# FAST SPACECRAFT THERMAL VACUUM
# AND
# THERMAL BALANCE TEST PLAN

FINAL

April 15, 1994

NASA/GODDARD SPACE FLIGHT CENTER
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# SMALL EXPLORER (SMEX) PROJECT ACRONYMS

| | |
|---|---|
| ACE | Attitude Control Electronics |
| ACS | Attitude Control System |
| A/D | Analog to Digital |
| ADC | Analog to Digital Converter |
| AHI | AMP Hour Integrator |
| AMPD | Assurance Management Policy Directive |
| AOS | Acquisition of Signal |
| ARAR | Accident Risk Assessment Report |
| A/SH | Acquisition/Safehold |
| ATP | Absolute Time Processor |
| ATS | Absolute Time Sequence |
| BASE | Base System Environment |
| BCRT | Bus Controller Remote Terminal |
| BOL | Beginning of Life |
| B/U | Backup |
| CAN | Canberra DSN Tracking Station |
| CCP | Contamination Control Plan |
| CCSDS | Consultative Committee for Space Data Systems |
| C/D | Charge/Discharge |
| C&DH | Command and Data Handling |
| CDR | Critical Design Review |
| CDU | Command Detector Unit |
| CLCW | Command Link Control Word |
| CM | Centimeters |
| CMD | Command |
| CMS | Command Management System |
| CPU | Central Processing Unit |
| CSLP | Cooperative Satellite Learning Project |
| CSS | Coarse Sun Sensor |
| CTA | Compatibility Test Area |
| CTT | Command and Telemetry Terminal |
| CTV | Compatibility Test Van |
| DAC | Digital to Analog Converter |
| DB | Decibels |
| DC | Direct Current |
| DPA | Destructive Physical Analysis |
| DPU | Data Processing Unit |
| DSM | Data Systems Manager |
| DSN | Deep Space Network |
| DSS | Digital Sun Sensor |
| DWV | Dielectric Withstanding Voltage |
| EEE | Electrical, Electronic, and Electromechanical |
| EMC | Electromagnetic Conduction |
| EN | Enable |
| ESA | Electrostatic Analyzer |
| ESD | Electrostatic Discharge |
| ESM | Embedded SIRT Module |
| EU | Engineering Unit |
| FAB | Fabrication |
| FAST | Fast Auroral Snapshot Explorer |
| FCGSE | Front-end Communications Ground Support Equipment |
| FDF | Flight Dynamics Facility |
| FLOP | Flight Operations Plan |

## SMALL EXPLORER (SMEX) PROJECT ACRONYMS

| | |
|---|---|
| FMECA | Failure Modes and Effects and Criticality |
| FOT | Flight Operations Team |
| FRB | Failure Review Board |
| FRR | Flight Readiness Review |
| FT | Foot |
| FTCP | Front-end Telemetry and Command Processor |
| FU | Factor of Uncertainty |
| | |
| GDS | Goldstone DSN Tracking Station |
| GEN | Generation |
| GEVS | General Environmental Verification Specification |
| GFE | Government Furnished Equipment |
| GIA | Government Inspection Agency |
| GMI | Goddard Management Instruction |
| GN | Ground Network |
| GND | Ground |
| GSE | Ground Support Equipment |
| GSFC | Goddard Space Flight Center |
| | |
| HCI | Horizon Crossing Indicator |
| HERTZ | Hertz |
| HILT | Heavy Ion Large Telescope |
| H/K | Housekeeping |
| HRR | High Rate Resolution |
| H&S | Health and Safety |
| HTR | Heater |
| HV | High Voltage |
| | |
| ICD | Interface Control Document |
| IDA | Interval Data Archive |
| IDPU | Instrument Data Processing Unit |
| IESA | Ion Electrostatic Analyzer |
| I/F | Interface |
| IOWG | Instrument Operations Working Group |
| I&T | Integration and Test |
| ITP | Integration and Test Protocol |
| | |
| JPL | Jet Propulsion Laboratory |
| JSC | Johnson Space Center |
| | |
| KBPS | Kilobits per Second |
| KM | Kilometer |
| KP | Kilopole |
| | |
| LAN | Local Area Network |
| LB | Pound |
| LCC | Leadless Chip Carrier |
| LEICA | Low Energy Ion Composition Analyzer |
| L&EO | Launch and Early Orbit |
| LOD | Letter of Delegation |
| LOS | Loss of Signal |
| LPARL | Lockheed Palo Alto Research Laboratory |
| LVPS | Low Voltage Power Supply |
| LVPSA | Low Voltage Power Supply Assembly |
| LV | Launch Vehicle |
| LZP | Level Zero Processed |

# SMALL EXPLORER (SMEX) PROJECT ACRONYMS

| | |
|---|---|
| MAG | Magnetometer |
| MAST | Mass Spectrometer Telescope |
| MBPS | Megabytes per Second |
| MEDS | Modular Environment for Data Systems |
| MGSE | Mechanical Ground Support Equipment |
| MIL-STD | Military Standard |
| MO&DSD | Mission Operations and Data Systems Directorate |
| MOI | Moment of Inertia |
| MOM | Mission Operations Manager |
| MOR | Mission Operations Room |
| MOSFET | Metal Oxide Transistor |
| MIPS | Million Instructions Per Second |
| MRB | Material Review Board |
| MRTP | Mission Readiness Test Plan |
| MRTS | Mission Readiness Test Section |
| MSFC | Marshall Space Flight Center |
| MSOCC | Multi Satellite Operations Control Center |
| MUA's | Materials Usage Agreements |
| MUE | Mission Unique Electronics |
| MUI | Moments of Inertia |
| MUX | Multiplexor |
| | |
| NASA | National Aeronautics and Space Administration |
| NASCOM | NASA Communications |
| NHB | NASA Handbook |
| NiCD | Nickel Cadmium |
| NSPARS | Nonstandard Parts Approval Request |
| | |
| OCD | Operations Concept Document |
| OI | Overcurrent |
| OPS | Operations |
| OPTO | Optic Coupler |
| ORR | Orbit Rate Rotation |
| OTS | Orbital Tracking Station |
| OV | Overvoltage |
| | |
| PA | Performance Assurance |
| PACOR | Packet Processor |
| PAIP | Performance Assurance Implementation Plan |
| PAP | Performance Assurance Procedure |
| PAR | Performance Assurance Requirements |
| P/C | Personal Computer |
| PDF | Programmable Data Formatter |
| PDL | Programming Design Language |
| PDOS | Power Disk Operating System |
| PD/PCU | Power Distribution/Pyro Control Unit |
| PDR | Preliminary Design Review |
| PET | Proton Electron Telescope |
| PIND | Particle Impact Noise Detection |
| POCC | Payload Operations Control Center |
| PROM | Programmable |
| P/S | Power Supply |
| PSD | Power Spectra Density |
| PSE | Power System Electronics |
| PSI | Pounds per Square Inch |
| PSS | Portable Spacecraft Simulator |
| PWM | Pulse Width Modulation |

## SMALL EXPLORER (SMEX) PROJECT ACRONYMS

| | |
|---|---|
| PWR | Power |
| | |
| RAM | Random Access Memory |
| RCVR | Receiver |
| RF | Radio Frequency |
| RFDU | Real Time Formatted Data Unit |
| RI | Remote Interface |
| RID | Madrid DSN Tracking Station |
| RPM | Revolutions per Minute |
| RPO | Revolutions Per Orbit |
| RPP | Recorder/Processor/Packetizer |
| R&QA | Reliability and Quality Assurance |
| RT | Remote Terminal |
| RTS | Relative Time Sequence |
| RWR | Wire Wound Resistor |
| | |
| S/A | Solar Array |
| SAMPEX | Solar Anomalous and Magnetospheric Particle Explorer |
| S/C | Spacecraft |
| SCDP | Safety Compliance Data Package |
| SCDR | Software Critical Design Review |
| SCM | SMEX Coordination Memo |
| SCP | Stored Command Processor |
| SEC | Second |
| SEDS | Small Explorer Data System |
| SELV | Small Expendable Launch Vehicle |
| SFDU | Standard Formatted Data Unit |
| SIRD | Support Instrumentation Requirements Document |
| SIT | Systems Implementation Team |
| SMEX | Small Explorer |
| SOC | Science Operations Center |
| SORD | Support and Operations Requirements Document |
| SPAN | Space Physics Analysis Network |
| SPAR-3 | Standard Payload Assurance Requirements |
| SPE | SWAS Power Electronics |
| SPEC | Specification |
| SRT | Safety Review Team |
| SSC | SWAS Spacecraft Computer |
| SSIP | System Safety Implement Plan |
| STDN | Spaceflight Tracking and Data Network |
| STOL | Standard Test and Operating Language |
| S/W | Software |
| SWAS | Submillimeter Wave Astronomy Satellite |
| SWMP | Software Management Plan |
| | |
| TBD | To Be Determined |
| T&E | Test and Evaluation |
| TCPS | Telemetry and Command Processing System |
| TCW | Test Conductor Workstation |
| TEAMS | Time of flight Energy Mass Spectrograph |
| TF | Transfer Frame |
| TGS | Temporary Ground Station |
| TLM | Telemetry |
| TOF | Time Of Flight |
| TOTS | Transportable Orbital Tracking Station |
| TPOCC | Transportable Payload Operations Control Center |
| TSA | Test and Simulations Assembly |

## SMALL EXPLORER (SMEX) PROJECT ACRONYMS

| | |
|---|---|
| UCB | University of California - Berkeley |
| UCLA | University of California - Los Angeles |
| UMD | University of Maryland |
| UMSOC | University of Maryland Science Operation Center |
| UNH | University of New Hampshire |
| UTC | Universal Time Coordinated |
| UTMC | United Technologies |
| UV | Undervoltage |
| | |
| VC | Virtual Channel |
| VLSI | Very Large Scale Integration |
| VME | Virtual Microsystems Eurocard |
| VSWR | Voltage Standing Wave Ratio |
| V/T | Voltage/Temperature |
| | |
| W | Watt |
| WCA | Worst Case Analysis |
| WG | Working Group |
| W/O | Without |
| WPC | Wave Particle Correlator |
| WPS | Wallops Island Tracking Station |
| WSMCR | Western Space and Missile Complex Regulation |
| | |
| XMTR | Transmitter |

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# 1. INTRODUCTION

This document describes the thermal vacuum and thermal balance tests to be performed on the all-up Fast Auroral Snapshot Explorer (FAST) spacecraft. According to the GEVS requirement, a minimum of four thermal vacuum (TV) cycles will be performed following a comprehensive thermal balance (TB) test.

## 1.1 Description

FAST is the second of the Small-Class Explorer (SMEX) missions. It will investigate the plasma physics of the auroral phenomena which occur around both poles of the earth. This will be accomplished by taking high data rate snapshots with electric and magnetic fields sensors, and plasma particle instruments, while traversing through the auroral regions.

FAST will orbit in a near-polar, highly elliptical orbit. Apsoidal rotation caused by this orbit configuration will position apogee over the northern polar region approximately four months after launch thus providing optimal science conditions. FAST's one year mission duration will be highlighted by this period of intense spacecraft and scientific activity. The measurements made by FAST will address a broad range of scientific objectives in such areas as:

- Electron and ion acceleration by parallel E-fields.
- Wave heating of ions-ion conics
- Electrostatic double layers
- Field-aligned currents
- Kilometric radiation
- General wave/particle interactions

The NASA/Goddard supplied FAST spacecraft is a 12 RPM classical spinner that will keep its spin axis continually aligned with the orbit-normal vector. Orbit altitude will be approximately 350 km x 4200 km at an inclination of 83°. FAST will be launched in August, 1994 aboard a Pegasus XL launch vehicle.

The FAST payload consists of four experiment packages:

1. Electric Field Experiment. The electric field experiment is composed of three orthogonal boom pairs. Spherical sensors deployed on radial wire and axial stacer booms will provide information on the plasma density and electron temperature.

2. Magnetic Field Experiment. The magnetic field experiment consists of two magnetometers mounted 180° apart on deployable graphite epoxy booms. The search coil magnetometer uses a three-axis sensor system to provide magnetic field data over the frequency range of 10 Hz to 2.5 kHz. The flux gate magnetometer is a three-axis system using high, stable, low noise, ring core sensors to provide magnetic field information for DC to 100 Hz.

3. <u>Time-of-Flight Energy Angle Mass Spectrograph(TEAMS)</u>. The TEAMS instrument is a high sensitivity, mass-resolving spectrometer that will measure full three-dimension distribution functions of the major ion species with one spin of the spacecraft. The TEAMS experiment will cover the core of all plasma distributions of importance in the auroral region.

4. <u>Electrostatic Analyzers (ESA).</u> Sixteen ESA's configured in four stacks will be used for both electron and ion measurements. The four stacks are placed around the spacecraft such that the entire package is provided a full 360° field of view. The ESA's can provide a 64-step energy sweep, covering approximately 3 eV to 30 KeV up to 16 times per second.

## 1.2 Test Objectives

The thermal vacuum and thermal balance tests are being performed to accomplish the following objectives:

- Demonstrate that the spacecraft can operate satisfactorily in all functional modes for the mission, at temperatures 10°C beyond the hot and cold extremes expected on orbit. If thermal balance test results do not agree with analytical predictions, components shall be tested to their qualification limits where possible.

- Demonstrate the ability of the payload to operate satisfactorily after exposure to survival temperature limits.

- Demonstrate satisfactory operation during and after temperature transition.

- Demonstrate that deployment mechanisms such as magnetometer booms/wire booms and, instrument aperture covers operate satisfactorily at extreme temperatures.

- Demonstrate satisfactory operation of the spacecraft thermal control systems. This shall include checking thermostat set points, thermistor data, and heater operation.

- Demonstrate satisfactory operation of the POCC end to end.

- Verify the FAST spacecraft meets the contamination requirements.

- Verify the FAST spacecraft and instrument thermal models.

- Verify the FAST spacecraft and instrument thermal design flight worthiness.

## 1.3 Test Item Description

The test article is the FAST spacecraft, including science instruments in the all-up launch configuration, as shown in Figure 1. FAST has a nine-sided faceted geometry, predominantly covered with solar cells. **HOWEVER, DUE TO THE UNAVAILABILITY OF THE FLIGHT SOLAR ARRAYS, ENGINEERING TEST UNIT (ETU) ARRAYS ARE BEING USED INSTEAD. THE ETUS HAVE BEEN THERMALLY AND ELECTRICALLY CONFIGURED TO BE COMPATIBLE WITH THE OBJECTIVES OF THE TV/TB TEST. ANY REFERENCE TO SOLAR ARRAY IN THIS TEST PLAN WILL MEAN ETU SOLAR ARRAY.** Cut-outs in the mid-section of the array allow clear fields of view for the deck mounted instruments. FAST's overall approximate dimensions in the test configuration are 42x42x36 inches. An antenna boom extends approximately 22 inches above the top of the spacecraft and two magnetometer booms extend approximately 20 inches above and 15 inches below the spacecraft. These and other booms deploy out from the spacecraft to form the on-orbit configuration shown in Figure 2. The entire payload weighs approximately 412 pounds. A breakdown of the FAST spacecraft assembly is depicted in Figure 3.

## 1.4 Test Set-up

The FAST spacecraft will be suspended in Chamber #238 (12'x15' cryopumped) via its eight hardpoints. Four (4) 1" x 1" x ~17" G-10 struts will be placed between the spacecraft's separation system and the chamber floor to provide fatigue relief to the hardpoints. The thermal environment will be simulated by four cryo-plates, one skin heater circuit, and the chamber shroud. The test configuration is shown in Figure 4.

The FAST spacecraft will be in its flight configurations with all flight hardware for both the thermal vacuum and thermal balance tests. All flight and test thermal blankets are to be provided by GSFC/754.

### 1.4.1 Quality Assurance

Twenty-four hours prior to start of test, QA must be notified. The test will not begin until QA has verified setup, instrumentation, and documentation.

