NA	NA	NA	NA
112	7	TC	(+Y) LAT Simulator - Zone 3 - Mid	NA	NA	NA	NA	NA	NA	NA	NA	NA
113	7	TC	(+Y) LAT Simulator - Zone 3 - Right	NA	NA	NA	NA	NA	NA	NA	NA	NA
114	7	TC										

APPENDIX D: THERMAL LIMITS AND QUALIFICATION TABLE

	Cold Conditions		Hot Conditions		Qualification Temps.	
Description	Red Limit	Yellow Limit	Red Limit	Yellow Limit	COLD	HOT
TDAs	-60	-55	45	40	-35	45
Electronics	-40	-35	45	40	-30	40
PMTs	-35	-30	45	40	-30	40

TABLE D-1 –ACD TEST LIMITS AND QUALIFICATION TEMPERATURES

APPENDIX E: THERMAL FLIGHT PREDICTIONS

TABLE E-1 – ACD FLIGHT TEMPERATURE PREDICTIONS

Description	Cold Operating Temperature	Hot Operating Temperature	Cold Survival Temperature	Hot Survival Temperature	Operating Temperature Limits	Survival Temperature Limits
Grid Boundary	-10	20	-15	30	-	-
Trackers Boundary	-10	25	-20	30	-	-
ACD Composite Shell	-13	28	-23	31	-	-
Tile Detector Assembly	-16	32	-25	36	-30 to 35	-60 to 45
Micro-meteroid Shield	-19	37	-28	41	-	-
BEA ±X Rail	-10	23	-20	31	-20 to 35	-40 to 45
BEA ±Y Rail	-9	22	-19	29	-20 to 35	-40 to 45

APPENDIX F: GSE DIAGRAMS

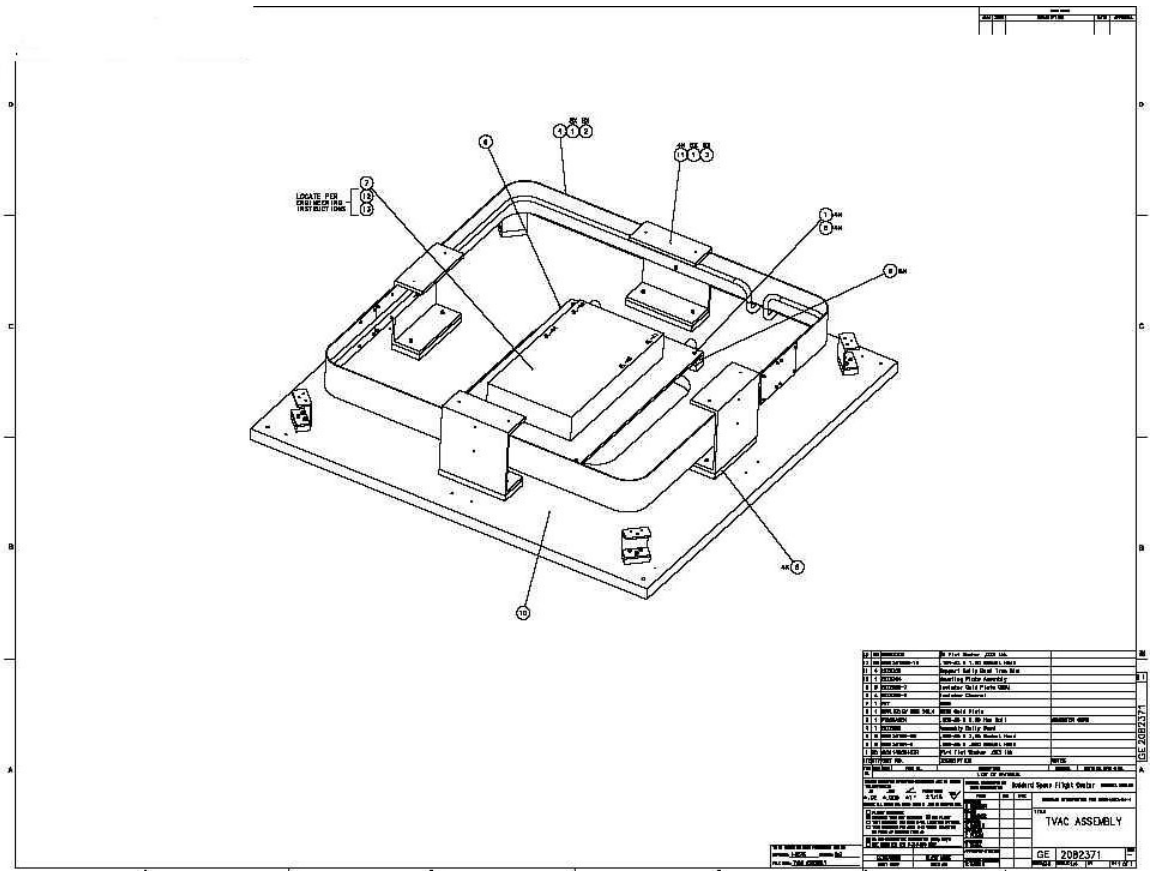


Figure F-1 - GSE - Belly Band, GASU, GASU Cold Plate, 2" Plate

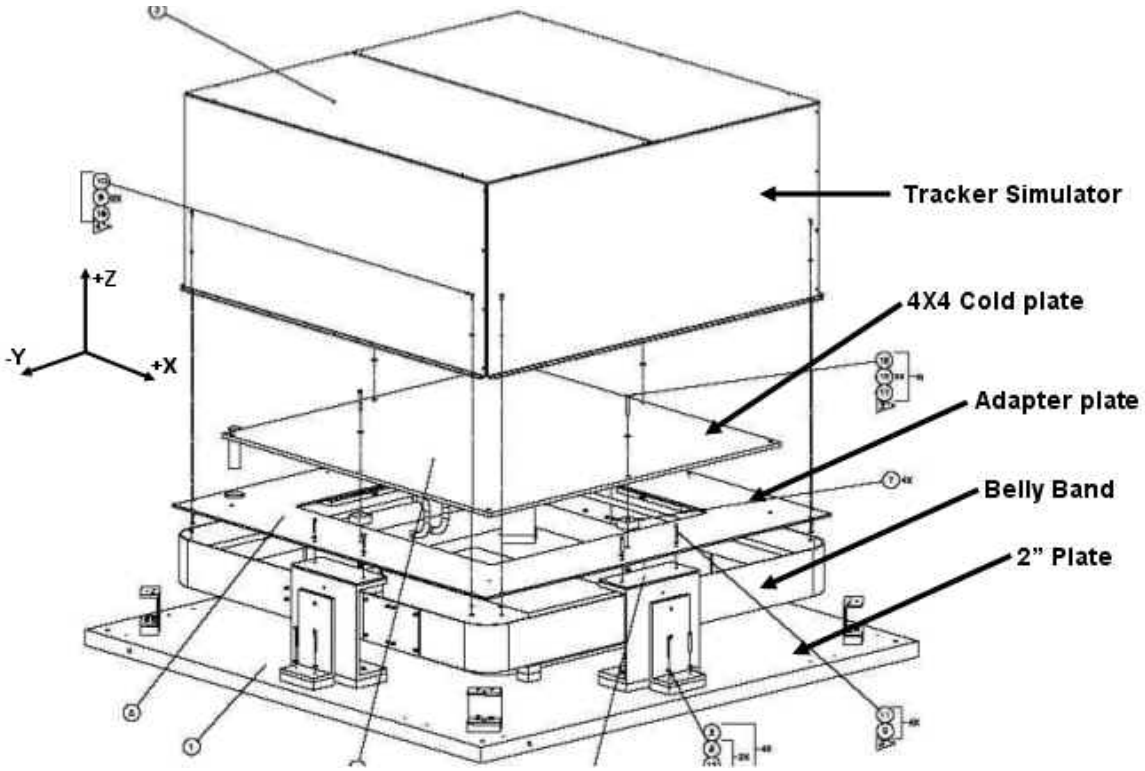