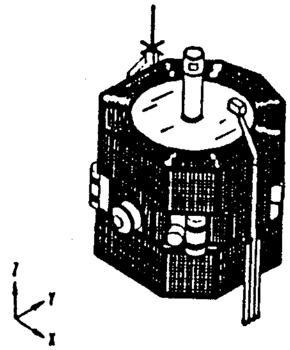


**FIGURE 1 - FAST LAUNCH CONFIGURATION**

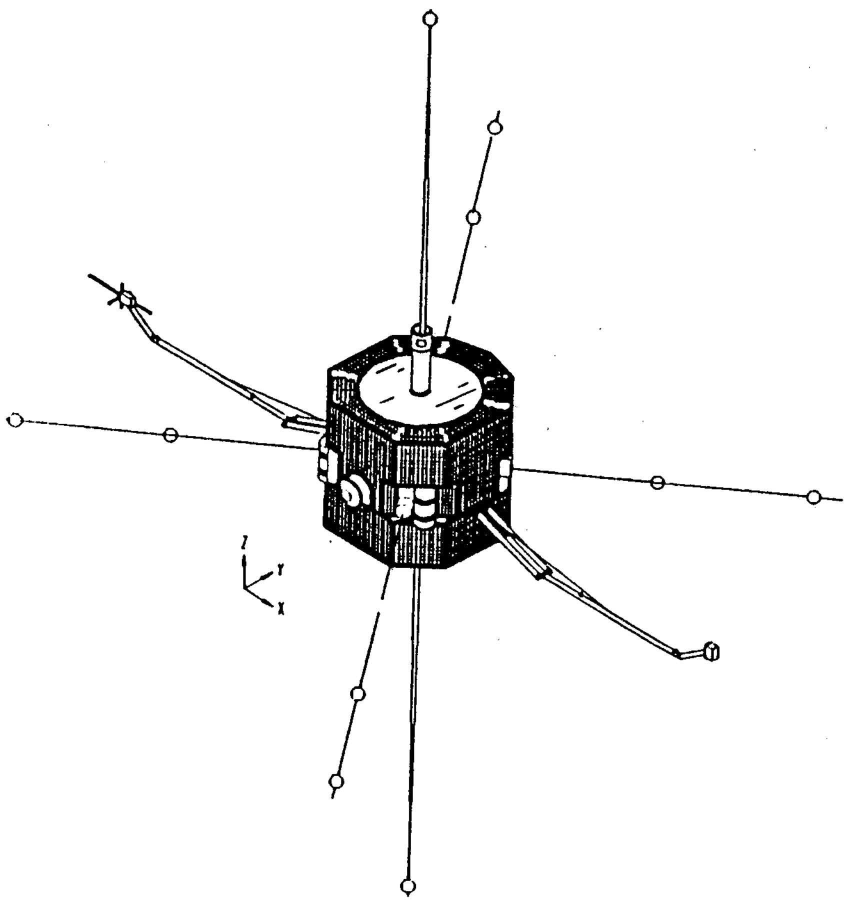


**FIGURE 2: FAST ON-ORBIT CONFIGURATION**

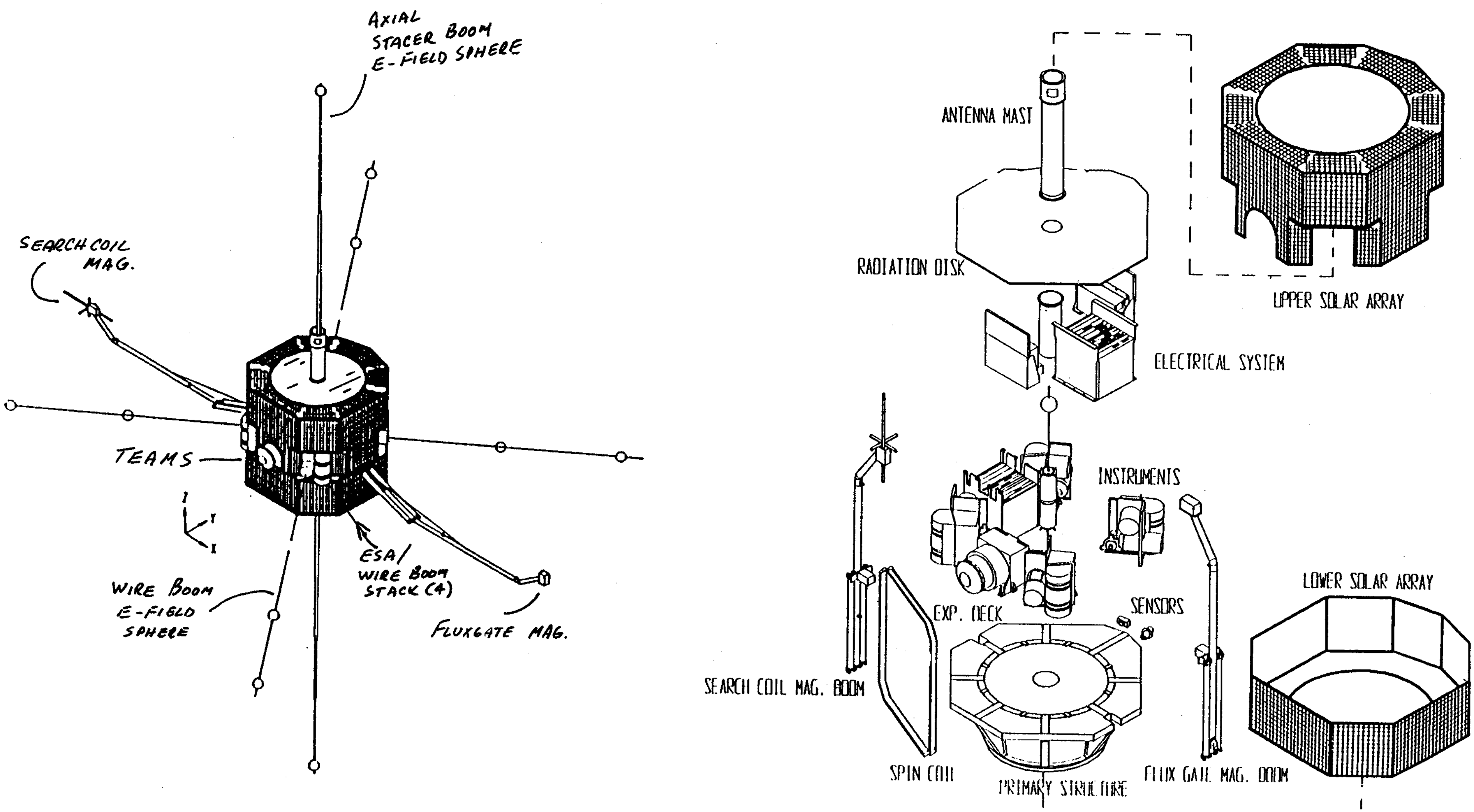
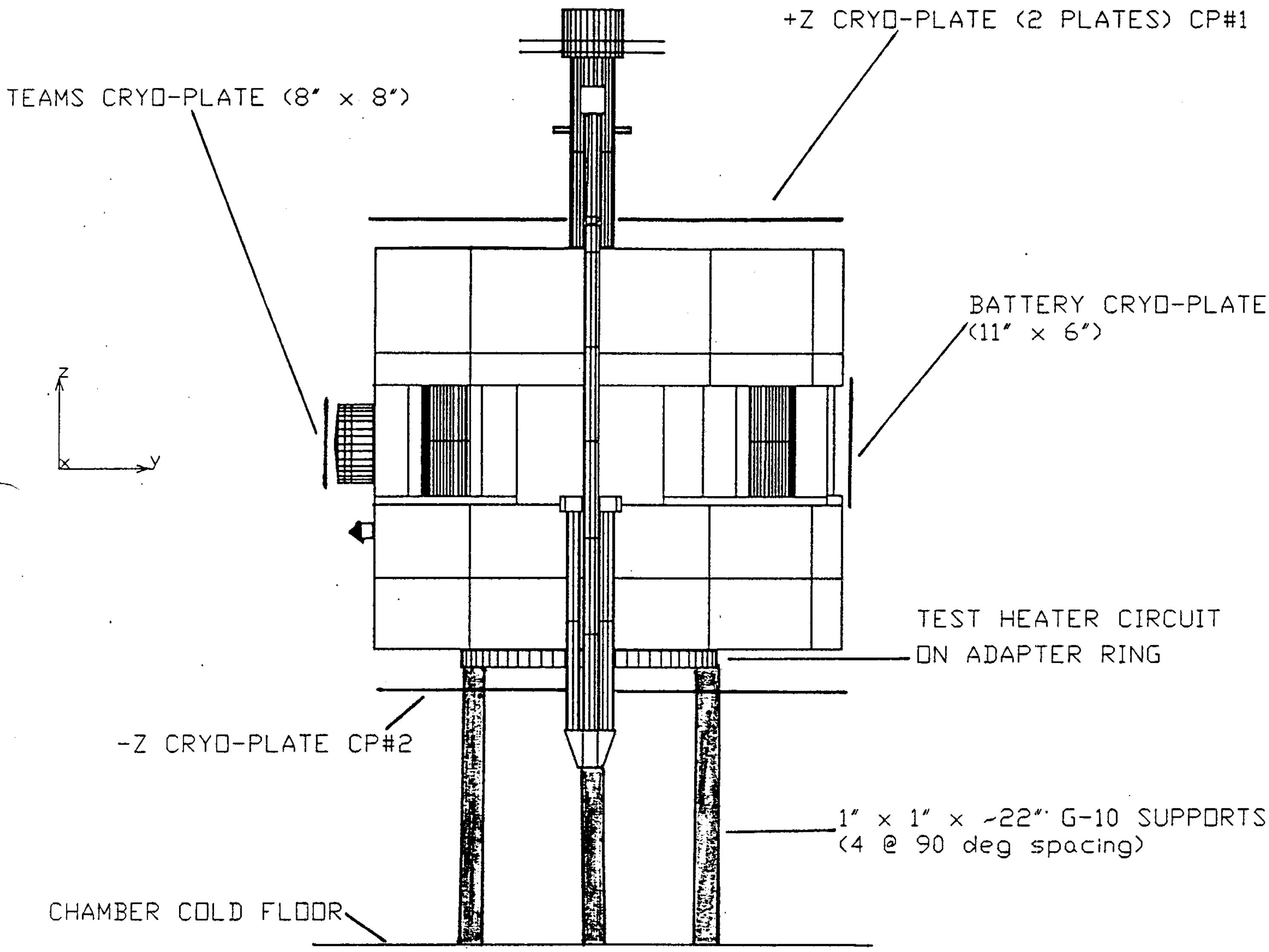



**FIGURE 3: FAST SPACECRAFT ASSEMBLY BREAKDOWN**




Support system, blanket closeouts, chamber walls, not shown.

**FIGURE 4: FAST THERMAL VACUUM TEST SETUP**

## 2. TEST PERSONNEL

### 2.1 Test Team Members

The test team that will perform this test is as follows:

| | |
|---|---|
| I&T Manager | T. Gehringer/740.4 |
| Test Director | T. Gehringer/740.4 |
| Functional Test Director | D. Everett/743.1 |
| Functional Test Conductors | B. Settles/743.3<br>A. Koslosky/743.3<br>T. Trenkle/743.1<br>M. Scott/745.1 |
| Thermal Test Director | K. Parrish/724.1 |
| Thermal Test Conductors | K. Rhee/724.1<br>L. Fantano/724.1<br>D. Nguyen/724.3<br>K. Gaulke/724.1<br>R. Harrison/724.1<br>G. Greer/724.3<br>R. Mencia/Swales<br>R. Chalmers/724.6 |
| Instrument Manager | R. Aleman/740.4 |
| Verification Manager | P. Mulé/750.2 |
| Thermal Vacuum Test Engineer | J. Dunn/754.4 |
| Q/A Manager | R. Kolecki/303 |
| Contamination Control Engineer | M. Rodriguez/Swales |
| POCC Interface | |

### 2.2 Test Team Responsibilities

The **I & T Manager** is responsible for accomplishing the test in a timely manner. The I & T Manager shall be responsible for scheduling of all the resources (FTC, facilities, etc.) and shall be the focal point of contact between all the organizations involved in the test. He shall coordinate all the pre-test activities to assure that everything needed for the test is taken care off. The I & T Manager will see to the completion of a final test report.

The **Test Director (TD)** has the overall responsibility for accomplishing the test according to the test plan/procedure and to insure that safety and welfare of the spacecraft is not compromised during the test. The TD has the ultimate authority to approve major changes to the test procedures.

The **Functional Test Director (FTD)** has the overall responsibility for spacecraft operations, procedures, and functional tests. The FTD shall insure that the functional test procedures are executed as planned and in accordance with the functional test procedure. The FTD is responsible for insuring that the thermal test procedure and functional test procedure are compatible and in agreement. The FTD directs the activities of the FTCs.

The **Functional Test Conductor (FTC)** is responsible for the operational aspects of electrical integration and functional testing of the spacecraft. The FTC shall be the single point of control of the spacecraft during operations when the spacecraft is energized and commands (or STOL procedures) are being sent to the spacecraft from the I&T GSE Test Conductor Workstation (TCW). The FTC's responsibilities further extend to directing the execution of test activities when operations are required from the I&T GSE TCW. The FTC understands the spacecraft hardware and its operation, is familiar with the written electrical integration procedures and STOL procedure operation, and must understand the function and operation of the I&T GSE and related software. The FTC must be aware of the test Area Storm Alert Status indicator and, when appropriate, terminates any ongoing test activity that requires the utilization of commercial power for energizing spacecraft hardware, I&T GSE, or other support equipment. The FTC shall also maintain a record (spacecraft log notebook) of all test activities. After the execution of the procedure, the FTC confers with the subsystem engineer involved with the test, and declares the procedure/test a success or failure, and logs the results into the test procedure and/or spacecraft log notebook. Authorization to proceed in testing is required of the FTC.

The **Thermal Test Director (TTD)** is responsible for overseeing the proper completion of the thermal test procedure. The TTD may make changes to the thermal test procedure with the approval of the TD. The TTD shall have the authority to make changes to chamber and cold plate temperatures if required to achieve the desired test goals and to protect the spacecraft. Further, the TTD shall have the authority to enable or disable any heater circuits if determined by the TTD to be necessary. The TTD will make red-line changes to the procedure and have QA initial those changes. The TTD shall maintain a log and record all chamber and test fixture setting changes.

The **Thermal Test Conductor (TTC)** is responsible for accomplishing and monitoring the thermal test of the spacecraft. The TTC shall assure that changes in the thermal environment, including the test fixtures will not jeopardize the health and safety of the spacecraft. The TTC will follow the thermal test procedure, report any anomalies to QA and the TTD, and have QA initial any red-line changes. The TTC shall maintain a log and record all chamber and test fixture settings, soak point initiations, thermostat open and close temperatures, operating, survival and test heater status, and any test anomalies. The TTC will notify the FTC that test conditions are established and/or completed.

The **Thermal Vacuum Test Engineer (TVTE)** is responsible for writing the thermal test procedure and for reviewing and approving the Facility Operations Test Procedure. The TVTE is responsible for the coordination of the chamber setup and tear-down activities before and after the test. The TVTE is also responsible for the proper operation of the test facility and test hardware. The test engineer or a designated representative has the sole authority for directing NSI in the operations of the chamber and all of its auxiliary equipment. All directions and changes in carrying out the test operations and procedure must go through this engineer after approval of the TD or TTD. In addition, the test engineer shall oversee the accomplishment of the Critical Handling and Installation Procedure. The TVTE shall also monitor the test and its operations and serve as an interface between the experimenters and the chamber operators. The TVTE shall maintain a log and record chamber and fixture data as required. The TVTE is responsible for monitoring and operating all test heater circuits, hot and cold plates utilized during the test. TVTE shall also maintain a log of all operations of the heaters and cold plates and record this data as required.

The **Quality Assurance Manager (QA)** or designated representative is responsible for overseeing that all test operations are carried out according to procedure and to initial and date all changes made to any test procedures. QA shall assure that all records are being kept accurate and up-to-date and that all standards are being maintained. Also, QA shall ensure that all test anomalies and failures are documented appropriately by the cognizant engineer.

## 3. EMERGENCY CONDITIONS

In the event of an anomaly, the Test Director, after appropriate consultations, will make the decision whether or not to halt the test.

Test article functional procedures and facility procedures shall be developed, implemented, and released prior to the start of the test by the **TVTE** in the event of the following emergencies:

- Building Evacuation
- Power Outage:
  - Chamber & Cold plate temperature control
  - Chamber pressure
  - Loss of instrumentation & data acquisition system
  - Loss of power, facility and spacecraft electronics
  - Emergency power
- Facility Failure
- Increase in Chamber Pressure

In addition, the malfunctioning of equipment identified as critical shall warrant stopping the test and performing the necessary repairs. The following equipment is identified as critical to supporting a successful test:

- Chamber temperature control
- Chamber pressure control
- Cold plate temperature control
- Hot plate temperature control
- Data acquisition system
- Power control
- Instrumentation

## 4. FACILITIES AND EQUIPMENT

This test shall be conducted at GSFC in thermal vacuum chamber number 238, located in building 7. The chamber shall provide the necessary appurtenances for the test article, cryo-plates, and support hardware. The chamber shall also be capable of maintaining a minimum vacuum of $1x10^{-5}$ torr. The temperature of the chamber walls shall be selectable in the range of -100°C to +90°C, +/- 2°C. In addition, the necessary number of heaters, thermocouples, and plumbing lines shall be provided. A list of the necessary test equipment is presented in the following:

- Cryo-plate #1 and cryo-plate #2, labeled CP #1 and #2, will provide a radiative sink temperature simulation for the top and bottom ends of the spacecraft respectively. The size and shape of each plate shall be such that they mimic the geometry of the spacecraft ends. CP#1 is to be constructed such that it may fit around the antenna boom extending from the top end of the spacecraft. Both CP#1 and CP#2 shall be mounted no further than four inches from the spacecraft ends. CP#1 is to also be notched to allow clearances around the two magnetometer booms. CP#2 shall have four holes or pass throughs for the G-10 support struts. The temperature of the plates shall be individually controllable from -140°C to +100°C. The spacecraft viewing side of each plate shall have a coating with an emittance of no less than 0.85. These plates shall be provided by code 754. Coating support can be provided by code 724.1

- Cryo-plate #3, designated TEAMS Cryo-plate, will provide a radiative sink temperature simulation for the TEAMS instrument aperture. The size of this plate shall be approximately 8" x 8". This plate shall be positioned within two inches of the TEAMS aperture and be individually controllable from -100 °C to +80 °C. The spacecraft viewing side of the plate shall have a coating with an emittance of no less than 0.85. This plate shall be provided by code 754. Coating support can be provided by code 724.1.

- Cryo-plate #4, designated Battery Cryo-plate, will provide a radiative sink temperature simulation for the battery radiator. The size of this plate shall be approximately 11" x 6". Since the battery radiator is recessed, this plate shall be positioned within two inches of the solar array and be individually controllable from -120 °C to +80 °C. The spacecraft viewing side of the plate shall have a coating with an emittance of no less than 0.85. This plate shall be provided by code 754. Coating support can be provided by code 724.1.

- Thermal close-outs (MLI) shall be provided between the equipment cryo-plates and their respective radiator and solar array panels. Vent holes shall be provided in the close-outs to create a vent path for radiator contaminants. Close-outs shall be provided by code 750.5/NSI.

• MLI cable/harness wraps shall be provided for all spacecraft and test wire bundles. The support cables shall also be wrapped. The four G-10 support struts are to also be covered in MLI.

• One test skin heater circuit will be required to simulate the solar heating on the SELV adapter ring. This will be designated as the adapter heater. The adapter ring will be approximately three inches wide with a diameter of 22 inches. The test heater is to provide controllable and evenly distributed heat to the ring up to a minimum of 75 watts.

• Test heater power measurement shall be provided for the skin heater circuit. Read-out accuracy shall be 1/2% of full scale, with a resolution of 0.1 watts. Power measurement shall be provided by code 754.

• All handling of the spacecraft shall be provided by code 741.

• Thermocouples shall be provided as indicated in Table I, FAST TV/TB Test Thermocouples. A maximum of 140 T/C will be required. T/Cs shall be provided by code 754 and installed as shown on drawings in the mechanical drawings in Appendix A.

• Two (2) Quartz Crystal Microbalances (QCMs) shall be provided with the detector to be located as per the direction of the contamination control engineer. The QCMs required shall be provided by code 754.

• A Residual Gas Analyzer (RGA) will be used to determine chamber gas content.

• A Scavenger Plate shall be operated by code 754 according to standard operating procedures. Cold finger shall be operated for eight (8) consecutive hours at the end of the last hot soak. It shall not be turned on until the QCM data readings have remained below 100 Hz/hr for five (5) consecutive hours during a hot soak. Once the test is completed, the cold finger shall be handled in accordance with ASTM-E-834-81 "Determining Vacuum Chamber Environment Using a Cold Finger".

• Data Acquisition System shall be provided which is capable of monitoring and recording data from a minimum of 121 T/Cs. Measurement resolution shall be no greater than 0.1°C, with a 2°C accuracy. The system shall also be capable of providing temperature print-outs at 0 to 60 minute intervals, selectable by the user. In addition, the system shall be capable of plotting all or a selected group of T/Cs, see Table II, FAST TV/TB Test Thermocouples. The TTD/TTC station shall have two dedicated monitors & hard copy capability.

• Temperature controllers, two (2) required, one (1) each for the thermocouple wire bundle Zero-Q, and the spacecraft cable bundle Zero-Q. Control temperature range -25 to 70°C. Contacts rated at a minimum of 2 amps at 28 VDC. Temperature controllers shall be provided by code 754.

- Flux controllers, if needed, shall be provided by code 754.

- Pressure interlock to the spacecraft 28 volt non-essential bus to activate at pressure greater than $1x10^{-4}$ torr.

- Test heater power supplies will be provided by Code 754.

- Chamber pressure and temperature indication shall be provided. This data shall be continuously recorded autonomously by the Data Acquisition System or strip chart recorder. Plots of these parameters shall be made available upon request.

- Four (4) radioactive sources (non flight) will be needed during FAST S/C thermal vacuum testing. Each source will be Nickle-63 with an emission strength of 10 milli-curie. One source will be mounted on each ESA stack for thermal vacuum cycling tests only. Details can be provided by R. Aleman/740.4. **Note: the only authorized personnel to handle the radiation sources are R. Aleman/740.4 and J. Byrd/740.4.**

- One magnetic field simulator, provided by M. Walker/745.1 will by mounted in the chamber near the ACS magnetometer. This simulator will simulate a magnetic field in order to verify proper operation of the ACS magnetometer. Temperature, mounting, and operational requirements will be provided by M. Walker.

- Two (2) video cameras will be required inside the thermal vacuum chamber with proper lighting. The position and operation of the cameras will be determined by G. Rosanova (741) and J. Watzin (740). The cameras will be provided by code 754.

- Working space ( G. Cooper )

- GSE ( G. Cooper )

- MSE ( G. Rosanova )
    - Spacecraft suspension equipment, ie cables, turnbuckles, etc.
    - Deployment test hardware
    - G-10 support struts
    - Code 754 will be responsible for configuring the hardpoints in chamber #238 for proper spacecraft suspension

- Nitrogen purge feed through for the particle instruments

• Chamber electrical feed-throughs shall be TBD. (G. Cooper)

• Provide a time reference, "EST" for tagging for thermocouple and test heater data. This shall be provided by Code 754.

## 5. INSTRUMENTATION

### 5.1 Temperature Sensors

#### 5.1.1 Thermocouples

Thermocouples shall be installed on the FAST spacecraft as listed in Table I, FAST TV/TB Test Thermocouple as shown in the mechanical drawings and sketches in the Appendix A. There are a total of 106 T/Cs required. The proper performance of each T/C shall be verified prior to spacecraft thermal blanket installation. Groups of thermocouples to be plotted are listed in the Appendix A. Certain thermocouples must be attached to the spacecraft prior to solar array installation. All thermocouples must be attached/taped such that they can withstand vibration testing.

#### 5.1.2 Thermistors

All thermistors are flight units. Their locations are shown on the mechanical drawings in Appendix B and listed in Table III. There are 40 spacecraft flight thermistors , 14 on the science instruments, and 26 spacecraft support equipment internal thermistors. Thermistor read-out data shall be provided by the cognizant FTC and recorded by the TTC. Since the ETU solar arrays are being used for the tests certain thermistors will be invalid.

### 5.2 Heaters

#### 5.2.1 Test Heaters

Heaters are required for the Pegasus adapter ring, thermocouple bundles, and spacecraft harnesses. Heaters shall be provided on equipment harnesses to minimize heat losses or gains. In this test plan these heaters are referenced as "Zero-Q" heaters. A summary of the test heaters is listed in Table III, FAST Test Heaters.

#### 5.2.2 Flight Heaters

There are three flight heater circuits. These heater circuits are listed in Table IV, FAST Flight Heaters. Heater locations are presented in the mechanical drawings in the Appendix C.