Figure F-2 Tracker Simulator, 4'x4' cold plate, and Adapter Plate

APPENDIX G: TEST BLANKETS

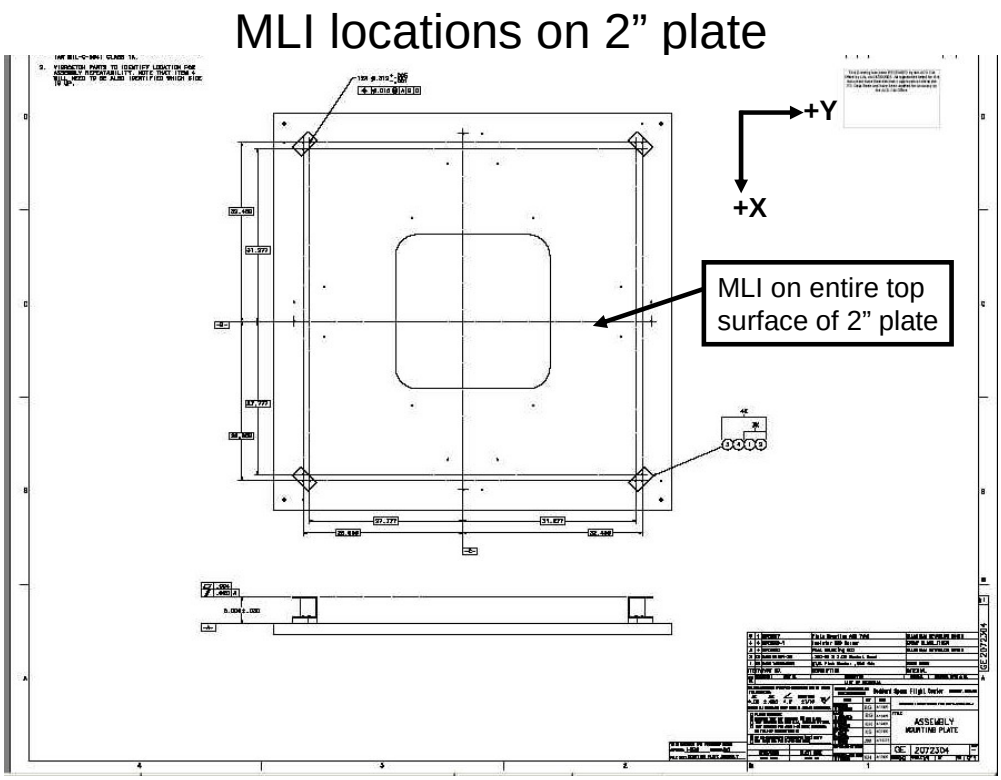


Figure G-1 - 2" Plate MLI locations

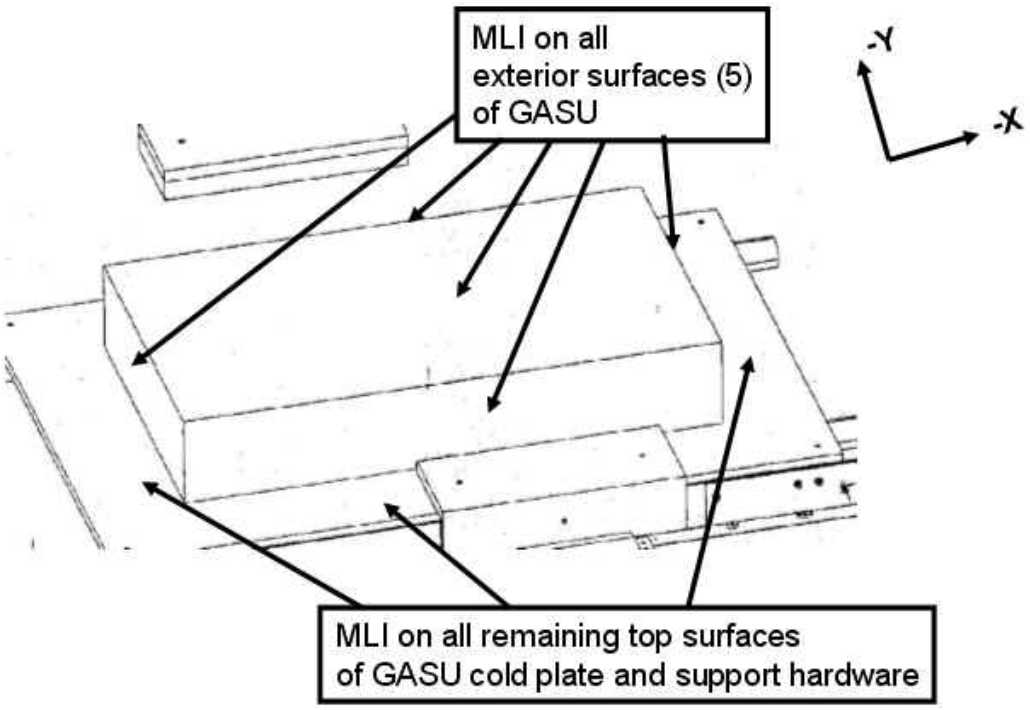


Figure G-2 - GASU and GASU Cold Plate MLI Locations

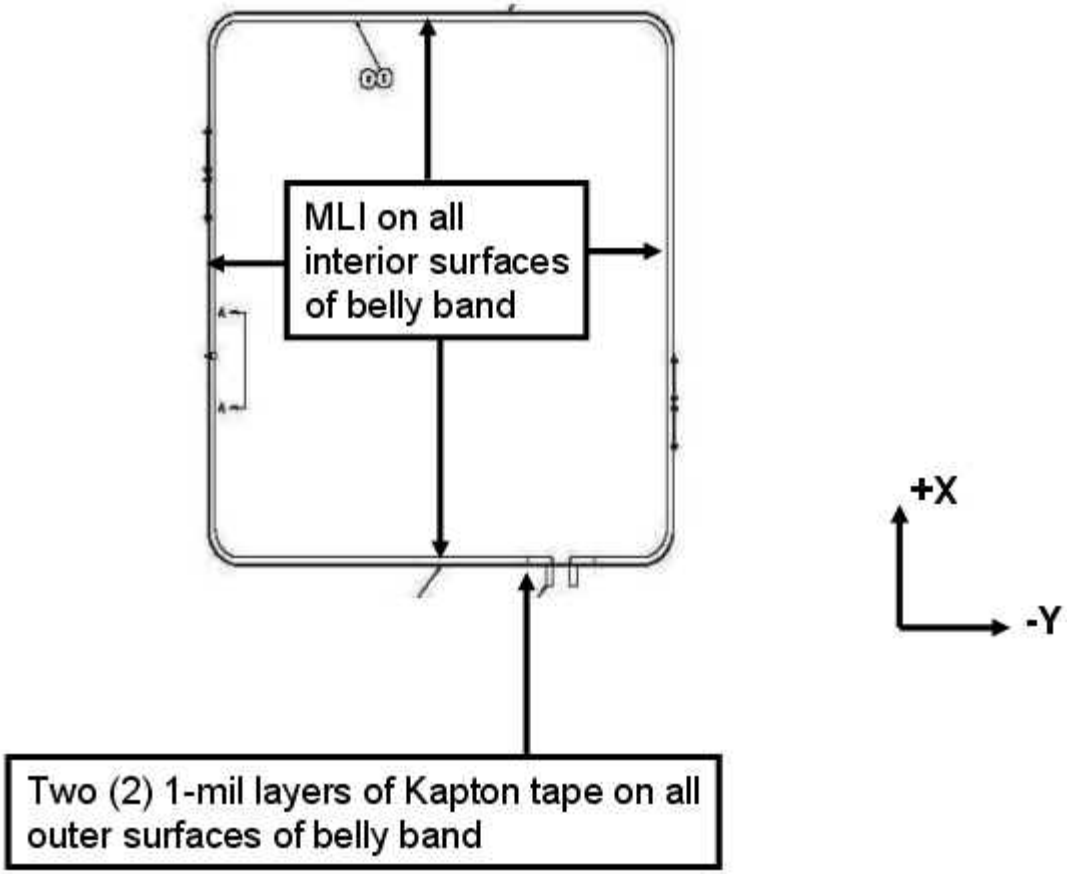
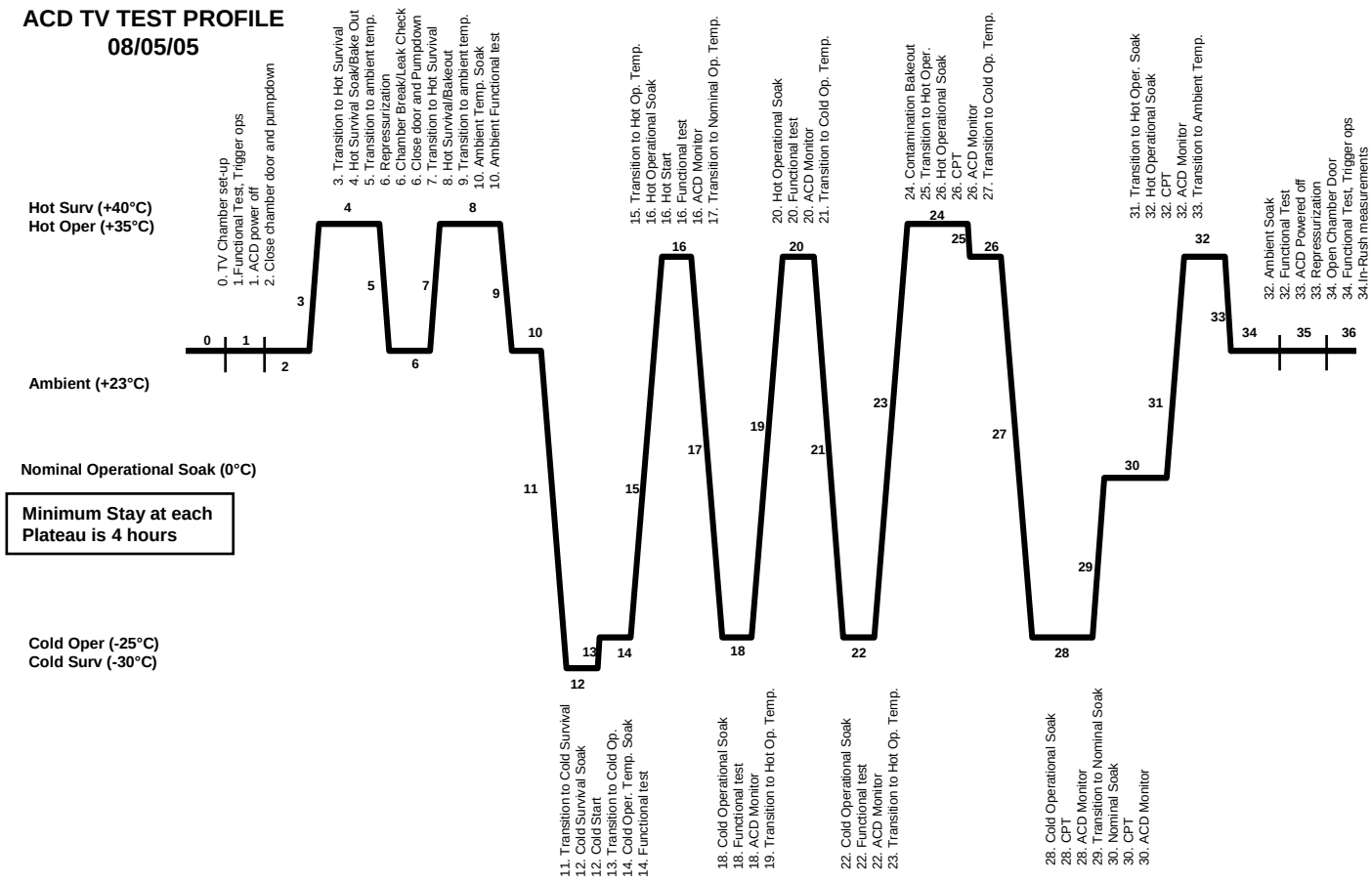