## TABLE I: SMEX/FAST TV/TB THERMOCOUPLE DESCRIPTIONS

| LOCATION | ID | THERMISTOR | TB TEMP °C | TV TEMP GOAL °C | SURV °C | NODE # | YELLOW LIMIT °C | RED LIMIT °C |
|---|---|---|---|---|---|---|---|---|
| STRUCTURE | | | | | | | | |
| UPPER SOLAR ARRAY (19) | | | | | | | | |
| End Outer A2 | 1 | SC1 PSA1TEMP | 0/41/45 | 48/-44 | -22 | 2660 | -80/90 | -95/106 |
| End Inner A2 | 2 | | 2/39/43 | 48/-43 | -35 | 1660 | -80/90 | -95/106 |
| Facet 1 Inner top (+x) A1 | 3 | SC2 PSA2TEMP | 20/-2/ 1 | 42/-38 | -25 | 2510 | -80/90 | -95/106 |
| Facet 1 Inner bottom (+x) A1 | 4 | SC2 PSA2TEMP | 26/-6/ 0 | 42/-34 | -23 | 2410 | -80/90 | -95/106 |
| Facet 2 Inner top A1 | 5 | | 55/-3/-1 | 41/-41 | -25 | 2520 | -80/90 | -95/106 |
| Facet 3 Inner top (+y) A1 | 6 | | 18/ 3/ 5 | 42/-40 | -26 | 2530 | -80/90 | -95/106 |
| Facet 5 Inner top A1 | 7 | | 17/ 2/ 3 | 42/-41 | -26 | 2550 | -80/90 | -95/106 |
| Facet 6 Inner top (-x) A1 | 8 | | 47/-5/-3 | 41/-38 | -26 | 2560 | -80/90 | -95/106 |
| Facet 6 Outer top (-x) A1 | 9 | SC3 PSA3TEMP | 47/-5/-3 | 41/-38 | -26 | 2560 | -80/90 | 106/-95 |
| Facet 6 Inner bottom (-x) A1 | 10 | | 32/-7/ 0 | 44/-32 | -23 | 2460 | -80/90 | -95/106 |
| Facet 8 Inner top (-y) A1 | 11 | | 28/-6/-3 | 41/-38 | -24 | 2580 | -80/90 | -95/106 |
| Bellyband Inner (+x) A1 | 12 | | 32/-7/3 | 46/-27 | -23 | 1310 | -80/90 | -95/106 |
| Bellyband Outer (+x) A1 | 13 | | 32/-8/3 | 45/-27 | -23 | 2310 | -80/90 | -95/106 |
| Deck Interface (+x) A1, A2 | 14 | | 32/-8/ 3 | 45/-27 | -23 | 2310 | -80/90 | -95/106 |
| Deck Interface (-x) A1 | 15 | | 34/-4/10 | 47/-23 | -23 | 2360 | -80/90 | -95/106 |
| Deck Interface (+y) A1, A3 | 16 | | 37/-8/ 4 | 46/-25 | -24 | 2333 | -80/90 | -95/106 |
| Deck Interface (-y) A1 | 17 | | 37/-4/ 9 | 44/-24 | -20 | 2370 | -80/90 | -95/106 |
| Recessed, Inner Bot. (+x,+y) A2, A6 | 18 | | 32/-6/ 5 | 46/-27 | -23 | 2320 | -80/90 | -95/106 |
| Recessed, Inner Top (+x,+y) A2, A6 | 19 | | 32/-6/ 5 | 46/-27 | -23 | 2320 | -80/90 | -95/106 |
| | | | | | | | | |
| LOWER SOLAR ARRAY (13) | | | | | | | | |
| End Outer A2 | 20 | SC4 PSA4TEMP | 69/-55/-48 | 48/-54 | -40 | 2860 | -80/90 | -95/106 |
| End Inner A2 | 21 | | 69/-54/-47 | 48/-54 | -40 | 3860 | -80/90 | -95/106 |
| Facet 1 Inner Bottom (+x) A1 | 22 | SC5 PSA5TEMP | 38/-28/-22 | 43/-40 | -27 | 2110 | -80/90 | -95/106 |
| Facet 1 Inner Top (+x) A1 | 23 | SC5 PSA5TEMP | 32/-19/-12 | 43/-39 | -24 | 2210 | -80/90 | -95/106 |
| Facet 3 Inner bottom (+y) A1 | 24 | | 40/-27/-20 | 43/-40 | -27 | 2130 | -80/90 | -95/106 |
| Facet 6 Inner Bottom (+y) A1 | 25 | | 35/-26/-12 | 43/-40 | -26 | 2160 | -80/90 | -95/106 |

TABLE I: SMEX/FAST TV/TB THERMOCOUPLE DESCRIPTIONS (cont.)

| LOCATION | ID | THERMISTOR/ RELAVANT | TB TEMP °C | TV TEMP GOAL °C | SURV °C | NODE # | YELLOW LIM °C | RED LIM. °C |
|---|---|---|---|---|---|---|---|---|
| Facet 6 Outer Bottom (-x) A1 | 26 | SC6 PSA6TEMP | 35/-26/-12 | 43/-40 | -26 | 2160 | -80/90 | -95/106 |
| Facet 6 Inner Top (-x) A1 | 27 | | 31/-16/27 | 43/-33 | -23 | 2260 | -80/90 | -95/106 |
| Facet 8 Inner Bottom (-y) A1 | 28 | | 35/-24/-18 | 43/-38 | -26 | 2180 | -80/90 | -95/106 |
| Deck Interface (+x) A1, A2 | 29 | | 32/-19/-12 | 43/-39 | -23 | 2210 | -80/90 | -95/106 |
| Deck Interface (-x) A1 | 30 | | 31/-16/27 | 43/-33 | -23 | 2260 | -80/90 | -95/106 |
| Deck Interface (+x) A1, A2, A3 | 31 | | 34/-20/-12 | 43/-35 | -25 | 2230 | -80/90 | -95/106 |
| Deck Interface (-y) A1 | 32 | | 32/-15/-7 | 43/-31 | -22 | 2280 | -80/90 | -95/106 |
| | | | | | | | | |
| PRIMARY STRUCTURE (5) | | | | | | | | |
| Pegasus Adapter Ring (+x) A3 | 33 | | 53/-7/9 | 50/-20 | -24 | 121 | -25/55 | -30/62 |
| Pegasus Adapter Ring (-x) A3 | 34 | | 53/-7/9 | 50/-20 | -24 | 121 | -25/55 | -30/62 |
| Thrust Cone Loewr (+x) A4 | 35 | SC20 STHRUSTTEMP | 46/-6/10 | 50/-20 | -24 | 403 | -25/55 | -30/62 |
| Thrust Cone Upper (+x) A4 | 36 | SC20 STHRUSTTEMP | 43/-5/12 | 50/-19 | -24 | 401 | -25/55 | -30/62 |
| Gusset A4 | 37 | | 44/-6/11 | 50/-20 | -24 | 1002 | -25/55 | -30/62 |
| | | | | | | | | |
| EQUIPMENT DECK (6) | | | | | | | | |
| Top of Deck Center A5 | 38 | | 42/-1/21 | 51/-10 | -23 | 449 | -25/55 | -30/62 |
| Top of Deck MUE A5 | 39 | SC22 SDECKTEMP | 42/-5/13 | 50/-19 | -24 | 441 | -25/55 | -30/62 |
| Top of Deck ESA (+x,+y) A5 | 40 | | 41/-5/11 | 49/-20 | -24 | 442 | -25/55 | -30/62 |
| Top of Deck Battery A5 | 41 | | 42/-5/12 | 49/-13 | -24 | 443 | -25/55 | -30/62 |
| Top of Deck IDPU A5 | 42 | SC23 IDECKTEMP | 41/-4/15 | 51/-13 | -24 | 445 | -25/55 | -30/62 |
| Top of Deck TEAMS/Shunt Box A5 | 43 | SC26 PSHUNTTEMP | 44/-4/16 | 51/-14 | -23 | 447 | -25/55 | -30/62 |
| | | | | | | | | |
| RADIATION DISK (5) | | | | | | | | |
| -Z (+x,+y) Shield Support A6 | 44 | | 29/8/21 | 49/-25 | -25 | 542 | -25/55 | -30/62 |
| +Z (+x,+y) Shield Support A6 | 45 | | 28/9/21 | 49/-25 | -25 | 742 | -25/55 | -30/62 |
| +Z Center A6 | 46 | | 31/10/25 | 50/-20 | -25 | 749 | -25/55 | -30/62 |
| +Z (-x) A6 | 47 | | 29/11/25 | 50/-23 | -26 | 745 | -25/55 | -30/62 |
| +Z (-y) A6 | 48 | SC21 SRADDECKTEMP | 28/12/25 | 49/-23 | -26 | 747 | -25/55 | -30/62 |

**TABLE I: SMEX/FAST TV/TB THERMOCOUPLE DESCRIPTIONS (cont)**

| LOCATION | ID | THERMISTOR | TB TEMP °C | TV TEMP GOAL °C | SURV °C | NODE # | YELL LIM °C | RED LIM.° C |
|---|---|---|---|---|---|---|---|---|
| SPACECRAFT EQUIPMENT | | | | | | | | |
| BATTERY ASSEMBLY (5) | | | | | | | | |
| Closeout Duct (2) A9 | 49,50 | | 20/0/ 5 | 25/-4 | -5 | 624 | -5/20 | -10/30 |
| Mount Plate (2) A9 | 51,52 | SC7 PBATTEMP | 20/0/ 5 | 25/-4 | -5 | 623 | -5/20 | -10/30 |
| Support Bracket A9 | 53 | | 25/1/8 | 33/-9 | -11 | 622 | -10/30 | -20/40 |
| | | | | | | | | |
| TRANSPONDER/RF ASSEMBLY (4) | | | | | | | | |
| Transponder Chassis A7 | 54 | | 43/2/37 | 53/7 | -20 | 671 | -10/55 | -20/65 |
| Support Bracket (2) A7 | 55,56 | SC11 XBRACKETTEMP | 43/2/37 | 53/6 | -20 | 672 | -10/55 | -20/65 |
| Shield Support A7 | 57 | | 37/5/27 | 51/-10 | -23 | 673 | -25/55 | -30/62 |
| Antenna A2, A7 | 58 | | 21/-15/-15 | 39/-40 | -21 | 532 | -100/55 | -110/60 |
| | | | | | | | | |
| MUE ASSEMBLY (3) | | | | | | | | |
| Chassis A7 | 59 | SC15 MENDPLATTEMP | 41/-3/15 | 51/-17 | -23 | 601 | -20/55 | -25/60 |
| Shield Support A7 | 60 | | | | | | -25/55 | -30/62 |
| Shunt Box A Foot NOT SHOWN | 61 | | 44/-4/16 | 51/-15 | -23 | 901 | -20/55 | -25/60 |
| | | | | | | | | |
| DPU ASSEMBLY (2) | | | | | | | | |
| Chassis A7 | 62 | SC16 IDPUBASETEMP | 48/6/33 | 60/2 | -24 | 652 | -20/55 | -25/60 |
| Shield Support A7 | 63 | | 40/3/20 | 53/-16 | -24 | 653 | -20/55 | -25/62 |
| | | | | | | | | |
| ACS ASSEMBLY (5) | | | | | | | | |
| Spin Coil (2) A4 | 64, 65 | | 28/15/26<br>43/-4/11 | 52/-27<br>52/-23 | -27<br>-25 | 6001,<br>6005 | -25/55 | -30/60 |
| Precession Coil NOT SHOWN | 66 | | | | | | -20/55 | -25/60 |
| Sun Sensor Head A7 | 67 | | 28/-16/-11 | 42/-34 | -22 | 752 | -40/60 | -60/65 |
| HCI Head A4 | 68 | | 39/-9/5 | 47/-24 | -23 | 712 | -23/45 | -30/60 |

**TABLE I: SMEX/FAST TV/TB THERMOCOUPLE DESCRIPTIONS (cont.)**

| LOCATION | ID | THERMISTOR | TB TEMP °C | TV TEMP GOAL °C | SURV °C | NODE # | YEL LIM°C | RED LIM °C |
|---|---|---|---|---|---|---|---|---|
| INSTRUMENTS | | | | | | | | |
| ESA/WIRE BOOM ASSEMBLY (4)+x,+y | | | | | | | | |
| Wire Boom Face A8 | 69 | | 38/-4/12 | 49/-21 | -24 | 161 | -20/55 | -30/60 |
| ESA Aperture Face A8 | 70 | SC18 IESA1ANLTEMP | 37/-4/11 | 49/-21 | -24 | 201 | -20/55 | -30/60 |
| Midwall A8 | 71 | | 37/-3/12 | 49/-21 | -24 | 162 | -20/55 | -30/60 |
| Electronics Chassis A8 | 72 | SC19 IESA2ELCTEMP | 37/-3/12 | 49/-20 | -24 | 202 | -20/55 | -30/60 |
| | | | | | | | | |
| TEAMS ASSEMBLY (3) | | | | | | | | |
| Aperture/Analyzer Housing (2) A8 | 73,74 | | 40/-3/11 | 41/-13 | -14 | TEAMS121 | -25/60 | -50/65 |
| TOF Chassis A8 | 75 | | 48/-1/26 | 54/-2 | -20 | TEAMS201 | -20/50 | -25/55 |
| Electronics Chassis A8 | 76 | SC17 ITEAMSTEMP | 43/-1/20 | 50/-11 | -21 | TEAMS302 | -20/55 | -25/60 |
| | | | | | | | | |
| MAGNETOMETER BOOMS ASSEMBLY (5) | | | | | | | | |
| Base Hinge (+x) A3 | 77 | | 31/-11/3 | 44/-28 | -22 | 5370 | -25/55 | -30/62 |
| Elbow/ACS Mag A2, A3 | 78 | | 23/-19/-19 | 40/-39 | -19 | 5280 | -35/46 | -55/56 |
| Elbow Searchcoil A3 | 79 | | 22/-20/-20 | 39/-40 | -20 | 5380 | -35/46 | -55/56 |
| Searchcoil Pre-amp Housing A2, A3 | 80 | | 33/-16/1 | 49/-19 | -20 | 5500 | -35/60 | -45/70 |
| Fluxgate Housing A2, A3 | 81 | | 33/12/13 | 52/-13 | -18 | 5255 | -35/60 | -45/70 |
| | | | | | | | | |
| TEST EQUIPMENT | | | | | | | | |
| CRYO-PLATE #1 (6) | 82-87 | | -94/78/78 | 50/-80 | -60 | 9000 | | |
| CRYO-PLATE #2 (5) | 88-92 | | 83/-128/-128 | 50/-80 | -60 | 9100 | | |
| TEAMS CRYO-PLATE (2) | 93,94 | | 38/-6/-6 | 30/-14 | 5 | 8700 | | |
| BATTERY CRYO-PLATE (2) | 95,96 | | -77/-40/-40 | -72/-32 | -32 | 8070 | | |
| CHAMBER SHROUD (6) | 97-102 | | 22/-20/-20 | 39/-40 | -20 | 8000 | | |
| THERMOCOUPLE BUNDEL (1) | 103 | | | | | | | |
| SPACECRAFT WIRE BUNDEL (1) | 104 | | | | | | | |
| SUPPORT PEG (1) | 105 | | | | | | | |
| SUPPORT CABLE (1) | 106 | | | | | | | |
| TOTAL | 106 | | | | | | | |

## 6. TEST TOLERANCES AND SPECIFICATIONS

Unless otherwise specified in the thermal test procedure, the following tolerances shall be used during the TB/TV test:

- Power:
  Internal power dissipated in the FAST Spacecraft shall be measured to an accuracy of 10%.

- Pressure/Vacuum:

| | |
|---|---|
| $1.3x10^4$ Pa (100 torr), | +/- 5% |
| $1.3x10^4$ to $1.3x10^2$ Pa (100 to 1 torr), | +/- 10% |
| $1.3x10^2$ to $1.3x10^1$ Pa (1 torr to 1 micron), | +/- 25% |
| Less than $1.3x10^1$ PA (1 micron), | +/- 80% |

- Thermal Stability:
  Thermal Balance - Temperature stabilization is defined as having occurred when, with a fixed power configuration, no spacecraft thermocouple exceeds a change of 0.1°C/2-hours over the previous 6-hour period and has a slope approaching zero,(ΔTemp/ΔTime). Thermal Balance test temperature stability will be determined by TTC.

- Soak Criteria:

  When one thermocouple from each control group in Table VIII, is within 2°C of the soak goal, the soak period will be considered started.

- Maximum Transition Rate:

  During transitions the payload's temperature, at the deck, change shall not exceed 20°C/hour.

## TABLE II. FAST FLIGHT THERMISTORS and CORRESPONDING T/Cs

| LOCATION | DESIGNATION | T/Cs | YELLOW LIMITS | RED LIMITS |
|---|---|---|---|---|
| Upper End Array | SC1 PSA1TEMP | 1 | -60/65 | -95/106 |
| Upper Body Array, Inside | SC2 PSA2TEMP | 3 | -35/40 | -95/106 |
| Upper Body Array, Out | SC3 PSA3TEMP | 9 | -35/40 | -95/106 |
| Lower End Array | SC4 PSA4TEMP | 20 | -60/65 | -95/106 |
| Lower Body Array, Inside | SC5 PSA5TEMP | 22,23 | -35/40 | -95/106 |
| Lower Body Array, Out | SC6 PSA6TEMP | 26 | -35/40 | -95/106 |
| Battery Adapter Plate | SC7 PBATTEMP | 51,52 | -5/22 | -10/30 |
| Battery Top of Cell | SC8 PBATTOCTEMP | | -5/25 | -10/30 |
| Amp Hour Integrator | SC9 PAHITEMP | | -5/25 | -10/30 |
| Battery CCP | SC10 PBATCCPTEMP | | -5/25 | -10/30 |
| Transponder Mount | SC11 XBRACKETTEMP | 55,56 | -5/50 | -20/65 |
| Transponder RF Amp | SC12 XRFAMPTEMP | | -10/55 | -20/65 |
| Transponder Power Supply | SC13 XPWRSUPLTEMP | | 10/55 | -20/65 |
| MUE Housekeeping Card | SC14 MHKCARDTEMP | | -10/50 | -25/75 |
| MUE End Plate | SC15 MENDPLATEMP | 59 | -5/40 | -25/60 |
| IDPU Chassis Wall | SC16 IDPUBASETEMP | 62 | -5/40 | -25/60 |
| TEAMS E-Box Housing | SC17 ITEAMSTEMP | 76 | -5/40 | -25/60 |
| ESA Unit 1, Analyzer | SC18 IESA1ANLTEMP | 70 | -10/45 | -25/50 |
| ESA Unit 2 E-Box Chassis | SC19 IESA2ELCTEMP | 72 | -10/45 | -25/60 |
| Thrust Cone | SC20 STHRUSTTEMP | 35 | -10/35 | -25/35 |
| Radiation Disk | SC21 SRADDECKTEMP | 36 | -10/50 | -25/60 |
| Deck\MUE | SC22 SDECKTEMP | 39 | -10/35 | -25/60 |
| Deck\IDPU | SC23 IDECKTEMP | 42 | -10/35 | -25/60 |
| HCI Mount | SC24 AHCITEMP | | -10/30 | -30/65 |
| Aeroheating | SC25 STOPTEMP | | -20/100 | -30/120 |
| Deck\Shunt Boxes | SC26 PSHUNTTEMP | 43 | -10/40 | -25/60 |
| ESA Unit 1 BEB Board | I1 IBEBTEMPA | | -30/55 | -45/65 |
| ESA Unit 2 BEB Board | I2 IBEBTEMPB | | -30/55 | -45/65 |
| ESA Unit 3 BEB Board | I3 IBEBTEMPC | | -30/55 | -45/65 |
| ESA Unit 4 BEB Board | I4 IBEBTEMPD | | -30/55 | -45/65 |
| IDPU Power Converter | I5 IPCTEMP2 | | -30/55 | -45/65 |
| IDPU Power Converter | I6 IPCTEMP1 | | -30/55 | -45/65 |
| IDPU Power Converter | I7 IMCTEMP1 | | -30/55 | -45/65 |
| IDPU Power Converter | I8 IMCTEMP2 | | -30/55 | -45/65 |
| IDPU Processor | I9 ICPUTEMP | | -30/55 | -45/65 |
| Axial Boom Board | I10 IAXBTEMP | | -35/55 | -45/65 |
| TEAMS Interface Board | I11 ITIOB | | -30/30 | -35/35 |
| TEAMS TAC/CODIF | I12 ITCDF | | -30/30 | -35/35 |
| Fluxgate Magnetometer | I13 IFLXTMP | 81 | -30/55 | -45/65 |
| Searchcoil Magnetometer | I14 ISCLTMP | 80 | -30/55 | -45/65 |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**TABLE III. FAST TEST HEATERS**

| Location | Circuit Number | Circuit Power, @ 28V Power(watts) | Setpoints (°C) | Control T/Cs |
|---|---|---|---|---|
| **FLUX CONTROLLERS** | | | | |
| Pegasus Adapter Ring | 1 | 0 - 100 | N/A | |
| | | | | |
| **ZERO Q:**[1] | | | | |
| Cable Bundle | 2 | 20 | <= 6[2] | |
| T/C Bundle | 3 | 20 | <= 6[2] | |

**NOTE:** 1. **Zero-Q heater control** - goal is to minimize the temperature difference between the two T/Cs listed in "Control T/Cs" column. This is to be accomplished by adjusting the control setpoint. In addition, large temperature excursions of the T/C located near the heater shall be avoided by trimming its Zero-Q heater power.

2. **The maximum allowable temperature difference between the designated thermocouples shall be 2°C.**

**TABLE IV. FAST FLIGHT HEATERS**

| HEATER TYPE | LOCATION | POWER @28V (watts) | CONTROL | SETPOINTS (°C) | T/Cs - THERM |
|---|---|---|---|---|---|
| Operational: | Battery Mount | 6.2 | Thermostat | -3 to +2 | 51/SC7 |
| Survival: | Battery Mount | 5.0 | Thermostat | -7 to -2 | 51/SC7 |
| | Transponder Mount | 5.0 | Thermostat | -12 to -6 | 54/SC11 |

## 7. CLEANLINESS AND CONTAMINATION REQUIREMENTS

Before the FAST thermal vacuum/thermal balance test, Chamber 238 and all chamber support equipment will be baked out at 100°C and pressures less than $1 \times 10^{-5}$ torr. The bakeout will continue until both 10 MHz quartz crystal microbalances (QCMs) have delta readings less than 100 Hz/hr and delta-delta readings less than 15 Hz/hr/hr for five consecutive hours. These criteria will be measured with the QCM temperatures at -20°C and the QCM frequencies less than 10,000 Hz. When one of the QCMs exceeds 10,000 Hz during the test, it will be baked out at 80°C until the frequency has dropped to approximately its starting value. Once the QCM criteria are met, the chamber cold finger will be cooled to approximately -190°C for eight hours. The chamber temperature and pressure will then be returned to ambient at the standard rates.

After Chamber 238 reaches ambient conditions, airborne particle levels and air flow in the chamber will be measured by Code 754. If the airborne particle levels exceed FED-STD-209D Class 100,000 or the air flow is less than 70 cfm, corrective action will be taken by Code 754. Once the environmental parameters have been satisfactorily verified, internal chamber surfaces and support equipment surfaces will be vacuumed and solvent wiped until visibly clean.

FAST will be lifted into the chamber after the chamber has been baked out and cleaned. The spacecraft will be sealed in approved bagging when it is moved into the chamber. The bagging will be removed after the spacecraft is fastened to the chamber attach points and the chamber lid is rolled into place. All chamber operations conducted after the bag is removed will conform with facility garment requirements and the FAST Clean Area Operation Procedure, FAST-PROC-003.

During spacecraft test preparations in Chamber 238, two 10 MHz QCMs will be positioned with the sensors directed at gaps between the upper solar array and two EESA stacks. The two EESA stacks that will be targeted are adjacent to the TEAMS instrument on the spacecraft deck. When the QCMs are positioned, the sensors will be approximately six inches from the spacecraft. Final positioning of the QCM sensors must be approved by Code 724 before the chamber door is closed for testing.

In addition to the two QCMs, the vacuum chamber will be instrumented with a cold finger. The cold finger temperature will float with the shroud temperature during most of thermal vacuum/thermal balance, but it will be cooled to approximately -190°C for the final eight hours of testing. Following testing, a solvent wash of the cold finger will be submitted to Code 313 for analysis.

Once spacecraft thermal vacuum/thermal balance testing begins, QCM data will be recorded autonomously and be printed out at the end of each shift. Spacecraft outgassing levels will be considered certified when both QCMs read less than 200 Hz/hr for five consecutive hours of a hot soak stage. If this criteria is not met by the scheduled end of the final hot soak, the soak will be extended until the criteria is met.