Figure G-3 - Belly Band MLI Locations

APPENDIX H: ACD TV TEST PROFILE


ACD TV TEST PROFILE
08/05/05
Hot Surv (+40°C)
Hot Oper (+35°C)
Ambient (+23°C)
Nominal Operational Soak (0°C)
Cold Oper (-25°C)
Cold Surv (-30°C)
Minimum Stay at each Plateau is 4 hours
0. TV Chamber set-up
1.Functional Test, Trigger ops
1. ACD power off
2. Close chamber door and pumpdown
3. Transition to Hot Survival
4. Hot Survival Soak/Bake Out
5. Transition to ambient temp.
6. Repressurization
6. Chamber Break/Leak Check
6. Close door and Pumpdown
7. Transition to Hot Survival
8. Hot Survival/Bakeout
9. Transition to ambient temp.
10. Ambient Temp. Soak
10. Ambient Functional test
11. Transition to Cold Survival
12. Cold Survival Soak
12. Cold Start
13. Transition to Cold Op.
14. Cold Oper. Temp. Soak
14. Functional test
15. Transition to Hot Op. Temp.
16. Hot Operational Soak
16. Hot Start
16. Functional test
16. ACD Monitor
17. Transition to Nominal Op. Temp.
18. Cold Operational Soak
18. Functional test
18. ACD Monitor
19. Transition to Hot Op. Temp.
20. Hot Operational Soak
20. Functional test
20. ACD Monitor
21. Transition to Cold Op. Temp.
22. Cold Operational Soak
22. Functional test
22. ACD Monitor
23. Transition to Hot Op. Temp.
24. Contamination Bakeout
25. Transition to Hot Oper.
26. Hot Operational Soak
26. CPT
26. ACD Monitor
27. Transition to Cold Op. Temp.
28. Cold Operational Soak
28. CPT
28. ACD Monitor
29. Transition to Nominal Soak
30. Nominal Soak
30. CPT
30. ACD Monitor
31. Transition to Hot Oper. Soak
32. Hot Operational Soak
32. CPT
32. ACD Monitor
33. Transition to Ambient Temp.
32. Ambient Soak
32. Functional Test
33. ACD Powered off
33. Repressurization
34. Open Chamber Door
34. Functional Test, Trigger ops
34.In-Rush measurements

APPENDIX I: TEMPERATURE GOAL SET-POINTS AND CONTROL THERMOCOUPLES

TEST POINT DESCRIPTION	Temperature Goal (°C)	Tracker Simulator Set Point (°C)	Belly Band Set Point (°C)	GASU Cold Plate Set Point (°C)	(+X) Heater Panel Set Point (°C)	Chamber Shroud Set Point (°C)
Safe Mode	20	20	20	20	20	20
Contamination Bake Out	40	40	40	20	40	40
Non-Op Hot Soak	40	40	40	20	90	40
Hot Operational Soaks	35	35	30	15	45	-100
Ambient Temperature Soaks	23	18	18	15	45	-100
Nominal Operational Soaks	0	0	-5	15	45	-100
Cold Operational Soaks	-25	-30	-30	15	45	-100
Non-Op Cold Soak	-30	-35	-30	20	45	-170

TABLE I-1 Temperature Goal Set Points

Component	Control PTE #'s	Red Lo	Yel Lo	Yel Hi	Red Hi
Tracker Simulator	74, 77, 80, 83, 86, 89, 93, 96, 99, 102	-	-	-	-
4 x 4 Cold Plate	27-30	-	-	-	-
Belly Band	19-26	-	-	-	-
GASU Cold Plate	15-18	0	10	40	50
(+X) Heater Panel	103-111	-	-	-	-
Chamber Shroud	FTE-1	-	-	-	-
ACD BEA (+X)	37-40	-35	-30	40	45
ACD BEA (+Y)	41-44	-35	-30	40	45
ACD BEA (-X)	45-48	-35	-30	40	45
ACD BEA (-Y)	49-52	-35	-30	40	45
ACD TSA (+X)	57	-50	-40	45	50
ACD TSA (+Y)	58	-50	-40	45	50
ACD TSA (-X)	59	-50	-40	45	50
ACD TSA (-Y)	60	-50	-40	45	50
ACD TSA (+Z)	56	-50	-40	45	50

TABLE I-2 Control Thermocouples

APPENDIX J: HEATER CIRCUITS

Rack # 1

Ckt. #	Location	Ctrl CTEs	Modes	Size	Quant.	R (Ω)	Ckt R (Ω)	Cable R(Ω)	Max V	Max I (a)	Max P (w)
315 1-1	(+X) Tracker Simulator - Zone 1	74	Temp	12 x 12	2	26.2	52.4		150.11	2.86	430
315 1-2	(+X) Tracker Simulator - Zone 2	77	Temp	12 x 12	2	31.3	62.6		150.12	2.40	360
315 1-3	(+Y) Tracker Simulator - Zone 3	80	Temp	12 x 12	2	26.2	52.4		150.11	2.86	430
315 1-4	(+Y) Tracker Simulator - Zone 4	83	Temp	12 x 12	2	31.3	62.6		150.12	2.40	360
315 1-5	(-X) Tracker Simulator - Zone 5	86	Temp	12 x 12	2	26.2	52.4		150.11	2.86	430
315 1-6	(-X) Tracker Simulator - Zone 6	89	Temp	12 x 12	2	31.3	62.6		150.12	2.40	360
315 1-7	(-Y) Tracker Simulator - Zone 7	92	Temp	12 x 12	2	26.2	52.4		150.11	2.86	430
315 1-8	(-Y) Tracker Simulator - Zone 8	95	Temp	12 x 12	2	31.3	62.6		150.12	2.40	360
315 1-9	(+Z) Tracker Simulator - Zone 9	98	Temp	12 x 12	2	26.2	52.4		150.11	2.86	430
315 1-10	(+Z) Tracker Simulator - Zone 10	101	Temp	12 x 12	2	26.2	52.4		150.11	2.86	430
315 1-11											
315 1-12											

TABLE J - 1 Tracker Simulator Heater Work Order

Ckt. #	Location	Ctrl CTEs	Modes	Ref T/C	Size	Quant.	R (Ω)	Ckt R (Ω)	Cable R(Ω)	Max V	Max I (a)	Max P (w)
315 2-1	Sun Simulator Upper Panel - Heater 1	103	Temp		12 x 12	2						400
315 2-2	Sun Simulator Upper Panel - Heater2	104	Temp		12 x 12	2						400
315 2-3	Sun Simulator Upper Panel - Heater 3	105	Temp		12 x 12	2						400
315 2-4	Sun Simulator Middle Panel - Heater 4	106	Temp		12 x 12	2						400
315 2-5	Sun Simulator Middle Panel - Heater 5	107	Temp		12 x 12	2						400
315 2-6	Sun Simulator Middle Panel - Heater 6	108	Temp		12 x 12	2						400
315 2-7	Sun Simulator Lower Panel - Heater 7	109	Temp		12 x 12	2						400
315 2-8	Sun Simulator Lower Panel - Heater 8	110	Temp		12 x 12	2						400
315 2-9	Sun Simulator Lower Panel - Heater 9	111	Temp		12 x 12	2						400