The QCM criteria for spacecraft thermal vacuum/thermal balance testing will be measured with the QCM temperatures at -20°C and the QCM frequencies less than 10,000 Hz. When one of the QCMs exceeds 10,000 Hz during testing, it will be baked out at 80°C until the frequency has decreased to approximately its initial value.

During thermal vacuum transitions from a cold soak to a hot soak, the temperature difference between test thermal control surfaces and the spacecraft will be regulated. The maximum temperature difference between the test cold plates and the spacecraft will not exceed 25°C, while the maximum difference between the chamber shrouds and the spacecraft will remain less than 10°C. In addition, during transitions to a hot soak, the temperature rate of change will not exceed 30°C/hour for the cold plates and 20°C/hour for the chamber walls.

# 8. TEST PLAN

## 8.1 General

Testing of the FAST spacecraft will encompass performing four (4) thermal vacuum cycles and thermal balance testing. The thermal balance test shall be performed first then followed by the thermal vacuum cycles. These results will be used to verify the FAST spacecraft thermal models, and also to confirm the thermal design is flight worthy. A sketch of the TV/TB test profile is shown in Figure 4, FAST TV/TB Test Profile. A cold survival soak will be conducted prior to the first cold soak. Test equipment temperature and power setting for TB and TV are presented in Table VII, FAST TV/TB TEST EQUIPMENT SETTINGS.

## 8.2 Test Setup Operations

Before testing can begin, FAST must be properly and safely suspended in chamber 238. Code 740 will be responsible for the design and handling of the suspension and support equipment with code 754 providing the chamber hard mount points. Any safety related issues regarding the test setup shall be handled by code 754. Figure 6 shows the spacecraft suspension method.

## 8.3 Thermal Balance

At the beginning of the test cycles, the thermal balance testing shall be performed. This shall be accomplished by holding electrical power, chamber and cryo-plate temperatures, and test heater power, constant and allowing the spacecraft to come to thermal stability as defined in section 7. All thermocouples must meet the stability requirement in order for thermal balance to be declared. Power dissipations used for thermal balance testing are presented in Table V.

### 8.3.1 Hot Thermal Balance

The first test to be performed will be a hot thermal balance. The objective of this test is to provide data for the verification of the FAST thermal models and to also verify that the thermal control system operates properly in worst case hot conditions. The test conditions will attempt to mimic the worst hot on-orbit thermal environment expected during the mission. Cryo-plates, shroud, and the test heater will be configured to simulate a sun angle of 50° from the -Z spin axis with a full sun orbit. The spacecraft will be configured to high dissipation full-operation science data collection mode. Only the transponder will be in a low power configuration. At the beginning of the hot thermal balance, a hot magnetometer boom deployment and instrument aperture opening test will take place.

### 8.3.2 Cold Thermal Balance

Immediately following the completion of the hot thermal balance test, the chamber environment will be transitioned to mimic the worse case cold on-orbit environment expected during the mission.

The cryo-plates, shroud, and test heater will be configured to simulate a relatively high sun angle of 30° from the +Z spin axis with a 17 minute eclipse period orbit. The spacecraft will be configured to a low dissipation operation mode, in which the instrument payload is on, but not in operation. At the completion of thermal balance, the spacecraft will be configured to its highest power configuration, instruments at full operation and transponder transmitter on, and a second cold balance point will be achieved. Since FAST operations include heavy duty cycling of the science payload, data from this second balance point will be used to gage the thermal response and heat dissipation capabilities of the spacecraft during transient operational scenarios.

## 8.4 Thermal Vacuum

This test will, as a goal, subject FAST components to hot and cold temperature extremes 10°C beyond their mission predictions. In general, the subsystems have previously been subjected to eight (8) TV cycles at the component level as part of their qualification.

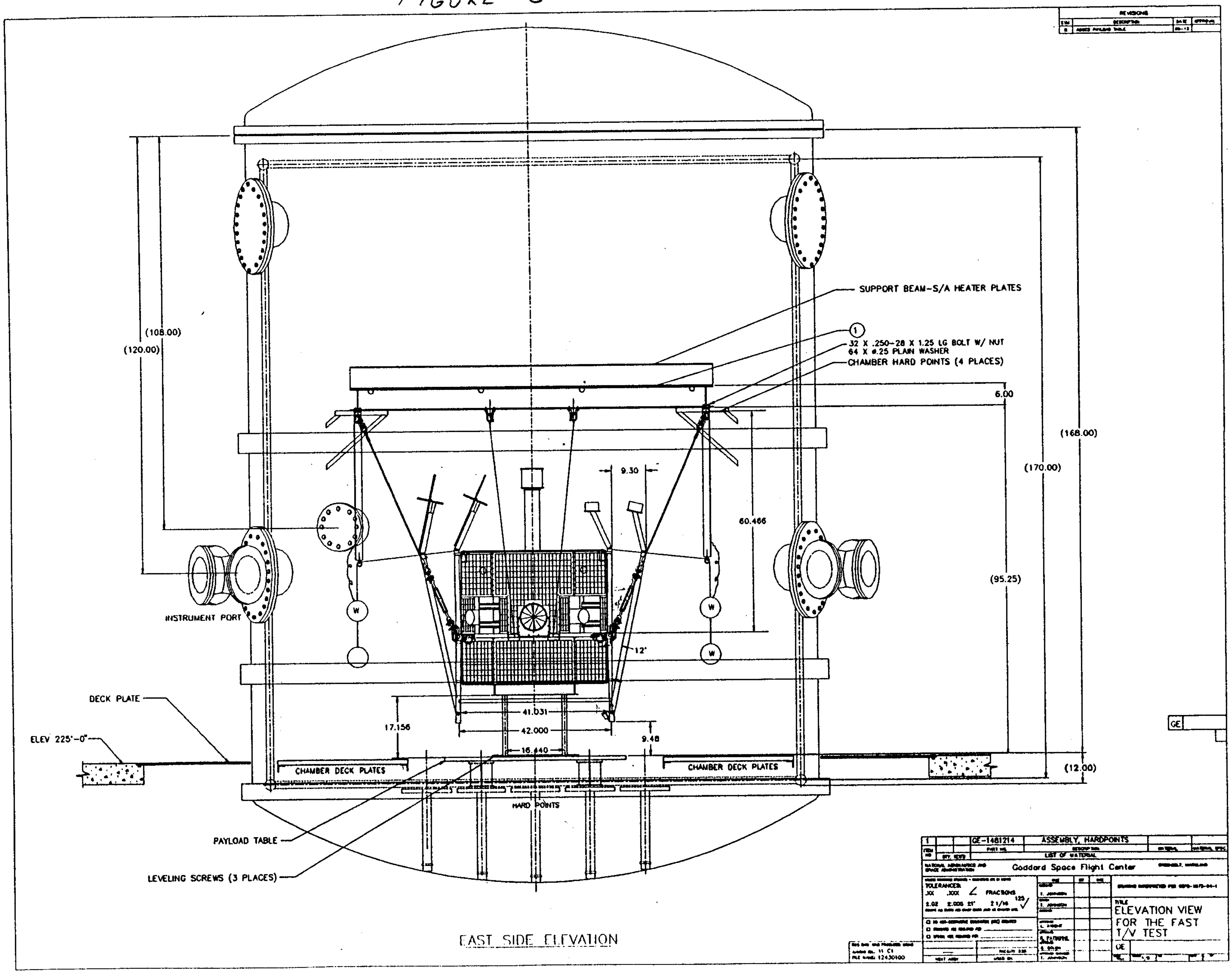
The temperature of the chamber and cryo-plates, and test heater settings chosen for the TV temperature soaks will, as a goal, subject components to 10°C beyond the worst mission on-orbit hot and cold operating scenarios.

During thermal vacuum testing functional tests shall be performed at each hot and cold soak and during the transitions. A cold magnetometer boom deployment and instrument aperture opening test shall be performed at the survival cold soak. At a minimum, two (2) long form functional tests will be conducted prior to the thermal vacuum test and after the thermal vacuum test.

The temperatures and test equipment settings were obtained from thermal analysis of the spacecraft in the test chamber, using geometric and thermal math models. Soak goal temperatures are presented in Table VI. The soak control thermocouples are presented in Table VIII. When one thermocouple from each control group is within 2°C of its goal, then the soak will be considered started. It should be noted, due to testing limitations, that these soak goal temperatures, in some cases are less extreme than the qualification limits. Also, since these are predicted soak values, the TTD may after reviewing the thermal data determine that less severe qualification limits will have to be accepted. The final soak temperature shall be determined by the TTD after consultation with the TD and the SMEX project.

Objectives for the TV test are to: demonstrate component hot and cold starts, demonstrate equipment functions correctly after exposure to non-operating survival limit, demonstrate equipment operates satisfactorily during exposure to temperatures 10°C beyond their flight predicted range, demonstrate proper operation during temperature transition, demonstrate proper thermostat/heater operation, verify thermostat "turn-on" and "turn-off" temperatures, and demonstrate the degree of spacecraft degradation before and after testing.

FIGURE 5




EAST SIDE ELEVATION

TABLE V FAST TB TEMPERATURE SUMMARY

TB ANALYSIS RESULTS 3/17/94

| Component | POWER DISSIPATIONS (WATTS) Hot | Cold 1 | Cold 2 | TEMPERATURE PREDICTIONS (°C) Hot | Cold 1 | Cold 2 |
|---|---|---|---|---|---|---|
| **INSTRUMENTS:** | | | | | | |
| | | | | | | |
| TEAMS | 4.5 | 1.38 | 4.5 | 42 | -2 | 20 |
| ESA Stacks | 7.7 | 0.0 | 7.7 | 36 | -3 | 12 |
| Wire Booms | 0 | 0.0 | 0.0 | 37 | -4 | 11 |
| Axial Boom Electronics | 1.0 | 1.0 | 1.0 | 39 | 8 | 24 |
| IDPU | 19.0 | 5.76 | 19.0 | 39 | -2 | 20 |
| Fluxgate Mag. | .06 | .06 | .06 | 33 | 13 | 14 |
| Searchcoil Mag. | .5 | 0.0 | .5 | 32 | -15 | 1 |
| | | | | | | |
| **SPACECRAFT:** | | | | | | |
| | | | | | | |
| MUE | 11.2 | 11.2 | 11.2 | 40 | -3 | 16 |
| Transponder | 3.9 | 3.9 | 32.0 | 42 | 2 | 37 |
| Battery | 6.0 | 3.0 | 3.0 | 16 | -1 | 4 |
| HCI Electronics | .47 | .47 | .47 | 42 | -1 | 22 |
| HCI Head | 0.0 | 0.0 | 0.0 | 38 | -9 | 5 |
| Sun Sensor Electronics | .34 | .34 | .34 | 42 | 0 | 23 |
| ACS Mag. | .07 | .07 | .07 | 23 | -19 | -19 |
| Spin Coil | 6.51 | 0.0 | 0.0 | 28 | 4 | 7 |
| Precession Coil | 7.75 | 0.0 | 0.0 | 41 | -7 | 12 |
| Shunt Electronics | 7.0 | .5 | 7.0 | 47 | -4 | 20 |
| UPPER SHUNT | 60.0 | 0.0 | 0.0 | | | |
| LOWER SHUNT | 0.0 | 0.0 | 30.0 | | | |
| | | | | | | |
| **TOTAL:** | 136.00 | 27.7 | 117 | | | |

TABLE VI. FAST FLIGHT PREDICTS VERSUS TV SOAK GOALS (°C)

| | Qual. Limit | Flight Predicts | TV Soak Goals |
|---|---|---|---|
| **INSTRUMENTS:** | | | |
| TEAMS Analyzer Mechanism | -50(-10)/60 | -35(0)/40 | -12/48 |
| TEAMS TOF/Electronics | -35/55 | -1/40 | -11/53 |
| ESA Aperture | -25/60 | -4/40 | -21/45 |
| ESA Electronics | -25/60 | -4/39 | -21/46 |
| Wire Booms | -25/60 | -4/42 | -21/46 |
| Axial Booms | -25/60 | -3/35 | -22/51 |
| Axial Boom Electronics | -25/60 | -10/40 | -11/53 |
| E-Field Spheres | -50/70 | -26/59 | -21/46 |
| IDPU | -25/60 | -5/42 | -16/50 |
| Fluxgate Mag | -45/70 | -13/53 | -13/45 |
| SearchCoil Mag. | -45/70 | -17/43 | -19/42 |
| Mag Boom Hinges | -25/60 | -35(-10)/46 | -40/31 |
| | | | |
| **SPACECRAFT:** | | | |
| MUE | -25/60 | -2/40 | -17/49 |
| Shunt Box | -25/60 | -3/45 | -10/55 |
| Transponder | -20/65 | -2/44 | -10/56 |
| Battery | -10/30 | -3/17 | -10/26 |
| HCI Electronics | -30/60 | -2/42 | -15/51 |
| HCI Head | -23/45 | -11/32 | -20/50 ** |
| Sun Sensor Electronics | -40/65 | -2/42 | -15/52 |
| Sun Sensor Head | -40/65 | -18/33 | -27/50 |
| Spin Coil | -30/60 | -17/38 | -28/50 |
| Precession Coil | -25/60 | -14/40 | -25/47 |
| ACS Mag | -45/56 | -35/46 | -29/50 |
| Nutation Damper | | -17/41 | -20/49 |
| Antenna | -110/60 | -102/42 | -30/50 |
| End Arrays | -95/106 | -62/78 | -36/32 |
| Upper Body Array | -95/106 | -48/48 | -31/45 |
| Lower Body Array | -95/106 | -44/46 | -31/45 |
| Bellyband Array | -95/106 | -16/36 | -22/49 |

PRELIMINARY TV ANALYSIS RESULTS 3/22/94

**TABLE VII. FAST TV/TB TEST EQUIPMENT TEMPERATURE SETTINGS**

TEST TEMPERATURE (°C)/HEATER POWER (watts)

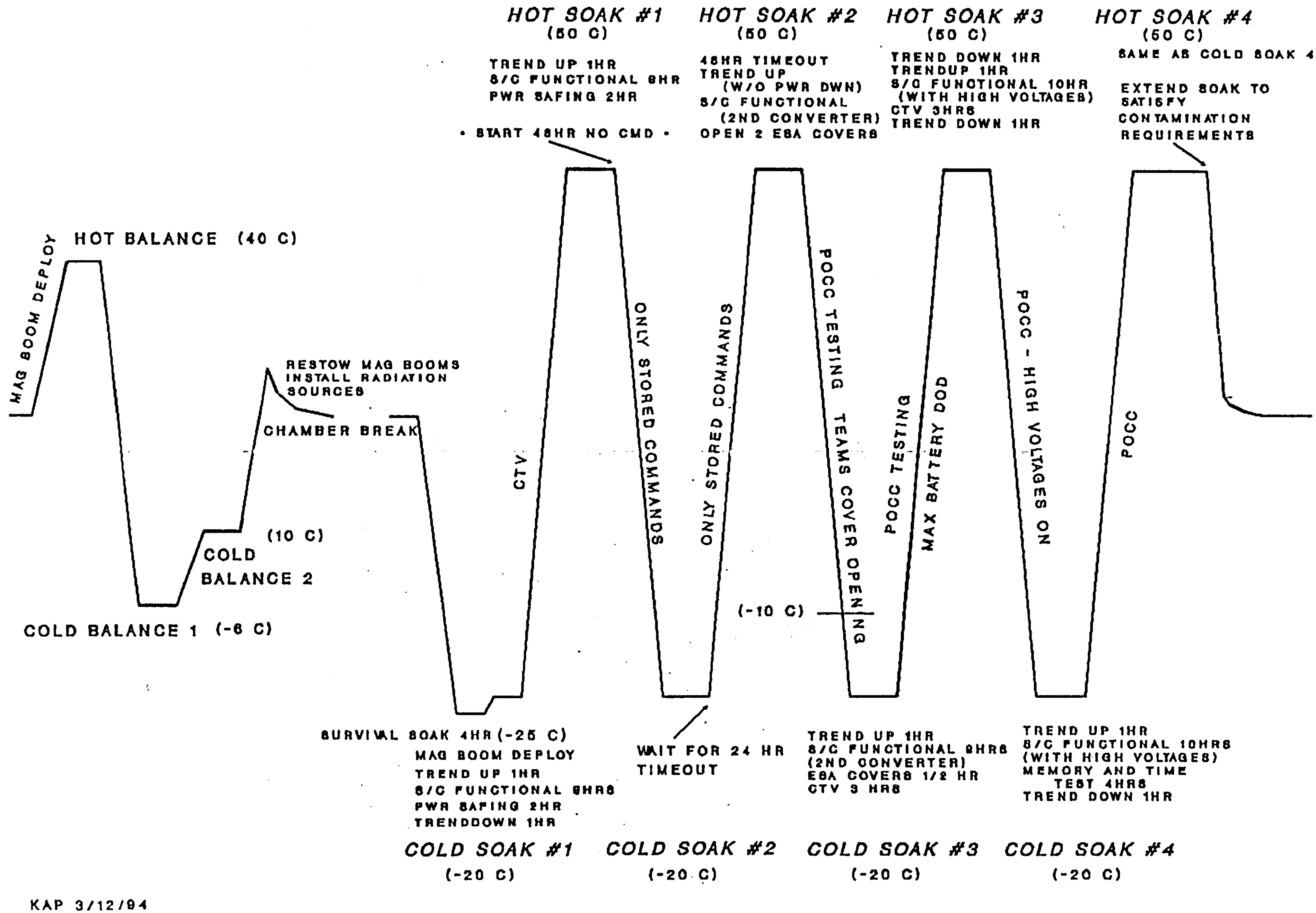
| | THERMAL BALANCE | | THERMAL VACUUM | | | |
|---|---|---|---|---|---|---|
| Item | Hot | Cold | Hot | Cold | Survival | TC/s |
| Chamber | 22 | -20 | 39 | -40 | -20 | 97-102 |
| Cryo-plate #1 | -94 | 78 | 50 | -80 | -60 | 82-87 |
| Cryo-plate #2 | 83 | -128 | 50 | -80 | -60 | 88-92 |
| TEAMS Cryo | 38 | -6 | 30 | -14 | 5 | 93,94 |
| Battery Cryo | -77 | -40 | -72 | -32 | -32 | 95,96 |
| Adapter Heater | 40.0 | 0.0 | 0.0 | 0.0 | 0.0 | N/A |

**TABLE VIII. CONTROL THERMOCOUPLE/SOAK GOAL SUMMARY**

| THERMOCOUPLE GROUP | COLD SURVIVAL | COLD SOAK | HOT SOAK |
|---|---|---|---|
| 12,13,18,19 BELLY BAND | -23 | -27 | 46 |
| 39,41,42,43 DECK | -24 | -19 | 50 |
| 47,48,49 RAD SHIELD | -26 | -23 | 50 |
| 69,70 ESA/WB FACE | -24 | -21 | 49 |
| 73,74 TEAMS APERTURE | -14 | -13 | 41 |
| 51 BATTERY BASEPLATE | -5 | -5 | 23 |
| | | | |
| | | | |
| | | | |

FIGURE C

# FAST TV/TB TEST PROFILE



## 9. TEST SET-UP

This test set-up shall be performed in the sequence given, any changes in this sequence must be approved by the TD.

1. Configure chamber, place test equipment in chamber.

2. Chamber Certification.

3. Install test heaters and thermocouples onto the spacecraft.

4. Lower S/C with elephant stand into chamber and attach to chamber floor, remove birdcage.

5. Attach support cables to spacecraft and chamber hardpoints.

6. Remove spacecraft from elephant stand, and raise spacecraft.

7. Install CP#2 along with the G-10 support pegs

8. Adjust support cables to relieve cable load on to support pegs.

9. Install remaining FAST flight hardware. Check out test heaters and T/Cs.

10. Install and check out remaining test hardware, cryoplates, etc.

11. Perform full S/C functional test.

12. Close chamber, begin pumpdown

## 10. TEST PROCEDURE

The test sequence outlined in this procedure shall be strictly followed. Any changes to the sequence must have prior approval from the TD. **Refer to Functional Test Script in the Appendix E for functional test procedure.**

Thermal test data will be collected according to the following:

- TTC shall snap thermocouple page from Code 754's data acquisition system every hour, on the hour. Frequency may be increased at the TTD's direction

- Eight hour plots of all thermocouple plot groups shall be made at the completion of each shift. One hour plots shall be made when verifying heater turn on and turn off.

- Chamber pressure shall be recorded every hour.

- Designated spacecraft telemetry pages shall be snapped on the hour every hour.

- Designated parameters, ie power, etc. shall recorded as directed.

- TTCs will log all thermal and functional events in the designated test log book

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10.1 THERMAL BALANCE TEST

10.1.1 HOT MAG BOOM DEPLOYMENT TEST

10.1.1.1 Start pump down of thermal vacuum chamber.

10.1.1.2 When chamber pressure reach $1x10^{-5}$ torr, set test equipment as per Table IX Test Matrix and make changes as noted.

**TABLE IX WILL BE FILLED IN DURING THE TV/TB TEST WITH THE ACTUAL CHANGES. AS THE TEST PROGRESSES, TABLE IX CAN BE REFERRED TO FOR PREVIOUS TRANSITION SETTINGS. THE TTD WILL GIVE INSTRUCTIONS TO THE TTCs FOR THE FIRST FEW TRANSITIONS ON TRANSITION RATES AND TEST SETTINGS. DURING TV/TB TESTING, DEVIATIONS FROM TABLE IX ARE PERMISSIBLE BY THE TTCs. TABLE IX SERVES ONLY AS A GUIDE. TTCs ARE TO TRANSITION THE PAYLOAD AT APPROPRIATE RATES IN ORDER TO MEET THE TEST OBJECTIVES AS EFFICIENTLY AS POSSIBLE WHILE, MAINTAINING SPACECRAFT CONTAMINATION INTEGRITY, AND, KEEPING TEMPERATURES WITHIN RED LIMITS.**

10.1.1.3 Monitor solar array temperatures carefully. The objective is to reach the following temperatures on the solar arrays and then deploy the magnetometer booms:

| ITEM | TCs | TEMPERATURE REQUIREMENT |
|---|---|---|
| Upper End Array | 1,2 | - 1°C (+2°/-5°) |
| Upper Body Array | 3,8,9 | 23°C (+/-5°) |
| Lower Body Array | 22,25,26 | 37°C (+/-5°) |
| Lower End Array | 22,22 | 70°C (+5°/-2°) |

When at least one thermocouple from each item reaches the required temperature, go for magnetometer boom deployment. **Refer to functional test script in Appendix E for the mag boom deployment test functional procedure.**

10.1.2 HOT THERMAL BALANCE

10.1.2.1 Immediately following the mag boom deployment, set the controls for the chamber, cryo plates and test heater to the settings indicated in Table VII, thermal balance hot soak temperatures. **Refer to functional test script in Appendix E for the Hot Balance functional procedure.**

10.1.2.2 Verify spacecraft is properly configured as per Table VI. Spacecraft should be in full operate, transponder idle. Verify and record battery voltage and trickle charge rate.

10.1.2.3 Instrument and "house-keeping" electronic power dissipations shall be as specified in Table VI and remain constant throughout the TB hot test. Power dissipation for each electronics box shall be recorded every hour. Check and make adjustments to "Zero-Q" heaters setpoints if necessary.

10.1.2.4 Allow payload temperatures to stabilize to the criteria specified in section 6, Test Tolerances. All temperature sensors shall be used to determine temperature stability. Record power and temperatures every hour.

10.1.2.5 When the spacecraft temperatures meet the stability requirements specified in Section 6, Test Tolerances, as determined by TTC, the hot case thermal balance test is completed. Record power and temperatures.

10.1.3 COLD THERMAL BALANCE TRANSITION

10.1.3.1 Use TTD instruction as a guide to transition the spacecraft to the cold thermal balance. **Refer to**

**functional test script in Appendix E for the Cold Balance transition functional procedure.**

10.1.4 COLD THERMAL BALANCE POINT 1

10.1.4.1 When spacecraft deck temperatures reach approximately 5°C ,set the controls for the chamber, cryo plates and test heater to the settings indicated in Table VII, thermal balance cold soak temperatures. When battery adapter temperatures reach 5°C also set battery cryo-plate temperature as indicated in Table VII. **Refer to functional test script in Appendix E for the Cold Balance functional procedure.**

10.1.4.2 Verify spacecraft is properly configured as per Table VI. Spacecraft should be in fully on but idling, transponder idling. Verify and record battery voltage and trickle charge rate.

10.1.4.3 Instrument and "house-keeping" electronic power dissipations shall be as specified in Table VI and remain constant throughout the TB cold test. Power dissipation for each electronics box shall be recorded every hour. Check and make adjustments to "Zero-Q" heaters setpoints if necessary.

10.1.4.4 Allow payload temperatures to stabilize to the criteria specified in section 6, Test Tolerances. All temperature sensors shall be used to determine temperature stability. Record power and temperatures every hour. Battery operational heaters may cycle.

10.1.4.5 When the spacecraft temperatures meet the stability requirements specified in Section 6, Test Tolerances, as determined by TTC, the cold case thermal balance test point one is completed. Record power and temperatures.

10.1.5 COLD THERMAL BALANCE POINT 2

10.1.5.1 When Cold Balance Point #1 has been confirmed, instruct TD to configure spacecraft to full operate, instruments in data collection mode, transponder transmitting. Verify that spacecraft is configured as per Table VI. Verify and record battery voltage and trickle charge rate.

10.1.5.2 Instrument and "house-keeping" electronic power dissipation shall be as specified in Table VI and remain constant throughout the TB cold test part 2.

Power dissipation for each electronics box shall be recorded. Check and make adjustments to "Zero-Q" heaters setpoints if necessary.

10.1.5.3 Record temperatures and power every hour.

10.1.5.4 When the spacecraft temperatures meet the stability requirements specified in section 6 as determined by the TTC, the cold thermal balance test is complete

10.1.6 TRANSITION TO AMBIENT

10.1.6.1 Reset chamber, cold plates, and test heater for transition to ambient temperatures. **Note: Refer to Section 7 for contamination requirements during transition.**

10.1.6.2 Monitor spacecraft temperatures and power levels carefully during transition. Power levels on the spacecraft should be lowered as the spacecraft approaches ambient temperatures.

10.1.6.3 When deck temperatures reach 27°C and battery adapter approaches 21°, reset all test equipment temperatures to ambient and power off test heaters.

10.1.6.4 When all TCs are at or above ambient, fill chamber and prepare to open chamber door.

10.2 CHAMBER BREAK

10.2.1 When safe to do so, the magnetometer booms and instrument a will be reset.

10.2.2 Install Nickle-63 radiation source. **NOTE: This is the last procedure to take place before closing chamber door, no personnel may enter chamber after source is installed.**

10.2.3 Close door and start pump down of thermal vacuum chamber.

10.3 THERMAL VACUUM TEST - CYCLE #1

10.3.1 Cold Survival Soak Transition

10.3.1.1 When chamber pressure reaches $1x10^{-5}$ torr, set test equipment controls as per TTD instruction. The goal of survival soak is to reach the soak criteria specified in Table VIII. Use Table VIII as a guide to all soak goals. The spacecraft should be configured in the launch/initial acquisition lowest power mode for survival soak.

10.3.1.2 As temperatures drop record the spacecraft's operational and survival heater thermostat "turn-on" temperatures. This shall be accomplished by monitoring the current draw through the operational and survival heater buses, and by monitoring key temperatures near heaters and thermostats. Record the TC temperature, heater current and voltage immediately after turn-on.

| HEATER | TCs | EXPECTED TURN-ON TEMP | ACTUAL TEMP | CURRENT |
|---|---|---|---|---|
| BATTERY OPER. | 51,52 | -3°C | ___________ | _______ |

* after battery heater turn-on, disable operational heater bus

| HEATER | TCs | EXPECTED TURN-ON TEMP | ACTUAL TEMP | CURRENT |
|---|---|---|---|---|
| BATTERY SURV. | 51,52 | -7°C | ___________ | _____ |
| TRANS. SURV. | 55,56 | -12°C | ___________ | _______ |

After both survival heaters have been verified disable survival heater bus. Make hard copies of one hour plots which indicate heater turn-on.
**Refer to TRANSITION #1 section in the Appendix E for functional procedure.**

10.3.2 SURVIVAL SOAK

10.3.2.1 Once control T/Cs reach cold survival soak temperatures as indicated in Table VIII, the TV survival cold soak shall be considered started. Stabilize the heat and cryo plates and chamber at the survival cold soak temperatures. The goal is to reach the survival temperature limits on the instrument assemblies and spacecraft electronics, therefore chamber and cold plate temperatures may have to be adjusted from these values to achieve this goal. Table VIII will be updated based on the first cycle.

10.3.2.1 At the completion of the 4 hours survival cold soak, cold start will be demonstrated by conducting spacecraft turn on procedure. **Refer to cold start functional test, in Appendix E.**

10.3.2.2 At the completion of the cold start, the magnetometer booms deployment test will occur. **See Appendix E, for mag boom deployment functional test procedure**

10.3.3 COLD SOAK #1

10.3.3.1 At the completion of all cold survival soak activities, set chamber, cryo-plate, and test heater controls to the cold soak settings listed in Table VII. **See Appendix E, for Cold Soak #1 functional procedures.**

10.3.3.2 Stabilize test equipment at the settings/temperatures listed in Table VII. The goal is to reach the soak temperatures listed in Table VIII, therefore the test equipment settings may have to be adjusted from what is listed. Monitor temperatures closely, to prevent red limit violations.

10.3.3.3 Maintain temperatures throughout the duration of the soak period. When all functional tests are complete cold soak #1 will be considered complete.

10.3.4 HOT TRANSITION #1

10.3.4.1 Reset the controls for the chamber, heat and cryo plates to the temperatures indicated by TTD instruction, to transition the payload to the hot soak temperatures. **Note: Refer to Section 7 for contamination requirements during transition.**

10.3.4.2 Re-enable survival heater bus. As temperatures rise record the spacecraft's operational and survival heater thermostat "turn-off" temperatures. This shall be accomplished by monitoring the current draw through the operational and survival heater buses, and by monitoring key temperatures near heaters and thermostats. After battery survival heater turn off is verified, re-enable the operational heater Record the TC temperature, heater current and voltage immediately before turn-off.

| HEATER | TCs | EXPECTED TURN-OFF TEMP | ACTUAL TEMP | CURRENT |
|---|---|---|---|---|
| BATTERY OPER. | 51,52 | 2°C | ________ | ______ |
| BATTERY SURV. | 51,52 | -2°C | ________ | ______ |
| TRANS. SURV. | 55,56 | -6°C | ________ | ______ |

Make hard copies of one hour plots which indicate heater turn-off.
**Refer to HOT TRANSITION #1 section in the Appendix E for functional procedure.**

10.3.4.3 Disable both heater buses

10.3.4.4 Stabilize test equipment at the settings/temperatures listed in Table VII. The goal is to reach the soak temperatures listed in Table VIII, therefore the test equipment settings may have to be adjusted from what is listed. Monitor temperatures closely, to prevent red limit violations.

10.3.4.5 Once control T/Cs reach hot soak temperatures as indicated in Table VIII, the TV hot soak shall be considered started. The **Refer to HOT SOAK #1 section in the Appendix E for functional procedure.**

10.3.4.6 Maintain spacecraft temperatures at the soak goals throughout the soak period. When all functional tests are complete hot soak #1 will be completed. **NOTE: AT THE END OF THE SOAK, THE SPACECRAFT WILL RUN ON STORED COMMANDS ONLY UNTIL THE SPACECRAFT'S 48 HOUR WATCHDOG TIMES OUT. THE HEATER BUSES WERE DISABLED BECAUSE NO COMMANDS ARE TO BE SENT TO THE SPACECRAFT.**

10.4 THERMAL VACUUM CYCLE #2

10.4.1 COLD TRANSITION #2

10.4.1.1 Transition spacecraft to cold soak temperatures. Use the guide in Table IX with test data from cycle #1 to adjust accordingly. **Refer to cold transition #2 section in Appendix E for function test plan.**

10.4.1.2 Stabilize test equipment at the settings/temperatures listed in Table VII. The goal is to reach the soak temperatures listed in Table VIII, therefore the test equipment settings may have to be adjusted from what is listed. Monitor temperatures closely, to prevent red limit violations.

10.4.1.3 Once control T/Cs reach COLD soak temperatures as indicated in Table VIII, the TV cold soak shall be considered started. The **Refer to COLD SOAK #2 section in the Appendix E for functional procedure.**

10.4.2 COLD SOAK #2

10.4.2.1 Maintain temperatures throughout the duration of the soak period. Cold Soak #2 will be complete when the 24 hour watchdog timer expires on the spacecraft. The FTC will notify. Cold soak #2 will end 24 hours after the start of cold transition #2

10.4.3 HOT TRANSITION #2

10.4.3.1 Reset the controls for the chamber, heat and cryo plates to the temperatures indicated in Table IX, to transition the payload to the hot soak temperatures. Use the test data from hot transition #1 as a guide. **Note: Refer to Section 7 for contamination requirements during transition.**

10.4.3.2 Stabilize test equipment at the settings/temperatures listed in Table VII. The goal is to reach the soak temperatures listed in Table VIII, therefore the test equipment settings may have to be adjusted from what is listed. Monitor temperatures closely, to prevent red limit violations.

10.4.3.3 Once control T/Cs reach hot soak temperatures as indicated in Table VIII, the TV hot soak shall be considered started. **The Refer to HOT SOAK #2 section in the Appendix E for functional procedure.**

10.4.4 HOT SOAK #2

10.4.4.1 After the 48 hour watchdog timer expires, functional testing will begin. Functional testing will include the opening of two ESA Stack's apertures. Verify ESA external temperature and contamination data before opening stacks. **THE TTD AND THE CONTAMINATION CONTROL ENGINEER MUST REVIEW THE THERMAL AND CONTAMINATION CONDITIONS BEFORE OPENING APERTURES**

10.5 THERMAL VACUUM CYCLE #3

10.5.1 COLD TRANSITION #3

10.5.1.1 Transition spacecraft to cold soak temperatures. Use the guide in Table IX, but also use the test data from cycles #1 and #2 to adjust accordingly. **Refer to cold transition #3 section in Appendix E for function test plan.**

10.5.1.2 Re-enable operational and survival heater bus

10.5.1.3 As temperatures drop record the spacecraft's operational and survival heater thermostat "turn-on" temperatures. This shall be accomplished by monitoring the current draw through the operational and survival heater buses, and by monitoring key temperatures near heaters and thermostats. Record the TC temperature, heater current and voltage immediately after turn-on.

| HEATER | TCs | EXPECTED TURN-ON TEMP | ACTUAL TEMP | CURRENT |
|---|---|---|---|---|
| BATTERY OPER. | 51,52 | -3°C | ____________ | _______ |

* after battery heater turn-on, disable operational heater bus

| HEATER | TCs | EXPECTED TURN-ON TEMP | ACTUAL TEMP | CURRENT |
|---|---|---|---|---|
| BATTERY SURV. | 51,52 | -7°C | ____________ | ______ |
| TRANS. SURV. | 55,56 | -12°C | ____________ | _______ |

After both survival heaters have been verified disable survival heater bus. Make hard copies of one hour plots which indicate heater turn-on.

10.5.1.4 Monitor TEAMS aperture temperatures, TCs 73 & 74, closely. When these temperature reach -10°C, the TEAMS aperture will be opened. **THE TTD AND THE CONTAMINATION CONTROL ENGINEER MUST REVIEW THE THERMAL AND CONTAMINATION CONDITIONS BEFORE OPENING APERTURE.**_

10.5.1.5 Stabilize test equipment at the settings/temperatures listed in Table VII. The goal is to reach the soak temperatures listed in Table VIII, therefore the test equipment settings may have to be adjusted from what is listed. Monitor temperatures closely, to prevent red limit violations.

10.5.1.6 Once control T/Cs reach COLD soak temperatures as indicated in Table VIII, the TV cold soak shall be considered started. **Refer to COLD SOAK #3 section in the Appendix E for functional procedure.**

10.5.2 COLD SOAK #3

10.5.2.1 Maintain temperatures throughout the duration of the soak period. During the cold soak, the other two ESA stacks will have their apertures opened. Verify ESA external temperatures and contamination data before opening stacks. **THE TTD AND THE CONTAMINATION CONTROL ENGINEER MUST REVIEW THE THERMAL AND CONTAMINATION CONDITIONS BEFORE OPENING APERTURES**

10.5.2.2 When all functional test activities are completed, cold soak #3 will be ended.

10.5.3 HOT TRANSITION #3

10.5.3.1 Reset the controls for the chamber, heat and cryo plates to the temperatures indicated in Table IX, to transition the payload to the hot soak temperatures. Use the test data from hot transition #1 and #2 as a guide. **Note: Refer to Section 7 for contamination requirements during transition. Refer to Hot Transition #3 section in Appendix E for functional procedure.**

10.5.3.2 Re-enable survival heater bus. As temperatures rise record the spacecraft's operational and survival heater thermostat "turn-off" temperatures. This shall be accomplished by monitoring the current draw through the operational and survival heater buses, and by monitoring key temperatures near heaters and thermostats. After battery survival heater turn off is verified, re-enable the operational heater Record the TC temperature, heater current and voltage immediately before turn-off.

| HEATER | TCs | EXPECTED TURN-OFF TEMP | ACTUAL TEMP | CURRENT |
|---|---|---|---|---|
| BATTERY OPER. | 51,52 | 2°C | ____________ | _______ |
| BATTERY SURV. | 51,52 | -2°C | ____________ | ______ |
| TRANS. SURV. | 55,56 | -6°C | ____________ | ______ |

Make hard copies of one hour plots which indicate heater turn-off.

10.5.3.3 During the transition, battery discharge and charge activity will be high. Monitor battery temperatures carefully and discuss battery activities with the FTC. **IT IS VERY IMPORTANT TO ANTICIPATE BATTERY HEAT DISSIPATIONS AND TO CHANGE THE CRYO-PLATE ACCORDINGLY. THE LARGE THERMAL MASS OF THE BATTERY NECESSITATES ADVANCED THERMAL CONDITIONING TO PREVENT RUNAWAY TEMPERATURES**

10.5.3.4 Stabilize test equipment at the settings/temperatures listed in Table VII. The goal is to reach the soak temperatures listed in Table VIII, therefore the test equipment settings may have to be adjusted from what is listed. Monitor temperatures closely, to prevent red limit violations.

10.5.3.5 Once control T/Cs reach hot soak temperatures as indicated in Table VIII, the TV hot soak shall be considered started. **The Refer to HOT SOAK #3 section in the Appendix E for functional procedure.**

10.5.4 HOT SOAK #3

10.5.4.1 During hot soak #3 the ESA and TEAMS high voltages will be turned on and left on for the duration of the thermal vacuum test. Confirm chamber pressure requirement before turning on high voltages.

**THE CHAMBER PRESSURE MUST BE BELOW 2.0 X $10^{-6}$ torr FOR THE PREVIOUS 12 HOURS BEFORE TURNING HIGH VOLTAGES ON. THE PRESSURE MUST REMAIN BELOW 2.0 X 10-6 torr WHILE THE HIGH VOLTAGES ARE ON. MONITOR CHAMBER PRESSURE CLOSELY WHILE THE HIGH VOLTAGES ARE ON AND RECORD EVERY 1/2 HOUR. IF THE PRESSURE RISES ABOVE THE REQUIREMENT, INSTRUCT FTC TO TURN INSTRUMENT HIGH VOLTAGES OFF.**

10.5.4.2 When all functional tests are complete, hot soak #3 will be complete

10.6 THERMAL VACUUM CYCLE #4

10.6.1 COLD TRANSITION #4

10.6.1.1 Transition spacecraft to cold soak temperatures. Use the guide in Table IX, but also use the test data from cycles #1,#2, and #3 to adjust accordingly. **Refer to cold transition #4 section in Appendix E for function test plan.**

10.6.1.2 As temperatures drop record the spacecraft's operational and survival heater thermostat "turn-on" temperatures. This shall be accomplished by monitoring the current draw through the operational and survival heater buses, and by monitoring key temperatures near heaters and thermostats. Record the TC temperature, heater current and voltage immediately after turn-on.

| HEATER | TCs | EXPECTED TURN-ON TEMP | ACTUAL TEMP | CURRENT |
|---|---|---|---|---|
| BATTERY OPER. | 51,52 | -3°C | ________ | ______ |

* after battery heater turn-on, disable operational heater bus

| HEATER | TCs | EXPECTED TURN-ON TEMP | ACTUAL TEMP | CURRENT |
|---|---|---|---|---|
| BATTERY SURV. | 51,52 | -7°C | ________ | ______ |
| TRANS. SURV. | 55,56 | -12°C | ________ | ______ |

After both survival heaters have been verified disable survival heater bus. Make hard copies of one hour plots which indicate heater turn-on.

10.6.1.3 Stabilize test equipment at the settings/temperatures listed in Table VII. The goal is to reach the soak temperatures listed in Table VIII, therefore the test equipment settings may have to be adjusted from what is listed. Monitor temperatures closely, to prevent red limit violations.

10.6.1.4 Once control T/Cs reach COLD soak temperatures as indicated in Table VIII, the TV cold soak shall be considered started. **Refer to COLD SOAK #4 section in the Appendix E for functional procedure.**

10.6.2 COLD SOAK #4

10.6.2.1 Maintain temperatures throughout the duration of the soak period. When all functional test activities are completed, cold soak #3 will be ended.

10.6.3 HOT TRANSITION #4

10.6.3.1 Reset the controls for the chamber, heat and cryo plates to the temperatures indicated in Table IX, to transition the payload to the hot soak temperatures. Use the test data from hot transition #1,#2 and #3 as a guide. **Note: Refer to Section 7 for contamination requirements during transition. Refer to Hot Transition #4 section in Appendix E for functional procedure.**

10.6.3.2 Re-enable survival heater bus. As temperatures rise record the spacecraft's operational and survival heater thermostat "turn-off" temperatures. This shall be accomplished by monitoring the current draw through the operational and survival heater buses, and by monitoring key temperatures near heaters and thermostats. After battery survival heater turn off is verified, re-enable the operational heater Record the TC temperature, heater current and voltage immediately before turn-off.

| HEATER | TCs | EXPECTED TURN-OFF TEMP | ACTUAL TEMP | CURRENT |
|---|---|---|---|---|
| BATTERY OPER. | 51,52 | 2°C | ____________ | _______ |
| BATTERY SURV. | 51,52 | -2°C | ____________ | ______ |
| TRANS. SURV. | 55,56 | -6°C | ____________ | _______ |

Make hard copies of one hour plots which indicate heater turn-off.

10.6.3.4 Stabilize test equipment at the settings/temperatures listed in Table VII. The goal is to reach the soak temperatures listed in Table VIII, therefore the test equipment settings may have to be adjusted from what is listed. Monitor temperatures closely, to prevent red limit violations.

10.6.3.5 Once control T/Cs reach hot soak temperatures as indicated in Table VIII, the TV hot soak shall be considered started. **The Refer to HOT SOAK #4 section in the Appendix E for functional procedure.**

10.6.4 HOT SOAK #4

10.6.4.1 At the beginning of the hot soak the cold finger and outgassing certifications will begin.

10.6.4.2 Hot soak #4 will continue until both the functional tests are complete and the contamination requirements of Section 7 are met.

10.7 RETURN TO AMBIENT

10.7.1 At the completion of the hot soak, transition the payload to ambient temperature. **Refer to Appendix E for functional test procedure during return to ambient.**

10.7.2 Back fill chamber and prepare to open chamber door. The TV/TB test is now over.

**TABLE IX. TV/TB TEST MATRIX TEST MATRIX**
(filled in during test)

| ACTION/DATE/TIME | CHAMBER TEMP | CP#1 TEMP | CP#2 TEMP | BATTERY CRYO TEMP | TEAMS CRYO TEMP | TEST HEATER (WATTS) | SPACECRAFT CONFIGURATION |
|---|---|---|---|---|---|---|---|
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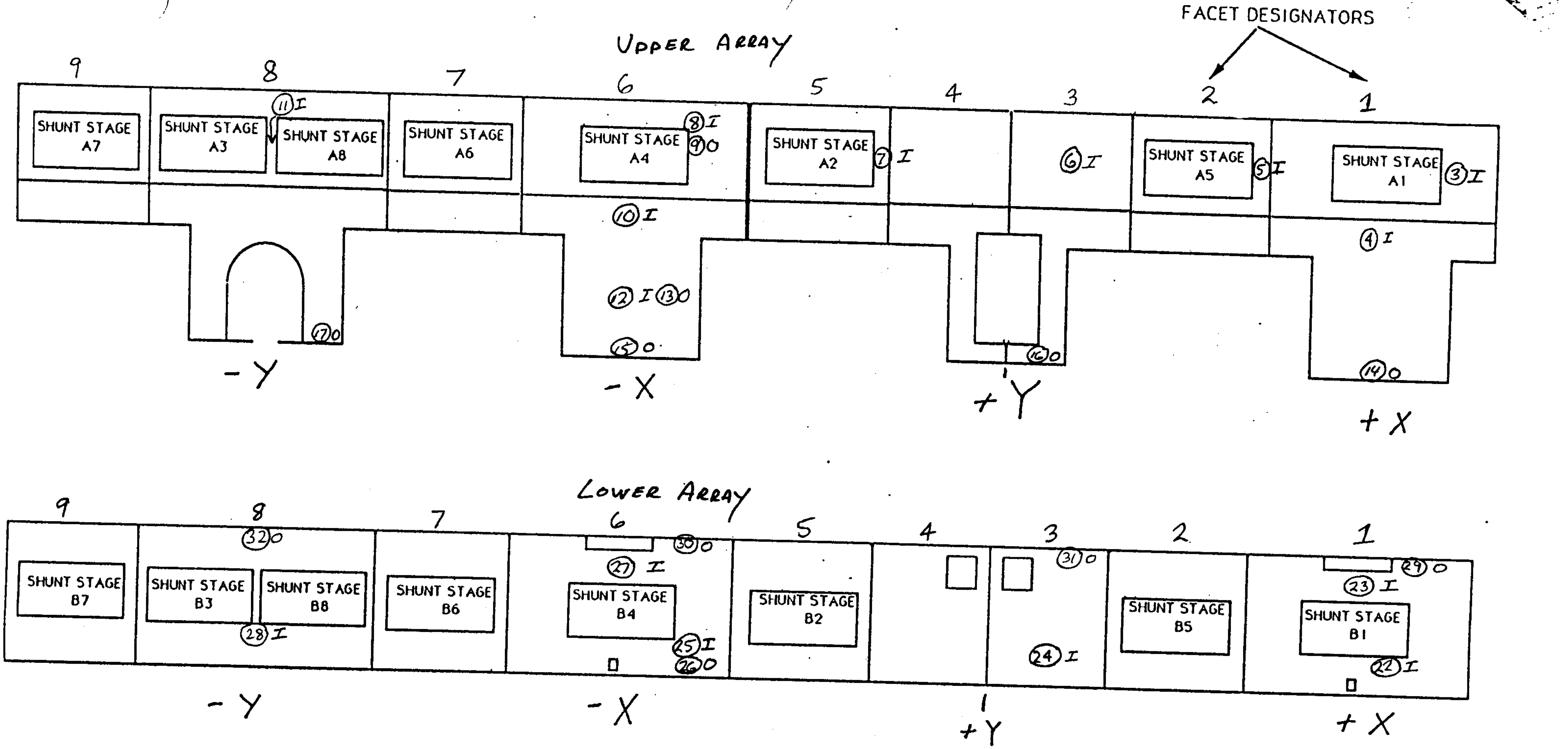
# APPENDIX A

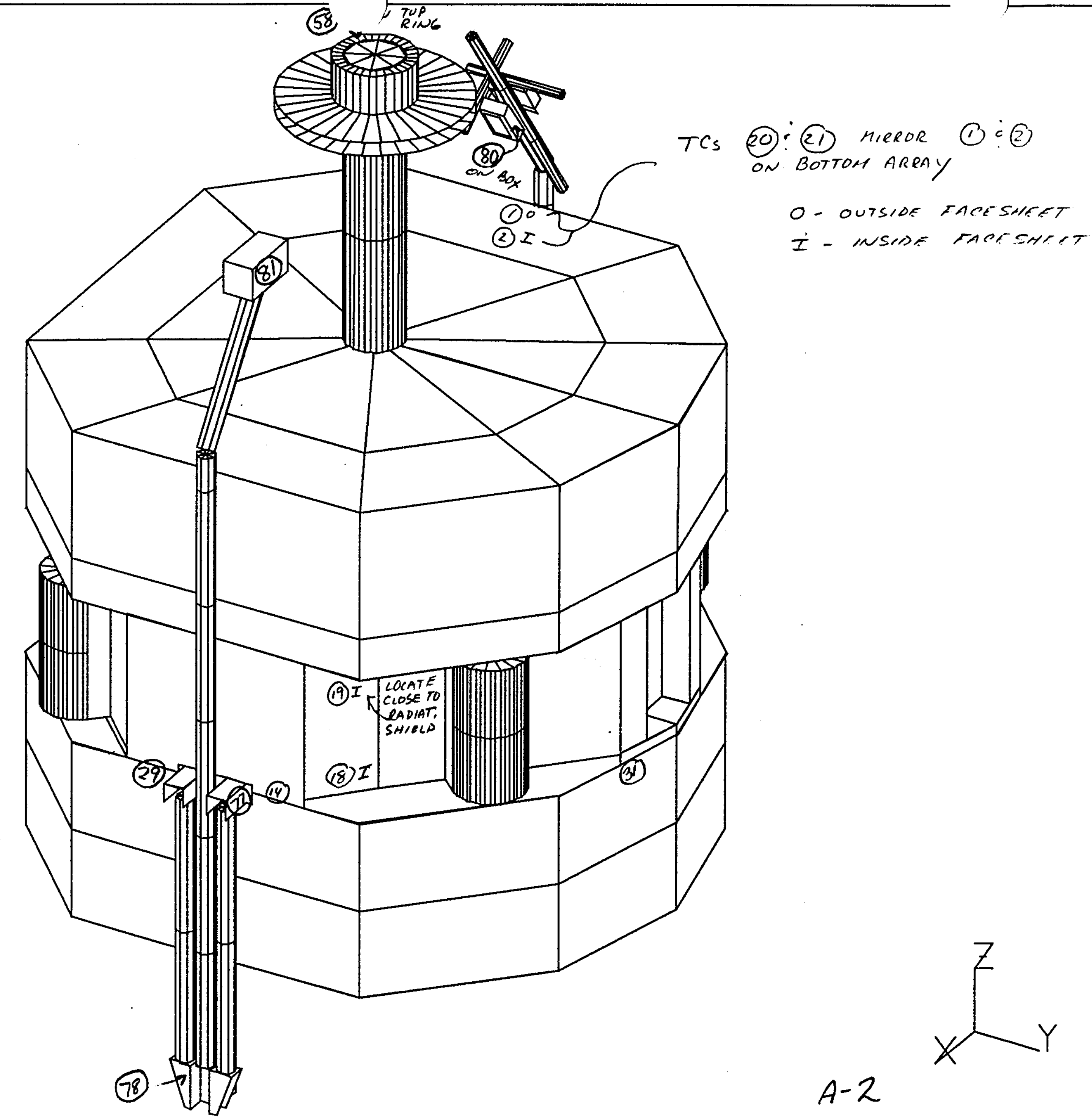
# THERMOCOUPLE LOCATIONS

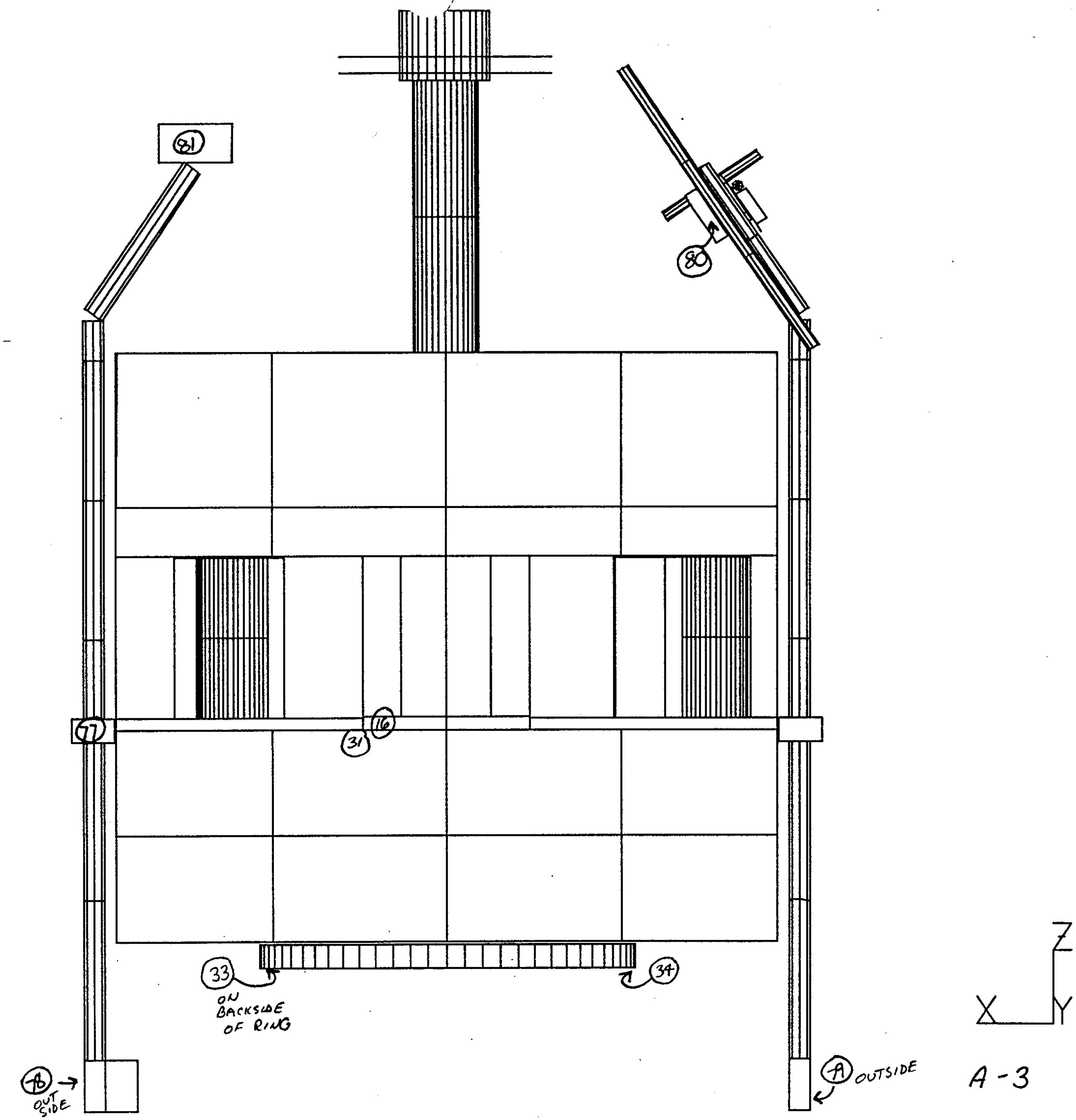



I - DESIGNATES INNER FACESHEET
O - " OUTER FACESHEET

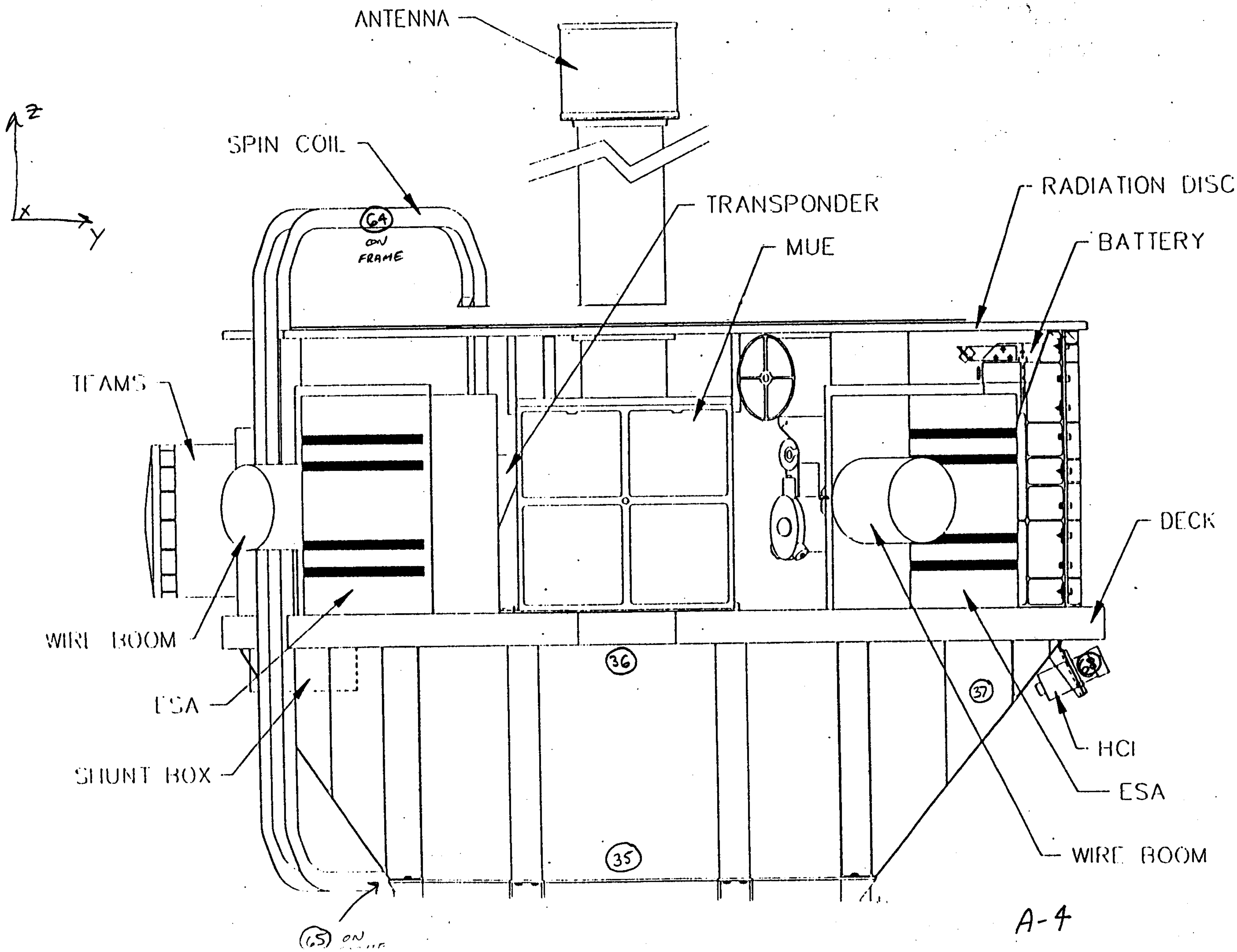
# BODY ARRAY THERMOCOUPLE LOCATIONS

* ARRAYS SHOWN FLAT FOR CLARITY


TCs (20) : (21) MIRROR (1) : (2)
ON BOTTOM ARRAY
O - OUTSIDE FACESHEET
I - INSIDE FACESHEET
(58) TOP RING
(80) ON BOX
(1) O
(2) I
(81)
(19) I
LOCATE CLOSE TO RADIAT. SHIELD
(18) I
(29)
(72)
(14)
(31)
(78)
Z
Y
X

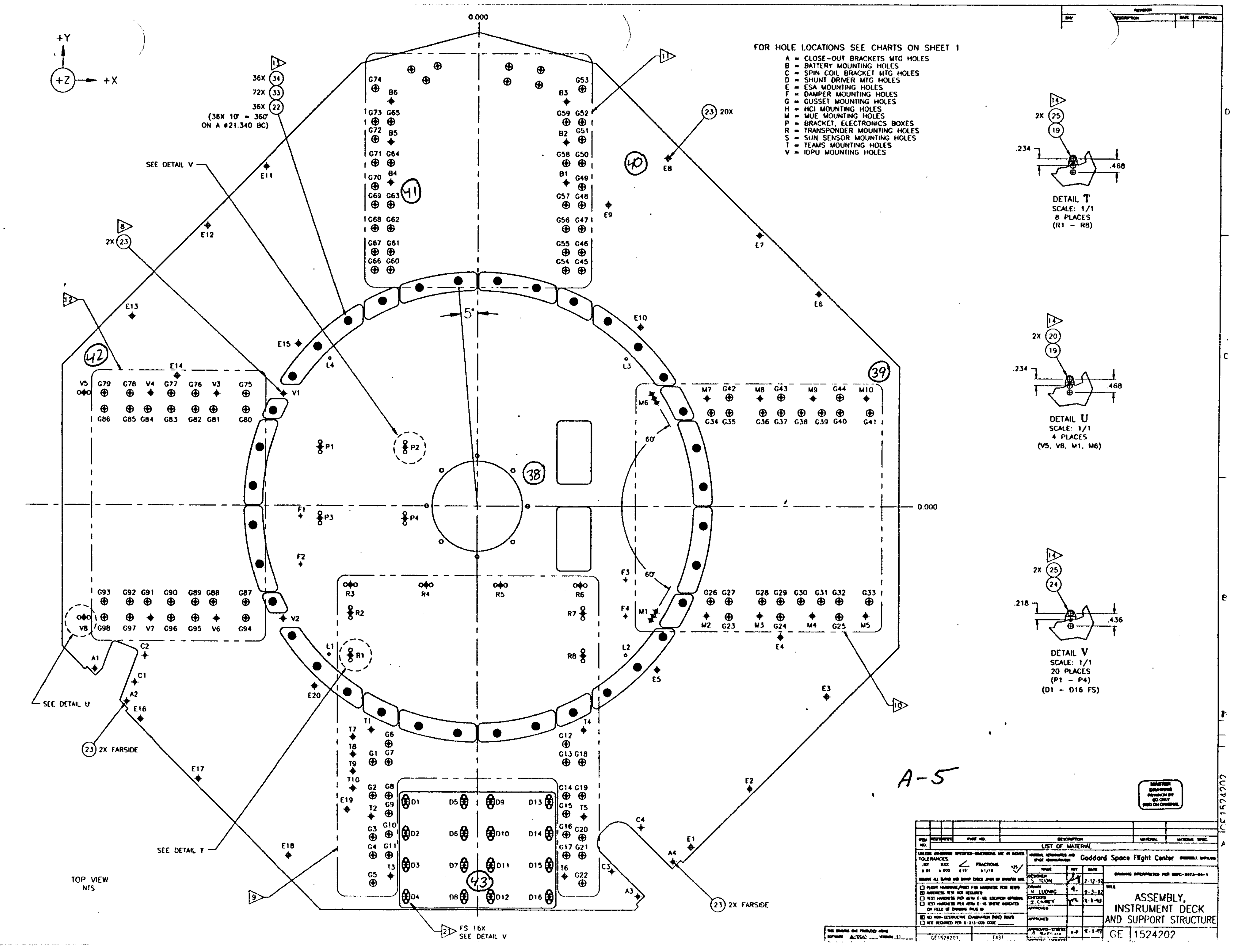



A-3



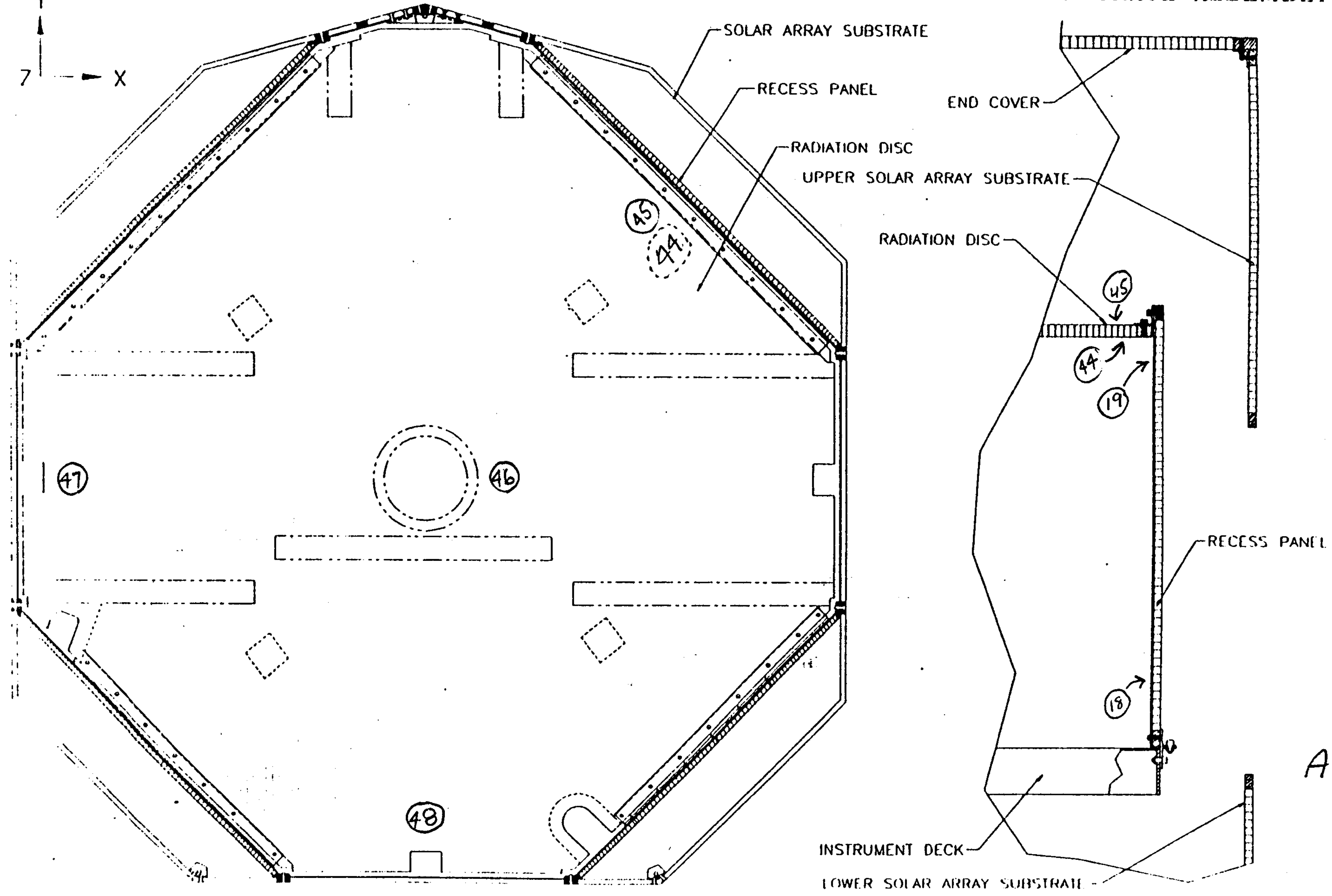
ANTENNA
SPIN COIL
64 ON FRAME
TRANSPONDER
MUE
RADIATION DISC
BATTERY
DECK
TEAMS
WIRE BOOM
ESA
SHUNT BOX
36
37
35
HCI
ESA
WIRE BOOM
Z
X
Y

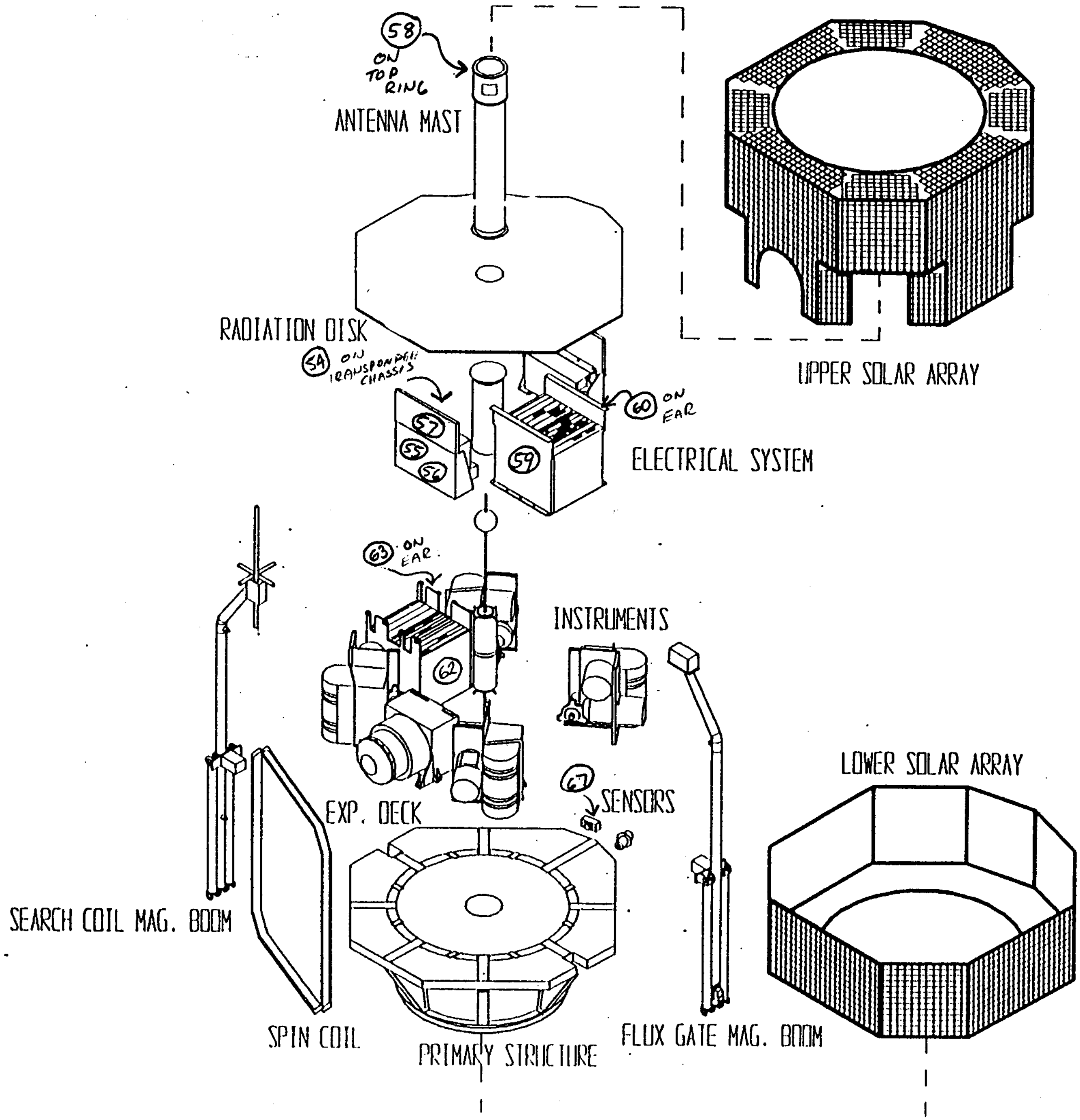

A-4

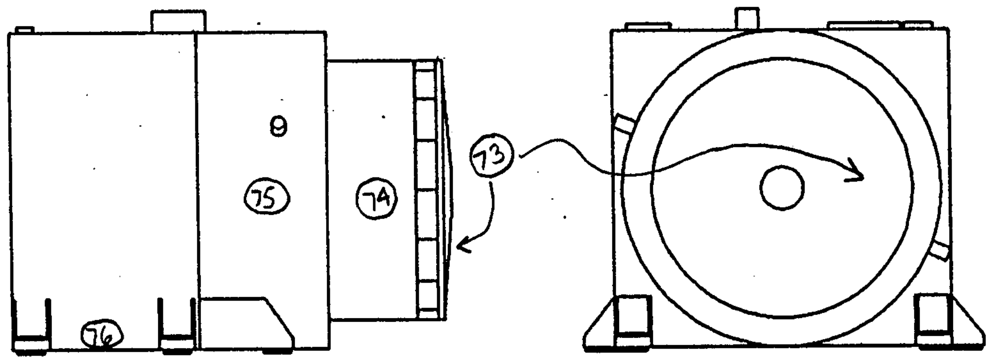

FOR HOLE LOCATIONS SEE CHARTS ON SHEET 1
A = CLOSE-OUT BRACKETS MTG HOLES
B = BATTERY MOUNTING HOLES
C = SPIN COIL BRACKET MTG HOLES
D = SHUNT DRIVER MTG HOLES
E = ESA MOUNTING HOLES
F = DAMPER MOUNTING HOLES
G = GUSSET MOUNTING HOLES
H = HCI MOUNTING HOLES
M = MUE MOUNTING HOLES
P = BRACKET, ELECTRONICS BOXES
R = TRANSPONDER MOUNTING HOLES
S = SUN SENSOR MOUNTING HOLES
T = TEAMS MOUNTING HOLES
V = IDPU MOUNTING HOLES
DETAIL T
SCALE: 1/1
8 PLACES
(R1 - R8)
DETAIL U
SCALE: 1/1
4 PLACES
(V5, V8, M1, M6)
DETAIL V
SCALE: 1/1
20 PLACES
(P1 - P4)
(D1 - D16 FS)
(38X 10° = 360° ON A ø21.340 BC)
SEE DETAIL V
SEE DETAIL U
SEE DETAIL T
FS 16X SEE DETAIL V
2X FARSIDE
TOP VIEW
NTS
A-5
LIST OF MATERIAL
Goddard Space Flight Center
ASSEMBLY,
INSTRUMENT DECK
AND SUPPORT STRUCTURE
GE 1524202

# SMEX / FAST

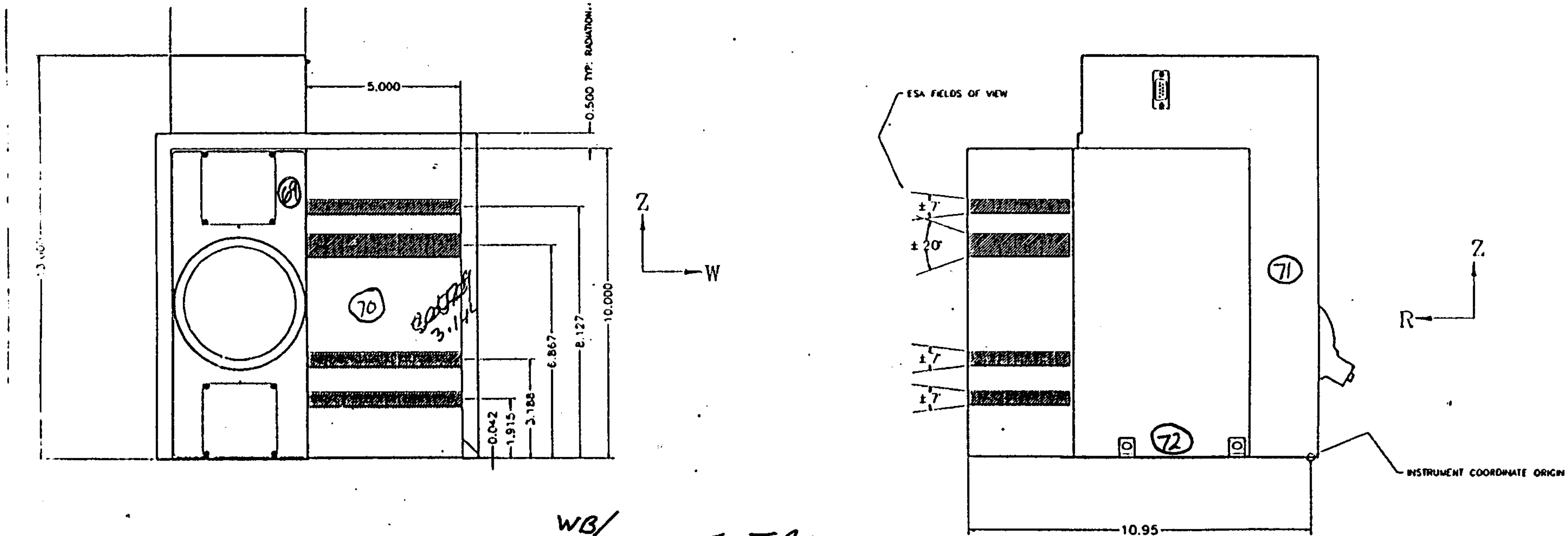
## SOLAR ARRAY SUBSTRATE ASSEMBLY



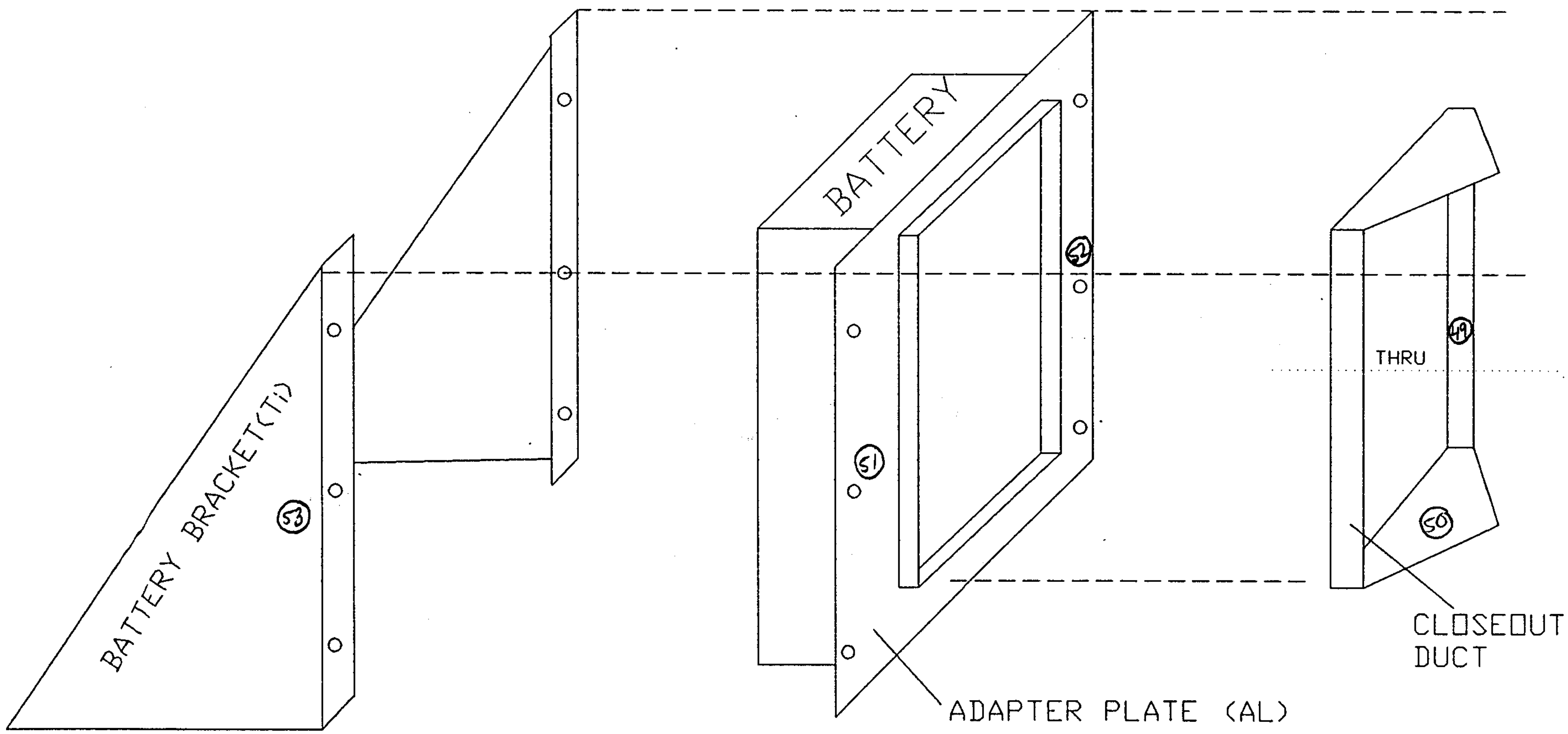

58
ON TOP RING
ANTENNA MAST
RADIATION DISK
54 ON TRANSPONDER CHASSIS
57
55
56
59
60 ON EAR
ELECTRICAL SYSTEM
UPPER SOLAR ARRAY
63 ON EAR
62
INSTRUMENTS
67
SENSORS
EXP. DECK
SEARCH COIL MAG. BOOM
SPIN COIL
PRIMARY STRUCTURE
FLUX GATE MAG. BOOM
LOWER SOLAR ARRAY




TEAMS TC LOCATIONS




WB/ +X+Y ESA UNIT TC LOCATIONS



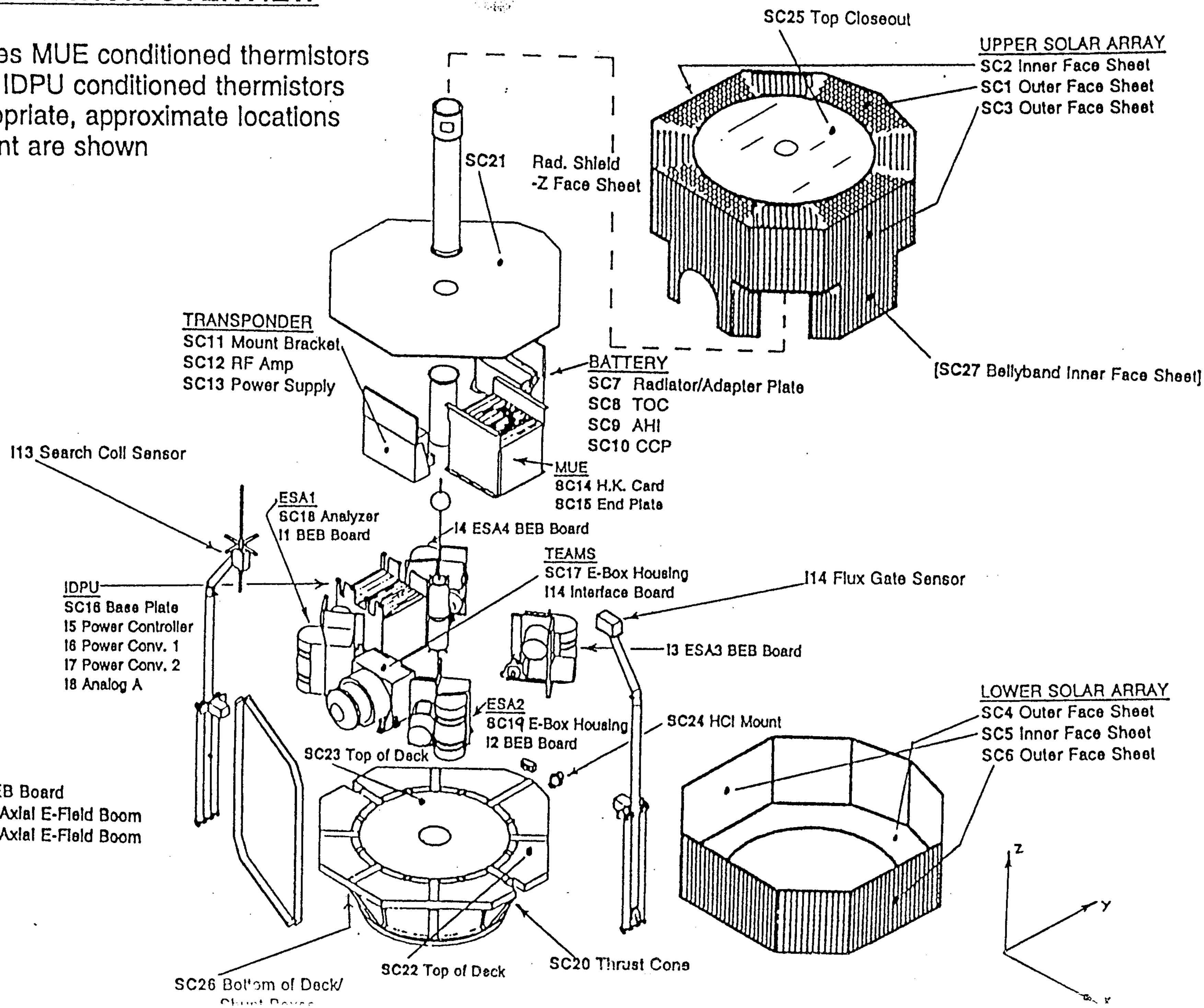

BATTERY ASSEMBLY TC LOCATIONS

# APPENDIX B

# SPACECRAFT THERMISTOR LOCATIONS

# THERMI[...]R LOCATION OVERVIEW

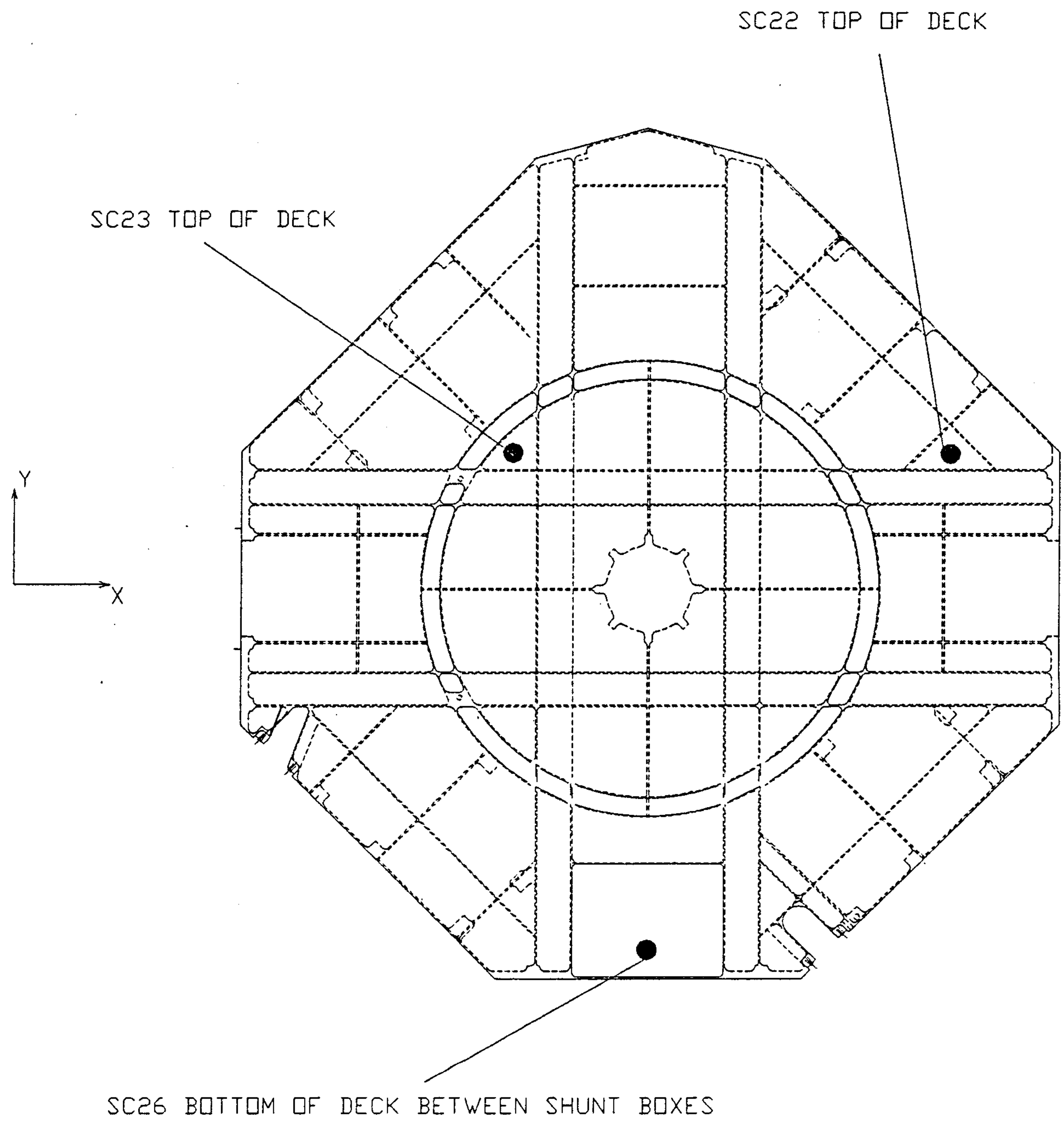
- SC designates MUE conditioned thermistors
- I designates IDPU conditioned thermistors
- Where appropriate, approximate locations on component are shown

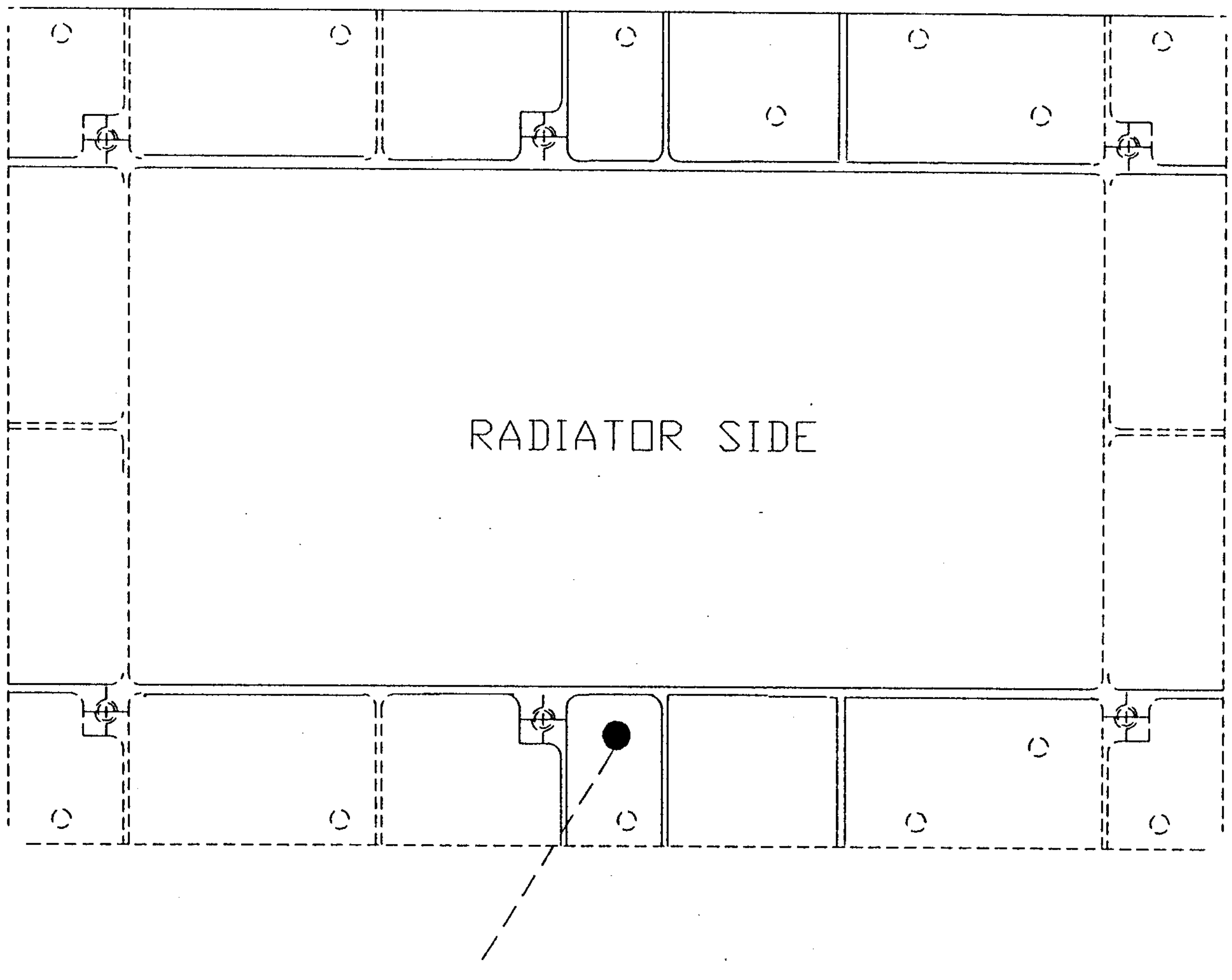



NOT SHOWN:

I9 Axial BEB Board
I10 Upper Axial E-Field Boom
I11 Lower Axial E-Field Boom

# FAST EQUIPMENT DECK THERMISTOR LOCATIONS

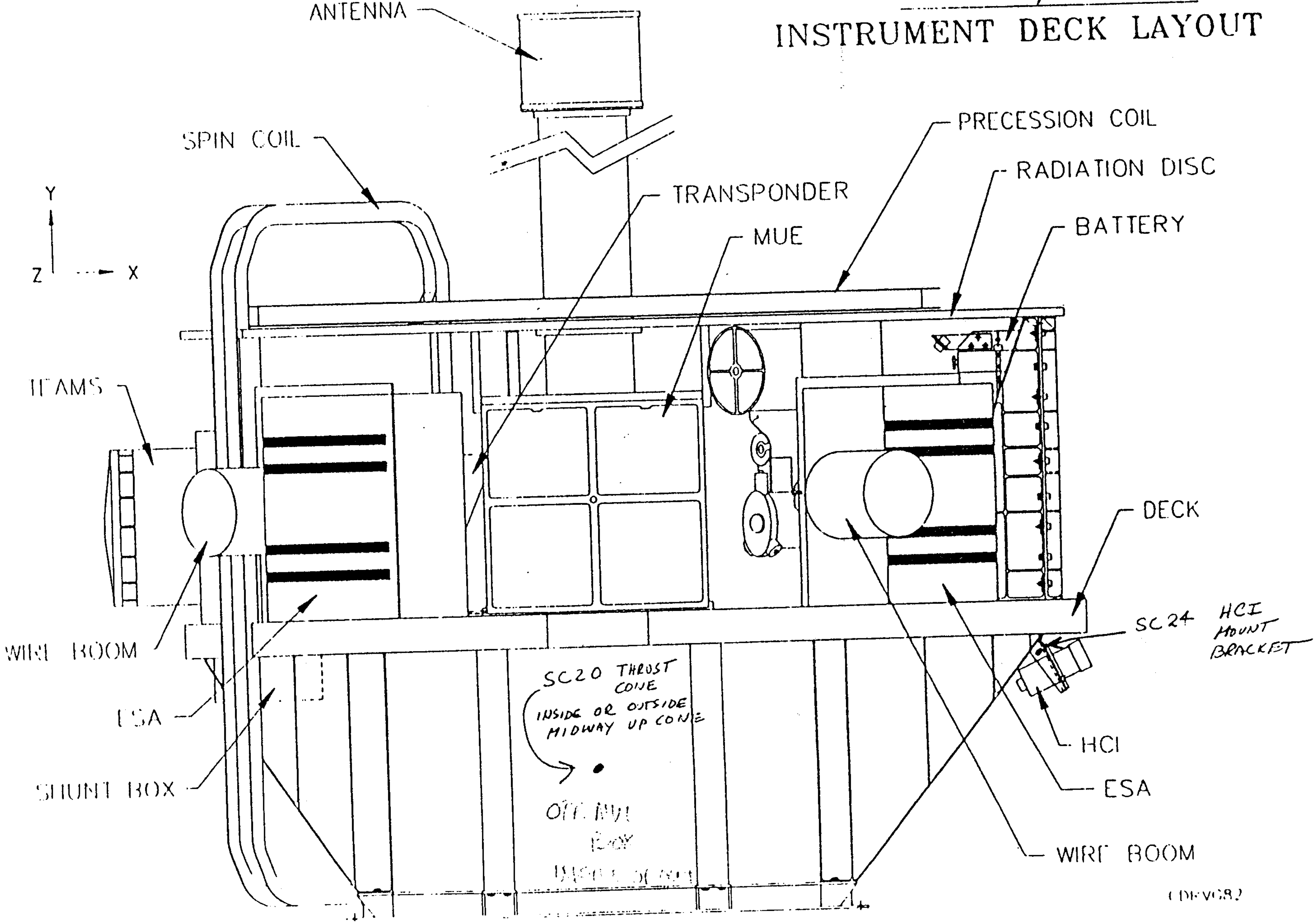





SC7 BATTERY ADDAPTER PLATE THERMISTOR

# SMEX / FAST

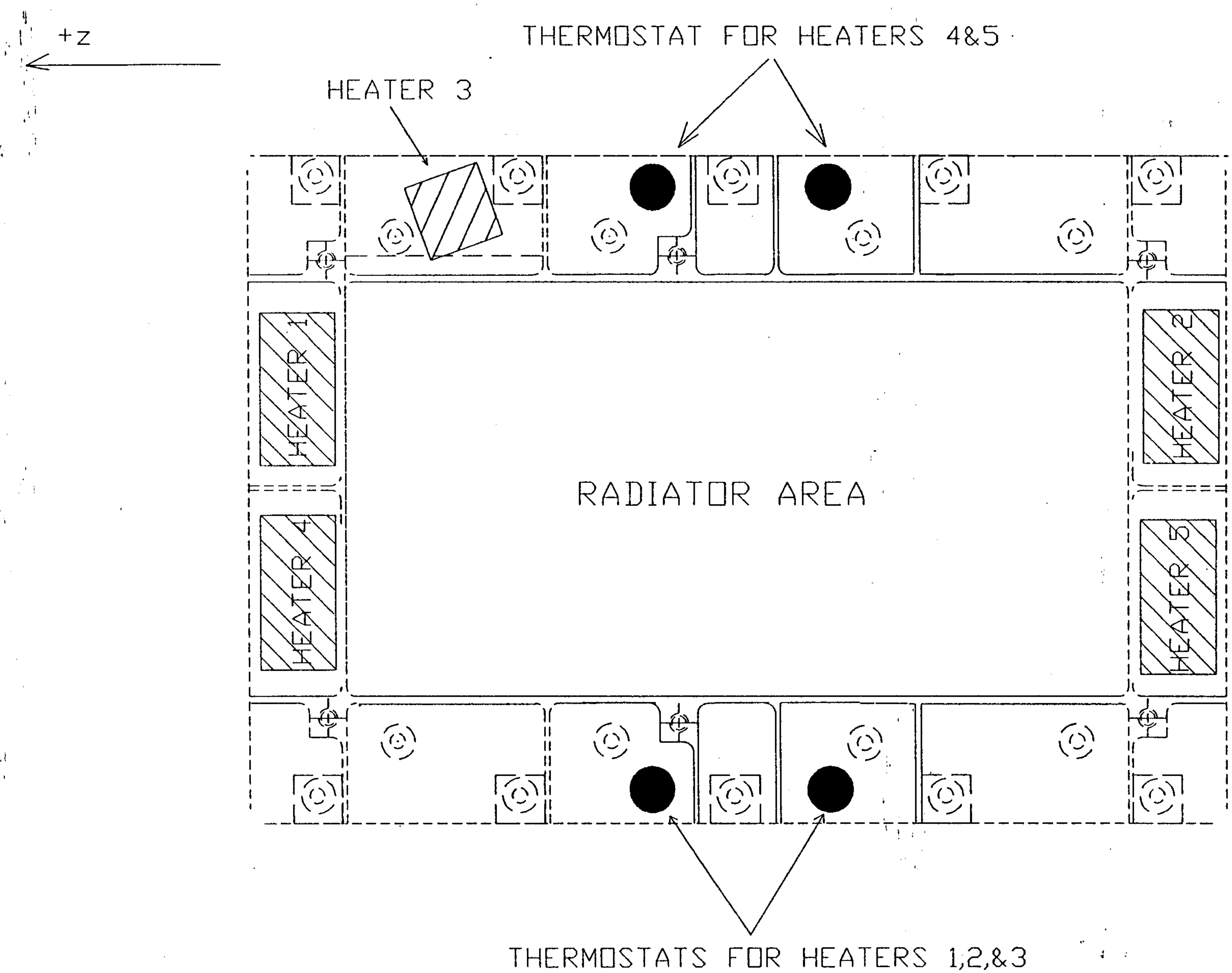
## INSTRUMENT DECK LAYOUT



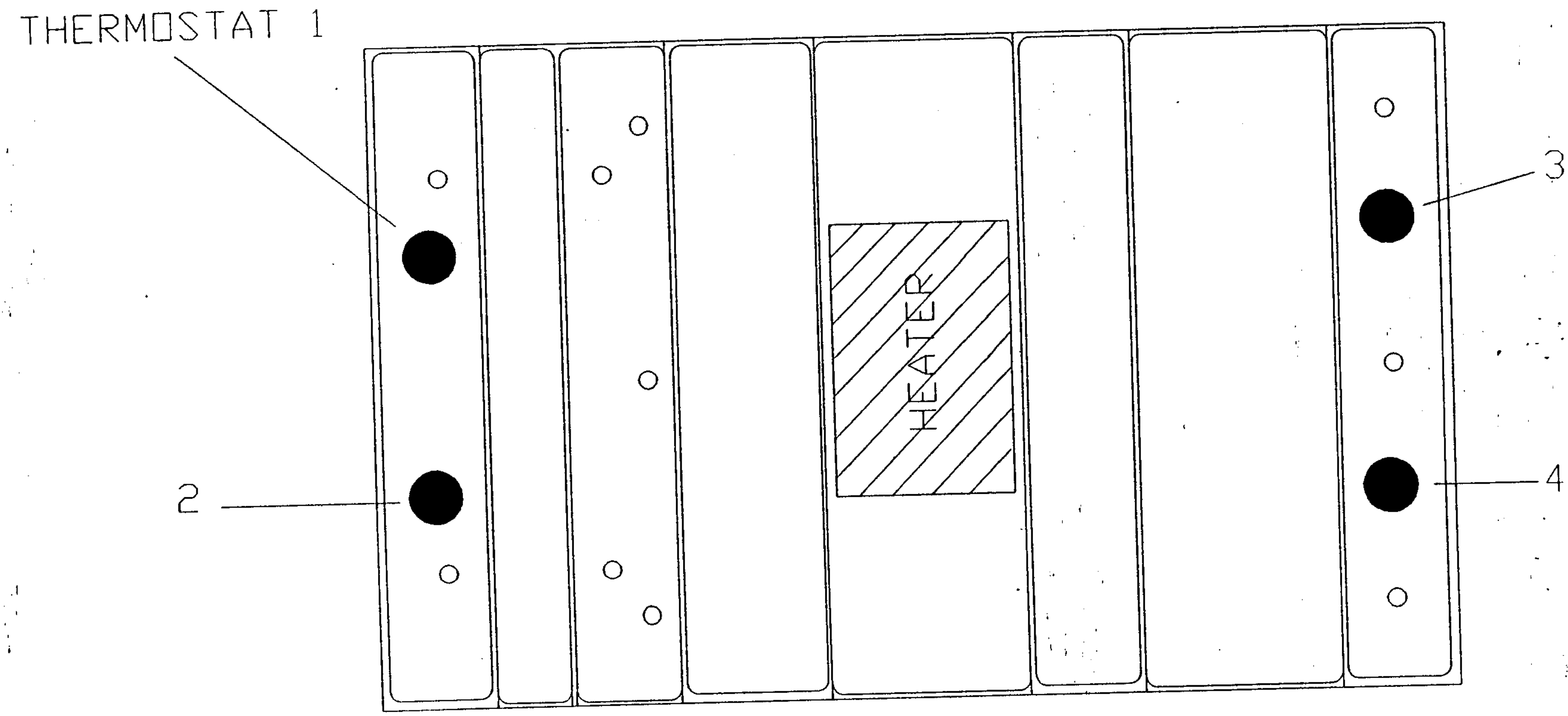
# APPENDIX C

# FLIGHT AND HEATER LOCATIONS

# FAST BATTERY ADAPTOR PLATE HEATER AND THERMOSTAT LOCATIONS



# TRANSPONDER MOUNT BRACKET SURVIVAL HEATER AND THERMOSTATS




(SEE HARNESS DRAWING FOR THERMOSTAT WIRING DETAILS)

# APPENDIX D
# FAST DATA FLOW

# APPENDIX E

# FAST FUNCTIONAL TEST SCRIPT

SMEX FAST
THERMAL VACUUM SCRIPT

David Everett
April 15, 1994

This script begins prior to closing the chamber door.

PRE-TEST

start strendup

start sfunctional

run MUE memory test

start strenddown

THERMAL BALANCE, TRANSITION TO HOT BALANCE

final spacecraft closeout

close chamber

begin pumpdown

wait until pressure is less than $10^{-5}$ torr

start strendup, battery on line

configure everything on except transmitter and instrument high voltages, battery in

trickle C/50, shunt B (upper array), 2 A shunt current

deploy magnetometer boom

HOT BALANCE

hot balance--wait for direction from thermal engineer

TRANSITION TO COLD BALANCE #1

start strenddown

battery on umbilical trickle (C/100)

wait for thermal go ahead

start spwrup, normal mode, battery on line, trickle = C/100, shunt A (lower array),

100 mA shunt current

start idpuaon

start instraon

back orbit configuration

COLD BALANCE #1

cold balance1--wait for direction from thermal engineer

TRANSITION TO COLD BALANCE #2

transmitter on override timer, all instruments on, 1 A shunt current, shunt A

COLD BALANCE #2

cold balance 2--wait for direction from thermal engineer

TRANSITION TO AMBIENT

CHAMBER BREAK

open chamber

stow magnetometer booms

install E-field stimulation

install radiation source

close chamber

TRANSITION TO SURVIVAL SOAK

pump down

wait until pressure is less than $10^{-5}$ torr

start trendup, finish in launch mode

transition to initial acquisition

verify heater operation

SURVIVAL SOAK

survival soak--initial acquisition, orbit cycle, worst case array output

COLD SOAK #1

deploy magnetometer boom

start spwrdwn

start strendup

start sfunctional

run ACS absolute time test

run ACS magnetometer gain test

run power system long functional (FAST-PROC-026) all sections except V/T and C/D

start strenddown

TRANSITION TO HOT SOAK #1

start spwrup

run ACS clock drift test continuously

run CTV tests

HOT SOAK #1

start spwrdwn

run ACS clock test continuously

start strendup

start sfunctional

run power system long functional (FAST-PROC-026) all sections except V/T and C/D

run ACS absolute time test

run ACS magnetometer gain test

set up for POCC commanding

POCC configures for no-command timer test

turn off PSK modulator

TRANSITION TO COLD SOAK #2

run ACS clock drift test continuously

continue no-command timer test, follow ATS from POCC

COLD SOAK #2

run ACS clock drift test continuously

continue no-command timer test, follow ATS from POCC

wait for 24 hour timeout

TRANSITION TO HOT SOAK #2

continue no-command timer test, follow ATS from POCC

HOT SOAK #2

wait for 48 hour timeout

DO NOT TAKE BATTERY OFF LINE OR DISABLE PWR until beginning of hot soak #3

set loopbacks on and reboot MUE

start strendup

start sfunctional

wait for acceptable cleanliness levels

open two ESA covers

TRANSITION TO COLD SOAK #3

KEEP POWER ON

run launch-day procedure--all hands required

configure for POCC commanding

POCC testing--L&EO simulation

when temperature reaches -10 C, open TEAMS cover

continue POCC testing

COLD SOAK #3

KEEP POWER ON

open remaining two ESA covers

set loopbacks on and reboot MUE

start strendup

start sfunctional

configure for CTV testing

CTV cold soak tests (about 3 hours)

verify pressure less than $2 \times 10^{-6}$ torr for 12 hours

verify TEAMS cover open for 24 hours

power on TEAMS high voltage (4 hours)

turn off high voltages

TRANSITION TO HOT SOAK #3

KEEP POWER ON

configure for POCC testing

POCC testing--L&EO

POCC testing--campaign scenario: deep discharge of battery (60%)

HOT SOAK #3

start strenddown, power off the spacecraft

start strendup

start sfunctional with high voltages

configure for CTV testing

CTV testing (about 3 hours); leave high voltages on

TRANSITION TO COLD SOAK #4

configure for POCC testing

POCC testing--campaign scenario with high voltages

COLD SOAK #4

run ACS clock drift test continuously

start strenddown

start strendup

start sfunctional with high voltages

run ACS absolute time test

run ACS magnetometer gain test

run memory test

TRANSITION TO HOT SOAK #4

run ACS clock drift test continuously

configure for POCC testing

POCC testing with high voltages on

HOT SOAK #4

run ACS clock drift test continuously

start strenddown

start strendup

start sfunctional with high voltages

run ACS absolute time test

run ACS magnetometer gain test

run memory test

wait until contamination requirements are met

TRANSITION TO AMBIENT

start strenddown