TABLE J - 2 (+X) Heater Panel Heater Work Order

APPENDIX K: ADDITIONAL ACD THERMAL VACUUM PICTURES

Figure K-1 - ACD in Chamber 225

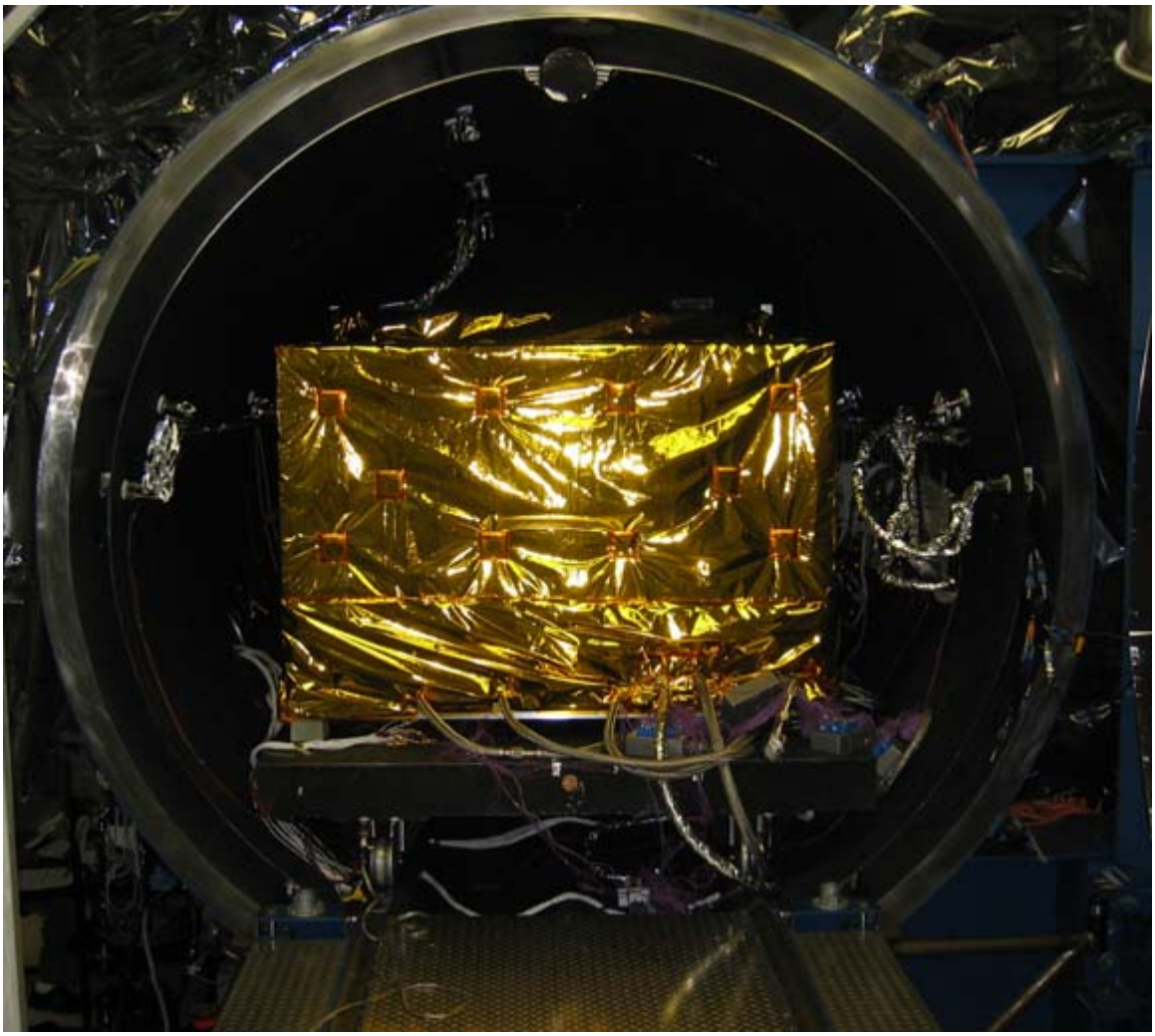
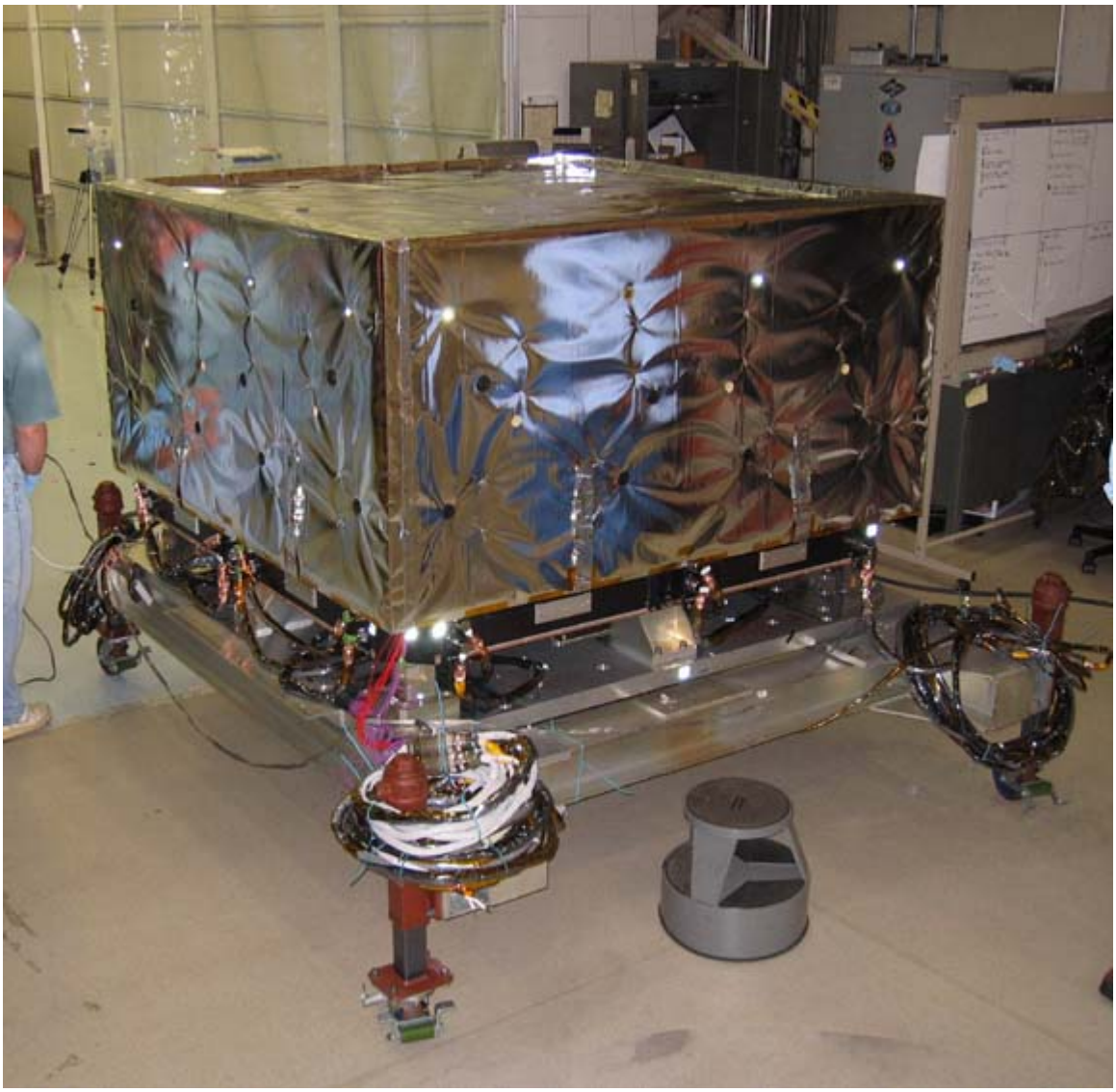


Figure K-2 - ACD installed on Thermal GSE

Figure K-3 - ACD Flight configuration without GBK outer Layer

Figure 0-1 K-4 - ACD with MMS installed, without MLI installed



APPENDIX L: CONTMINATION DATA

TQCM Data is found in the ACD Library under the following documents:

TQCM #1	ACD-DATA-000426
TQCM #2	ACD-DATA-000427

The following is the report from the materials Engineering group on the Coldfinger and Scavenger Plate analysis from the ACD Thermal Vac Test:

MATERIALS ENGINEERING BRANCH
CODE 541
CHEMICAL ANALYSIS REPORT

TO: 549.4/Head, Space Simulation Test Engineering Section/E. Packard

FROM: 541/Materials Engineering Branch/M. Sovinski

SUBJECT: Chamber 225 GLAST ACD Samples

DATE: August 12, 2005

ANALYSIS #: 05-100

PROJECT: GLAST

Samples Submitted:

Sample(s):	Cold Finger #14217
	Scavenger Plate #14218
Item:	ACD Samples
Post Test:	8/5/05
TARS #:	6268
Facility:	225

Analysis Performed:

[X] Mass Determination (*NASA ECN 1815360*)
[X] Fourier Transform Infrared Spectroscopy {FTIR} (*NASA ECN 2036845*)
[X] Gas Chromatography/Mass Spectrometry {GC/MS} (*NASA ECN 1955352*)

Results:

Facility Cold Finger #14217

Total Amount of Residue: 0.72 ± 0.02 mg
Chemical Constituents (*in order of abundance*):

1. Various hydrocarbons

2. Dibutyl sebacate
3. Di (2-ethylhexyl) phthalate - plasticizer
4. Tris (2,3,-dichloropropyl) phosphate
5. Dibutyl phthalate – plasticizer
6. Triphenylphosphine oxide
7. Cyclohexyl formamide

Facility Scavenger Plate #14218

Total Amount of Residue: 89.73 ± 0.02 mg

Chemical Constituents (*in order of abundance*):

1. Various hydrocarbons
2. Benzoic acid
3. An ester
4. Caprolactam – from nylon bagging
5. Dibutyl phthalate – plasticizer
6. Dibutyl sebacate
7. Tris (2,3,-dichloropropyl) phosphate
8. Unknown compound
9. Di (2-ethylhexyl) phthalate - plasticizer
10. Tris (allyl) cyanurate
11. Triphenylphosphine oxide

Recent Chamber History:

Facility #	Sample(s)	Post Test Date	Length of T/V Test, hrs.	Collection Length, hrs.	Max. Shroud Temp.,° C	Max. P/L Temp., ° C	Total Amt. Of residue	Report #
225	CF 14217; ACD Samples SP 14218; GLAST	8/5/05 8/5/05	315.7 315.7	104.5 316.7	45.2 45.2	----- -----	0.72mg 89.73mg	05-100

Comments:

1. The cold finger residue consisted mainly of various hydrocarbons and dibutyl sebacate. Lesser amounts of di (2-ethylhexyl) phthalate, tris (2,3, -dicholoropropyl) phosphate, dibutyl phthalate, triphenylphosphine oxide, and cyclohexyl formamide were also found to be present. The dibutyl sebacate, tris (2,3, -dicholoropropyl) phosphate, dibutyl phthalate, and cyclohexyl formamide are outgassing species from GLAST ACD.

2. There was 89.73mg of residue from the scavenger plate. The residue was composed mainly of various hydrocarbons, benzoic acid, an ester, caprolactam, and dibutyl phthalate. Lesser amounts of dibutyl sebacate, tris (2,3, -dichloropropyl) phosphate, an unknown compound, di (2-ethylhexyl) phthalate, tris (allyl) cyanurate, and triphenylphosphine oxide were also found to be present in the scavenger plate sample. The di (2-ethylhexyl) phthalate and the triphenylphosphine oxide are background constituents; the other compounds are likely outgassing species from GLAST ACD.

Ms. Doris Jallice is acknowledged for conducting the GCMS analysis on the samples. If there are any questions regarding this report, please contact me at x6-1371.

Marjorie Sovinski

cc:

540/ Duncan, V.	541/ Blackwood, J.	541/ Jallice, D.
541/ Joy, P.	541/Montoya, A.	546/ Rosecrans, G.
546/ Chen, P.	546/ Collins, A.	549.4/Espiritu, M.
549.4/Saulino, H.	549.5/Tilwick, L.	

APPENDIX M: ELECTRICAL EGSE TEST SET UP: