SEPT/SIT Thermal Balance Test Plan

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ACRONYMS AND ABBREVIATIONS Update

GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
ICD	Interface Control Document
I/F	Interface
MLI	Multi-Layer Insulation
MGSE	Mechanical Ground Support Equipment
MHz	MegaHertz
PRT	Platinum Resistance Thermometer
QCM	Quartz Crystal Microbalance
RGA	Residual Gas Analyzer
S/C	Spacecraft
STEREO	Solar Terrestrial Relations Observatory
TCU	Thermal Control Unit
TD	Test Director
TE	Test Engineer
TLM	Telemetry
TMS	Telemetry Measurement System
T/C	Thermocouple
T/M	Thermistor
TTC	Thermal Test Conductor
TV	Thermal Vacuum
TVTE	Thermal Vacuum Test Engineer

APPLICABLE DOCUMENTS

- STEREO Environment Definition, Observatory, Component and Instrument Test Requirements Document.
- STEREO Contamination Control Plan.
- IMPACT Environmental Test Plan
- IMPACT Contamination Control Plan

1.0 INTRODUCTION

This document establishes the test conditions, requirements, and procedures for the IMPACT Instrument SEPT and SIT thermal balance test and the SIT thermal vacuum cycling. This test will complete the Instrument level thermal vacuum requirement for SEPT and SIT. The test will consist of two thermal balance phases with a chamber break in between. Subsequently, the SIT instruments will undergo thermal vacuum cycling. The Phase 1 thermal balance test articles will include SEPT-E Ahead, SEPT-E Behind and SIT Ahead. The Phase 2 thermal balance test articles will include SEPT-NS Ahead, SEPT-NS Behind and SIT Behind. Next, the AHEAD and BEHIND SIT instruments will undergo thermal vacuum cycling. Figures 1 and 2 show the Phase 1 and Phase 2 thermal balance test set-ups. The SIT thermal vacuum test set-up is shown in figure 3.

2.0 TEST OBJECTIVES

The primary objectives of this test are to:

1) Validate the thermal design by subjecting the test article to thermal test environments that conservatively simulate the flight hot and cold environments.

2) Confirm the thermal interface between the instrument and spacecraft via mounting standoffs and cabling.

3) Gather steady state data in order to correlate the thermal models (Thermal Balance).

4) Verify that survival heaters perform as specified. That they maintain the hardware within survival limits in the simulated worst case flight conditions.

5) Verify that the operational heaters perform as specified. That they maintain the hardware within operational limits in the simulated worst case flight conditions.

6) Verify satisfactory deployments of all aperture doors in the simulated worst case flight conditions.

7) Verify the functionality of the test article at hot and cold environments in accordance with the STEREO Environment Definition, Observatory, Component and Instrument Test Requirements Document. (TV)

8) Verify hot and cold turn on of all components.(TV)

9) Insure proper workmanship through six thermal vacuum cycles per the STEREO Environment Definition, Observatory, Component and Instrument Test Requirements Document. (TV)

10) Bakeout the components according to contamination requirements (TV).

3.0 SUCCESS CRITERIA

The following compliance matrix illustrates how the Test Objectives will be achieved during the test:

Objective	**Compliance Criteria**
Verify the functionality of the SIT instruments at hot and cold environments with margin.	At environmental temperatures outlined in Table 5, all hardware passes functional testing.
Verify the survival heaters of the SEPT and SIT Instruments maintain the hardware above survival limits.	The survival heaters keep SEPT and SIT above survival temperatures at the steady survival environment temperatures outlined in Table 1.
Verify that the operational heaters perform as specified.	The operational heaters keep SEPT and SIT above operational temperatures at the temperatures outlined in Table 1.
Verify hot and cold turn on of the SIT instruments.	After a soak at environmental temperatures outlined in Table 5, all SIT electronics properly turn on and operate.
Insure proper workmanship through six thermal cycles.	After six thermal cycles the SIT instruments pass functional tests.
Gather steady state data in order to correlate the thermal models.	Thermal Balance must be achieved at hot and cold environment conditions and data is gathered.
Verify satisfactory deployments of all aperture doors in the simulated worst case flight conditions.	Through the chamber windows visually confirm all the doors opened completely.
Bakeout the components to contamination requirements.	TQCM Readings are within the specifications.

4.0 DESCRIPTION OF TEST HARDWARE

The test hardware consists of the test article and ground support equipment (GSE). The test article is the collection of flight hardware being tested including instrument components and flight blankets, isolators and cabling. GSE is any hardware in support of the test but exclusive of the test article. GSE includes the chamber and its control system, cryopanel, interface plate, test heaters, thermocouples, interface cabling, stimulii and the thermal data acquisition system.

4.1 TEST ARTICLE

The test articles shown in Figures 1&2 consists of two SEPT components and a SIT component. The Phase 1 Test article will be SEPT-E Ahead, SEPT-E Behind and SIT Ahead. The Phase 2 Test article will be SEPT-NS Ahead, SEPT-NS Behind and SIT Behind. Each component is mounted to the interface plate using the flight isolators. Flight-like MLI will be installed in the flight configuration. Ground straps between the test article and the interface plate will be configured as flight-like as possible. Flight cables will be routed and secured to the interface plate as flight-like as possible. Cables that attach to SEP Central in flight will attach to a test cable and mounting plate. The mounting plate will be controlled to the temperatures in table 1. SEP Central is outside the chamber during this test.

4.2 GSE

The Goddard supplied GSE will include a cryoplate with a hard mounted interface plate and a solar simulating heater panel. Project supplied GSE will include Test article mounted test heaters (if used). The functions of the GSE components are described below:

6.4.1 Cryoplate/ Heater Panel

The cryoplate and interface plate to which the test article mounts simulates the Spacecraft mounting interface, and will be temperature controlled to values shown in Table 1. The heater panel will simulate solar heating from the Sun and will be temperature controlled to values shown in Table 1. The cryoplate and heater panel must be independently controllable and stable within 2°C of their setpoints. The Solar heating panel will be mounted to the interface plate with thermal isolation and have an MLI blanket on the side facing away from the test article. It will have heating capability only and will need to be controllable between TBD and TBD ^{O}C. The power delivered to the heater needs to be controllable from zero to maximum power. The S/C interface cryoplate needs to be controlled to (–18^{O}C) to (+45^{O}C), therefore will need cooling as well as heating capability. The test article will mount to the spacecraft interface plate via mounting isolators as shown in Figure TBD. The S/C interface plate will need an MLI blanket on top, facing the test article as the spacecraft would be blanketed.

6.4.2 Test Heaters

Test heaters (if used) will be supplied by the project. They will be placed in TBD locations and will be sized to provide a maximum of TBD Watts. Test heater circuits shall be independently controlled with separate Goddard supplied GSE variable power supplies. Heaters shall be supplied (and installed on the test article) by the Project, but wiring to GSE harnesses shall be done at GSFC.

5.0 TEST TEAM

The following personnel or their designated representatives will be associated with these tests:

Test Directors - TBD

Thermal Test Conductor	- TBD
Thermal Vacuum Test Engineer	- TBD
Contamination Engineer	- TBD
Product Assurance Engineer	- TBD

Note: Additional personnel will provide support as required.

The Test Director (TD) has the overall responsibility for managing the test. The TD approves all test plans and procedures and has the responsibility of determining the Instrument is in flight configuration. The Test Director or a representative is responsible for approving all major deviations to the test procedure. The TD is also responsible for assuring all objectives of the thermal test will be satisfied. The TD will assure that fixtures and all components of the Test Article(s) are supplied and properly integrated for the test.

The Thermal Test Conductor (TTC) is responsible for coordinating TV Test Environmental activities. The TTC monitors the thermal test during actual operation and verifies that all systems are acting correctly and all test activities are executed. The TTC is responsible for detecting any out-of-limit temperature conditions of the test components and taking the necessary steps to correct that condition. The TTC is also responsible to determine when steady state conditions are achieved to continue to the next set point or to conclude the test. The TTC shall have the responsibility to adjust the test condition temperatures based on test data.

The Thermal Vacuum Test Engineer (TVTE) is responsible for the verification of the cleanliness of the chamber, fixtures and cables prior to the initiation of the test. The Thermal Vacuum Test Engineer also serves as the interface between the Thermal Test Conductor and the facility operators. The Thermal Vacuum Test Engineer is responsible for the operation, monitoring and maintenance of the test facility and auxiliary systems such as fixtures, cold plates, conditioners, etc.

The Contamination Control Engineer is responsible for assuring that the test is performed in accordance with proper contamination requirements. This person is also responsible for monitoring the contamination data to assure that the chamber, fixtures, meet the established contamination criteria.

The Product Assurance Engineer (PAE) responsibilities are contained in Section 8.0.

6.0 TEST PROGRAM

6.1 FACILITY DESCRIPTION

The thermal balance test will be conducted in a Thermal Vacuum Facility at GSFC. The layout of the chamber facility is shown in Figure TBD. The thermal shroud within the chamber can be controlled to temperatures between (LN2) and TBD(+75°C). The facility must be capable of maintaining the pressure below 10^{-5} Torr for this test. The facility including all GSE internal to the chamber must meet the following contamination criteria prior to the start of the test: (#Hz/hr @#°C on a –20°C Quartz Crystal Microbalance (QCM)). The facility has the capability to read out (94) test thermocouple sensors.

6.2 TEST CONFIGURATION

The test set-up for the Phase 1 test is shown in Figure TBD. The test set-up for the Phase 2 test is shown in Figure TBD. For both tests the test article is mounted to an interface plate which is hard mounted to a cryoplate and uses the chamber shroud as the radiative environment. A heater panel is used to simulate the solar flux upon the Instrument. The Phase 2 test does not require simulation of solar flux but the heater panel should be used to help control transitions (unless test heaters are used).

6.3 TEST SET-UP

The Project will provide all materials and equipment pertaining to operation of the test article including wiring harnesses and ground support equipment. The Project will provide all feed through connector plates and electrical harnessing.

Code TBD(545) will provide T/Cs with associated signal conditioning and recording equipment including computer monitors to display T/C data in tabular and “real time” plotted format. The project will provide the EGSE and personnel required to operate and monitor the test article during powered operation.

6.4 INSTRUMENTATION

There are TBD# thermocouple temperature sensors on the test article that need to be read out continuously during this test. A list of all T/C temperature sensors is included in Table 2. Detailed locations of the T/C temperature sensors are outlined in Figures 4 - 6. The sensor designations and locations should be identical for both phases of the test. The test article is equipped with flight thermistor temperature sensors which are read out by the EGSE and may not be available when the test article is powered off. A list of all T/M temperature sensors is included in Table 3.

Test T/Cs can only be mounted on the external surfaces of the Instruments. Internal component temperatures (with their own test limits) can be monitored by the flight telemetry electronics. Test T/C temperatures will be monitored during the test, but the red and yellow temperature limits should only be used as a rough estimate as to internal component temperatures.

6.4.1 Test T/Cs on GSE

There should be two T/Cs placed on the interface plate. The heater panel should have two T/Cs. GSE T/C temperature sensors are included in Table 2. Detailed locations of the temperature sensors are shown in Figure TBD. The facility shroud should already be equipped with temperature sensors.

6.5 TEMPERATURE LIMITS

The temperature limits on the hardware are contained in Table 2. Thermocouple limits are shown in Table 2. Internal component (thermistor) temperature limits are shown in Table 3.

6.6 TEMPERATURE CONTROL

T/Cs TBD through TBD will be used to determine the test articles temperature stability. The chamber shroud, cryoplate and solar simulator heater panel will be used to adjust environmental conditions. Internal component (thermistor) temperatures shall be monitored as well, but will use the flight telemetry electronics circuitry.

6.7 TEMPERATURE CYCLING TV Only

Predicted temperatures of SEPT and SIT in flight (on the Ahead and Behind STEREO Spacecrafts) are shown in Table TBD. Test Red limits are also shown for reference.

Components should be cycled at least 10^{O}C above 5^{O}C below the flight predictions shown in Table 4, but care must be observed to not exceed the test Red limits.

Survival thermostats on SEPT and SIT have turn-on temperatures of approximately (-26^{O}C). Therefore, predicted component flight survival temperatures are in this range for the cold condition. During Cold Survival thermal cycling, environmental temperatures shown in Table 1 should be used, but may be adjusted to achieve desired temperatures.

Hot Survival thermal cycling is somewhat of a non-realistic case, since in flight the Instrument gets the hottest during hot operational conditions. However, a hotter than nominal TV condition is useful for stressing the Instrument's components in a non-operational scenario.

6.8 CONTAMINATION/STATIC REQUIREMENTS

The test article is contamination and Electro-Static Discharge (ESD) sensitive in the test configuration and the following shall be adhered to at all times:

6.8.1 Contamination

The test article will be double bagged for transportation to the TV facility. All test fixtures and instrumentation/harnessing will be cleaned by Contamination Control (CC) prior to use in the TV facility. Cleanroom uniforms are required during use and handling of hardware inside the TV facility. A log will be kept to record personnel entering and exiting the chamber.

One 15 Mhz TQCM shall be placed viewing, and within 3 feet of the the test article. The Contamination Engineer shall verify that both are properly placed prior to closing the chamber door. This TQCMs shall be held at -20 C throughout the test, with the exception of the TQCM bake out portion. The data will be used for evaluation of the cleanliness of the test article.

The bakeout will be at the beginning of the test, and will last the duration specified by the contamination engineer.

6.8.2 Static

The test article is ESD sensitive in the test configuration and proper grounding of the hardware and personnel is required.

6.9 TEST DESCRIPTION

6.9.1 Pre-Test Activities

Pre-operation activities include attaching thermocouples and installing MLI blanketing on the

Instruments. Mount the Instruments and heater plates to the interface plate and install the assembly in the chamber.

6.9.2 Test Readiness Review

A test readiness review (TRR) will be conducted prior to the test and attended by personnel involved in the test. The test procedure and any other pertinent documentation will be reviewed and discussed to resolve any problems or discrepancies with regards to safety, test configuration, facility requirements, and test operations. The test procedure must be approved prior to the test. An "as run" test procedure will be generated during the test by the TD or designated representative. Deviations to the test procedure during the test shall be recorded as red lines to the original procedures and will be approved by either the TD or designated representative and quality assurance engineer prior to performing the deviation.

6.9.3 Pre-Test Check List

The following is a list of steps required before testing occurs.

1. Drill holes in the interface plate that will accept the Instrument foot prints as shown in Figure 4. Instrument isolators (12) will be supplied by the Project.
2. Fit check the Instrument before installing into the chamber.
3. Install all test T/Cs on the Instruments.
4. Install two T/Cs onto the heater plate and two onto the interface plate.
5. Wire (TBD) test heaters to the instruments.
6. Install an MLI blanket to the top of the interface plate.
7. Install the Instruments and harnesses into the chamber.
8. Perform functional tests on the heaters and T/Cs to verify nominal installation.
9. Perform functional tests on the Instruments to verify nominal installation.
10. Close the Chamber

6.9.4 Instrumentation Check

Prior to testing, the test facility will be checked out and verified to be ready for testing. Installation and checkout of the required instrumentation will be conducted on the test article prior to closing the TV chamber door.

6.9.5 Temperature Rate of Change

The chamber shroud shall not exceed a rate of change of 5°C/min. The bulk Instrument temperature shall not exceed a rate of change of more than 3°C/min.

6.9.6 Thermal Stabilization Criteria

Environmental stability will be reached when the Chamber and heater plates are within 2°C of its setpoint. Hardware temperature stability during TV is achieved when the temperature is within 3 °C of the plateau and the rate of change is less than 1 °C/hour.

Test Article stability for Thermal Balance will be reached when the T/Cs come to equilibrium at < (0.1°C/hr) change for at least (1) hours.

6.9.7 Test Description

Thermal Balance

Phase 1
Hot Door Actuation

1. Once the chamber pressure is lower than 10^{-5} torr, bring the shroud to LN2 temperature and the cryoplate to +45°C at a rate not to exceed 5°C/min. The shroud is to stay flooded for the duration of the Phase 1 portion of the Thermal Balance test. Set the solar simulator heater panel controller temperature setpoint to the Hot Survival Balance setting (TBD°C) and adjust the power supply so that the heater plate does not exceed 5°C/min. The test article stays powered off for door actuations.
2. Transition test article to the hot survival balance temperature predicts at the fastest rate not to exceed 3°C/min. Adjust the solar simulator heater plate power as necessary to maintain transition rate within limits.
3. As test article approaches hot survival balance temperatures, adjust solar simulator heater controller setpoint as necessary to avoid exceeding any survival limits on the test article.
4. When temperatures are within +/-3°C of the HOT balance temperatures deploy sun side doors on SEPT-E Ahead and Behind.
5. When temperatures are within +/-3°C of the HOT balance temperatures deploy SIT door (assuming hot actuation required).

Cold Door Actuation and Survival heater turn on

6. When all hot door actuations are complete and verified (visually), enable all survival heaters at max volts, bring the cryoplate to -18°C at a rate not to exceed 5°C/min. Start the transition by reducing power to the solar simulator heater panel controller to zero.
7. Transition test article to the survival heater turn-on temperature (-26.1°C specified) at the fastest rate not to exceed 3°C/min. Power can be applied to the solar simulator heater plate to maintain transition rate within limits.
8. When leading temperature on test article reaches -16°C(10° from goal) Set the solar simulator heater panel controller temperature setpoint to the Cold Survival Balance setting TBD°C and increase the power so that the heater plate reaches the control temperature. Confirm that test article transition rate responds by rolling off to verify the ability to safely stop the transition.
9. Reduce solar sim heater panel power to reestablish transition to survival heater turn-on.
10. When temperature (TC TBD) reaches (-26°C) deploy cold side doors on SEPT-E Ahead and Behind.
11. When temperature (TC TBD) reaches (-26°C) deploy SIT door (if cold actuation required).
12. When all cold door actuations are complete, visually verify proper deployment.

13. Verify that all survival heaters activate. Take data snaps at each activation. Record heater activation data in Table TBD.

Cold Survival Balance

14. Reduce survival heater voltage to 25V and increase solar simulator heater plate controller power so that the heater plate reaches the control temperature (Cold Survival Balance setting TBD°C). Do not further adjust survival heater voltage unless temperatures approach lower survival limit or heater turn off temperature. Requirement is that survival heaters can maintain the instrument within survival limits at 25V (IMPACT ICD).
15. Let the balance control T/Cs on the test article come to equilibrium at < 0.1°C/hr change for 1 hour. Soak for four hours after this criterion is met. Keep the GSE within 2 degrees of their setpoints.
16. Take appropriate data snaps. Record survival heater voltage and current.

Cold Operational Balance

17. Increase survival heater voltage to 30.5V max.
18. Bring the cryoplate to -13°C at a rate not to exceed 5°C/min.
19. Set the solar simulator heater panel controller temperature setpoint to the Cold Operational Balance setting TBD°C and adjust the power supply as necessary so that the heater plate reaches and maintains the temperature setpoint without exceeding any rate limits.
20. Verify that all survival heaters deactivate. Take data snaps at each deactivation. Record heater deactivation data in Table TBD.
21. When all test article temperatures are within operational limits, simultaneously turn-on the instrument, enable the operational heaters at 30.5Vmax and disable the survival heaters. Set the SEPT operational heater setpoints to TBD(-15°C)
22. Decrease operational heater voltage until heaters operate at 100% duty cycle. Do not further adjust operational voltage unless temperatures approach lower operational limit or SIT heater turn off temperature -8.3. Requirement is that operational heaters have a 75% duty cycle at 30.5V.
23. Let the balance control T/Cs on the test article come to equilibrium at < 0.1°C/hr change for 1 hour. Soak for four hours after this criterion is met. Keep the GSE within 2 degrees of their setpoints.
24. Take appropriate data snaps. Record operational bus voltage and current. **Need to be able to determine time averaged heater power on SEPT software controlled operational heaters.**

Hot Operational Balance

25. Power the test article on at TBD(max) V, set SEPT software controlled operational heaters to TBD°C and enable all operational heaters.
26. Bring the cryoplate to +45°C at a rate not to exceed 5°C/min. Set the solar simulator heater panel controller temperature setpoint to the Hot Operational Balance setting TBD°C and adjust the power supply so that the heater plate does not exceed 5°C/min.

27. When the solar simulator heater plate reaches Hot Operational Balance setting adjust solar simulator heater controller setpoint only if necessary to avoid exceeding any operational limits on the test article.
28. Let the balance control T/Cs on the test article come to equilibrium at < 0.1°C/hr change for 1 hour. Soak for four hours after this criterion is met. Keep the GSE within 2 degrees of their setpoints.
29. Take appropriate data snaps. Record operational bus voltage and current.

Return to Ambient

30. Keep the test article powered on at 30.5V, set SEPT software controlled operational heaters to TBD(27°C ambient+5) and enable all operational heaters.
31. Bring all GSE (shroud, cryoplate and solar simulator heater panel) to TBD(+22°C) at rates not to exceed 5°C/min on GSE or 3°C/min on the test article.
32. Shut down test article when all GSE are at ambient (+22°C) and instrument starts to drift up.
33. Shut off all electronics inside chamber.
34. Once the temperatures are below 27^{O}C backfill the chamber to 600 torr with dry nitrogen. **Nitrogen backfilling must occur at a reduced rate so not to cause air turbulence near the Instrument.**

Chamber Break

Phase 2

Cold Door Actuation and Survival heater turn on

35. Once the chamber pressure is lower than 10^{-5} torr, enable all survival heaters at 30.5 volts bring the shroud to LN2 temperature and the cryoplate to -18°C at a rate not to exceed 5°C/min. The shroud is to stay flooded for the duration of the Phase 2 portion of the Thermal Balance test. Set the solar simulator heater panel controller temperature setpoint to ambient 22°C and reduce power to the solar simulator heater panel controller to zero.
36. Transition test article to the survival heater turn-on temperature -26.1°C at the fastest rate not to exceed 3°C/min. Power can be applied to the solar simulator heater plate to maintain transition rate within limits.
37. When leading temperature on test article reaches -16°C(10° from goal), reduce solar sim heater panel power to zero. Heater panel needs to be off so it will not influence cold deployments.
38. When control TCs (TBD) reaches -26°C deploy all doors on SEPT-NS Ahead and Behind and deploy SIT door.
39. When all cold door actuations are complete, visually verify proper deployment.
40. Verify that all survival heaters activate. Take data snaps at each activation. Record heater activation data in Table TBD.
41. If any test article temperature approaches the survival limit with the survival heaters active at full power, it may be necessary to use the solar simulator heater panel. Set the controller setpoint to TBD degrees above the current control sensor temperature and increase the power to control. Increment controller setting until temperatures recover. Otherwise, the solar sim heater should stay off.

Cold Survival Balance

42. Reduce survival heater voltage to 25V. Do not further adjust survival heater voltage unless temperatures approach lower survival limit or heater turn off temperature. Requirement is that survival heaters can maintain the instrument within survival limits at 25V (IMPACT ICD).
43. Let the balance control T/Cs on the test article come to equilibrium at < 0.1°C/hr change for 1 hour. Soak for four hours after this criterion is met. Keep the GSE within 2 degrees of their setpoints.
44. Take appropriate data snaps. Record survival heater voltage and current.

Cold Operational Balance

45. Increase survival heater voltage to 30.5V max.
46. Bring the cryoplate to -13°C at a rate not to exceed 5°C/min.
47. Turn the solar simulator heater power to zero. The solar simulator heater panel should not be used to speed the transition.
48. When all test article temperatures are within operational limits, simultaneously turn-on the instrument, enable the operational heaters at 30.5Vmax and disable the survival heaters. Set the SEPT operational heater setpoints to -15°C
49. If any test article temperature approaches the cold operational limit with the operational heaters active at full power, it may be necessary to use the solar simulator heater panel. Set the controller setpoint to TBD degrees above the current control sensor temperature and increase the power to control. Increment controller setting until temperatures recover. Otherwise, the solar sim heater should stay off.
50. Adjust operational voltage so that the operational heaters operate at a 100% duty cycle. Do not further adjust operational voltage unless temperatures approach lower operational limit or SIT heater turn off temperature (-8.3°C). Requirement is that operational heaters have a 75% duty cycle at 30.5V.
51. Let the balance control T/Cs on the test article come to equilibrium at < 0.1°C/hr change for 1 hour. Soak for four hours after this criterion is met. Keep the GSE within 2 degrees of their setpoints.
52. Take appropriate data snaps. Record operational bus voltage and current. **Need to be able to determine time averaged heater power on SEPT software controlled operational heaters.**

Return to Ambient

53. Keep the test article powered on at 30.5V, set SEPT software controlled operational heaters to TBD(27°C ambient+5) and enable all operational heaters.
54. Bring all GSE (shroud, cryoplate and solar simulator heater panel) to TBD(+22°C) at rates not to exceed 5°C/min on GSE or 3°C/min on the test article.
55. Shut down test article when all GSE are at ambient (+22°C) and instrument starts to drift up.
56. Shut off all electronics inside chamber.
57. Once the temperatures are below 27^{O}C backfill the chamber to 600 torr with dry nitrogen. **Nitrogen backfilling must occur at a reduced rate so not to cause air turbulence near the Instrument.**

7.0 DOCUMENTATION

7.1 CHANGES TO TEST PROCEDURE

7.1.1 During Test

Deviations to the test procedure during the test shall be recorded in the chronological test log and approved by both the TD and the PAE prior to performing the deviation. The deviation number shall be recorded at the affected line of the "as run" procedure. Procedure errors recorded during the test shall be incorporated in the test plan prior to testing subsequent items.

7.1.2 Post-Test

Changes that result from either design changes or discrepancies shall be incorporated as a subsequent revision to the test plan. Other changes shall be processed as deviations or waivers.

7.2 TEST DATA

The test data will be recorded as required documenting Instrument performance during testing. Test data and "as run" procedures will be kept in the test logbook and submitted to the TD by the test engineers upon completion of the test.

7.3 TEST LOG BOOK

A chronological log will be kept by the Test Engineer throughout the testing program. The logbook will contain a copy of the test plans. The Test Engineer will make daily entries in a brief manner describing the days testing activities. In addition, the log will record the operating times of the test as well as significant events such as failures, damage, or photo records.

The thermal test conductor shall also maintain a log.

7.4 TEST REPORT

Following completion of the test, a report shall be written in order to document the results of the tests, including a discussion of data with conclusions and/or recommendation. The original shall be submitted the Project within thirty working days after test completion. The Test Engineer will submit the test report.

7.5 TEST FAILURE AND ANOMALY REPORTS

7.5.1 Test Failure Criteria

Either of the following constitutes a failure of the test:

1. Unacceptable operation of the test article during the time that the test is being conducted

2. No data is recorded due to failure of the instrumentation or recording equipment

7.5.2 Failure Reports

Malfunction or failure that requires corrective action or re-testing will result in a Failure Report.

8.0 QUALITY ASSURANCE

The performance of this plan will be under the cognizance of the assigned Product Assurance Engineer (PAE) or a designated representative. The PAE will verify that the test article is ready for the test by:

1. Verifying the presence of an approved test procedure
2. Verifying completion and documentation of all Instrument assemblies and inspection operations.
3. Verifying that all support fixtures are within current proof load limits.
4. Visual inspection of the test article and the test set-up for correct configuration and handling/safety constraints.
5. Verify that the assembly of the test article is per the design.

9.0 SAFETY

This test shall be conducted in accordance with the GSFC standards of Safety and Engineering Services Division Safety Manual Rev A, with no unacceptable risks or hazards to the test article and personnel.

Test directors must assure that the test complies with all Occupational Safety and Health Act (OSHA) regulations and that protective equipment is used where necessary.

10.0 TECHNICAL PHOTOGRAPHY

Photographic services will be provided by Code 545. The TD shall arrange appropriate times to take photographs before closing the TV chamber. The purpose for using technical photographs is to document the test set-up and to record any relevant data taken during the test. The test set-up photographs should capture the test article, instrumentation, and test equipment. Discrepancies and unusual data should also be photographed.

ZONE	Hot Operation	Cold Operation	Cold Survival
Chamber Shroud	-180°C	-180°C	-180°C
S/C Cryo Panel	+45°C	-13°C	-18°C
SEP Cable Plate	+30°C	-25°C	-25°C
Solar Simulator Plate	TBD	TBD	TBD

Table 1: TB Test Environment Settings

Sensor Number	Location	Fig #	Yellow Limits (°C)	Red Limits (°C)	Yellow Limits (°C)	Red Limits (°C)
			Operational		Survival	
1	Front of SIT EBOX	4	-30/+45	-35/+50	-35/+45	-45/+50
2	Front of HVPS	4	-30/+45	-35/+50	-35/+45	-45/+50
3	Right Side of SIT EBOX	4	-30/+45	-35/+50	-35/+45	-45/+50
4	Right Side of HVPS	4	-30/+45	-35/+50	-35/+45	-45/+50
5	Right Side of SIT Telescope	4	-30/+30	-35/+35	-35/+35	-45/+40
6	Top of SIT Telescope	4	-30/+30	-35/+35	-35/+35	-45/+40
7	Top Front of SIT Telescope	4	-30/+45	-35/+50	-35/+45	-45/+40
8	Top of SIT Collimator	4	-70/+65	-75/+70	-70/+65	-75/+70
9	Right Side of SIT Collimator	4	-70/+65	-75/+70	-70/+65	-75/+70
10	Front of SIT Telescope	4	-30/+30	-35/+35	-35/+35	-45/+40
11	Top of SIT Telescope	4	-30/+30	-35/+35	-35/+35	-45/+40
12	Back of SIT Telescope	4	-30/+30	-35/+35	-35/+35	-45/+40
13	Left Side of SIT Telescope	4	-30/+30	-35/+35	-35/+35	-45/+40
14	Left Side of HVPS	4	-30/+45	-35/+50	-35/+45	-45/+50
15	Left Side of SIT Telescope	4	-30/+30	-35/+35	-35/+35	-45/+40
16	Front of SIT Telescope	4	-30/+30	-35/+35	-35/+35	-45/+40
17	Back of SIT Telescope	4	-30/+30	-35/+35	-35/+35	-45/+40
18	Back of HVPS	4	-30/+45	-35/+50	-35/+45	-45/+50
19	Back of SIT EBOX	4	-30/+45	-35/+50	-35/+45	-45/+50
20	Bottom of SIT EBOX	4	-30/+45	-35/+50	-35/+45	-45/+50
21	Bottom of SIT EBOX	4	-30/+45	-35/+50	-35/+45	-45/+50
22	Under SIT Collimator exterior	4	-70/+65	-75/+70	-70/+65	-75/+70
23	Right Side of SIT Collimator	4	-70/+65	-75/+70	-70/+65	-75/+70
24	Front of SEPTA on Bracket	5	-30/+45	-35/+50	-35/+45	-45/+50
25	Front of SEPTA Telescope	5	-30/+45	-35/+50	-35/+45	-45/+50
26	Front of SEPTA Telescope	5	-30/+45	-35/+50	-35/+45	-45/+50
27	Front of SEPTA Telescope	5	-30/+45	-35/+50	-35/+45	-45/+50
28	Front of SEPTA on Bracket	5	-30/+45	-35/+50	-35/+45	-45/+50
29	Front of SEPTA Telescope	5	-30/+45	-35/+50	-35/+45	-45/+50
30	Front of SEPTA Telescope	5	-30/+45	-35/+50	-35/+45	-45/+50
31	Front of SEPTA on Bracket	5	-30/+45	-35/+50	-35/+45	-45/+50
32	Front of SEPTA EBOX	5	-30/+45	-35/+50	-35/+45	-45/+50

33	Back of SEPTA on Bracket	5	-30/+45	-35/+50	-35/+45	-45/+50
34	Back of SEPTA Telescope	5	-30/+45	-35/+50	-35/+45	-45/+50
35	Back of SEPTA Telescope	5	-30/+45	-35/+50	-35/+45	-45/+50
36	Back of SEPTA Telescope	5	-30/+45	-35/+50	-35/+45	-45/+50
37	Back of SEPTA on Bracket	5	-30/+45	-35/+50	-35/+45	-45/+50
38	Back of SEPTA Telescope	5	-30/+45	-35/+50	-35/+45	-45/+50
39	Back of SEPTA Telescope	5	-30/+45	-35/+50	-35/+45	-45/+50
40	Back of SEPTA on Bracket	5	-30/+45	-35/+50	-35/+45	-45/+50
41	Back of SEPTA EBOX	5	-30/+45	-35/+50	-35/+45	-45/+50
42	Bottom of SEPTA Bracket	5	-30/+45	-35/+50	-35/+45	-45/+50
43	Bottom of SEPTA Bracket	5	-30/+45	-35/+50	-35/+45	-45/+50
44	Radiator Side of SEPTA	5	-30/+45	-35/+50	-35/+45	-45/+50
45	Bottom of SEPTA	5	-30/+45	-35/+50	-35/+45	-45/+50
46	Bottom of SEPTA	5	-30/+45	-35/+50	-35/+45	-45/+50
47	Front of SEPTB on Bracket	6	-30/+45	-35/+50	-35/+45	-45/+50
48	Front of SEPTB Telescope	6	-30/+45	-35/+50	-35/+45	-45/+50
49	Front of SEPTB Telescope	6	-30/+45	-35/+50	-35/+45	-45/+50
50	Front of SEPTB Telescope	6	-30/+45	-35/+50	-35/+45	-45/+50
51	Front of SEPTB on Bracket	6	-30/+45	-35/+50	-35/+45	-45/+50
52	Front of SEPTB Telescope	6	-30/+45	-35/+50	-35/+45	-45/+50
53	Front of SEPTB Telescope	6	-30/+45	-35/+50	-35/+45	-45/+50
54	Front of SEPTB on Bracket	6	-30/+45	-35/+50	-35/+45	-45/+50
55	Front of SEPTB EBOX	6	-30/+45	-35/+50	-35/+45	-45/+50
56	Back of SEPTB on Bracket	6	-30/+45	-35/+50	-35/+45	-45/+50
57	Back of SEPTB Telescope	6	-30/+45	-35/+50	-35/+45	-45/+50
58	Back of SEPTB Telescope	6	-30/+45	-35/+50	-35/+45	-45/+50
59	Back of SEPTB Telescope	6	-30/+45	-35/+50	-35/+45	-45/+50
60	Back of SEPTB on Bracket	6	-30/+45	-35/+50	-35/+45	-45/+50
61	Back of SEPTB Telescope	6	-30/+45	-35/+50	-35/+45	-45/+50
62	Back of SEPTB on Bracket	6	-30/+45	-35/+50	-35/+45	-45/+50
63	Back of SEPTB on Telescope	6	-30/+45	-35/+50	-35/+45	-45/+50
64	Back of SEPTB EBOX	6	-30/+45	-35/+50	-35/+45	-45/+50
65	Bottom of SEPTB Bracket	6	-30/+45	-35/+50	-35/+45	-45/+50
66	Bottom of SEPTB Bracket	6	-30/+45	-35/+50	-35/+45	-45/+50
67	Bottom of SEPTB	6	-30/+45	-35/+50	-35/+45	-45/+50
68	Bottom of SEPTB	6	-30/+45	-35/+50	-35/+45	-45/+50
69	Radiator Side of SEPTB EBOX	6	-30/+45	-35/+50	-35/+45	-45/+50
70	Top of SEPTA NS Mount	6	N/A	N/A	N/A	N/A
71	Top of SEPTB NS Mount	6	N/A	N/A	N/A	N/A
72	SEP Central connector plate	TBD	N/A	N/A	N/A	N/A
73	Solar simulator heater plate	1	N/A	N/A	N/A	N/A
74	Solar simulator heater plate	1	N/A	N/A	N/A	N/A
75	S/C Simulator Heater Plate	1	N/A	N/A	N/A	N/A
76	S/C Simulator Heater Plate	1	N/A	N/A	N/A	N/A

Table 2: TB Thermocouple Locations

Sensor No.	Location	Flight Allowable (°C)	Operational Yellow Limit (°C)	Operational Red Limit (°C)	Survival Yellow Limit (°C)	Survival Red Limit (°C)
TBD	SIT A motherboard	-25/+40	-30/+45	-35/+50	-35/+45	-45/+50
TBD	SIT A Digital TOF	-25/+40	-30/+45	-35/+50	-35/+45	-45/+50
TBD	SIT A telescope, inside front	-25/+30	-30/+35	-35/+40	-40/+35	-45/+40
TBD	SIT A telescope, inside rear	-25/+30	-30/+35	-35/+40	-40/+35	-45/+40
TBD	SIT B motherboard	-25/+40	-30/+45	-35/+50	-35/+45	-45/+50
TBD	SIT B Digital TOF	-25/+40	-30/+45	-35/+50	-35/+45	-45/+50
TBD	SIT B telescope, inside front	-25/+30	-30/+35	-35/+40	-40/+35	-45/+40
TBD	SIT B telescope, inside rear	-25/+30	-30/+35	-35/+40	-40/+35	-45/+40
TBD	SEPTE AHEAD below the sensor aperture	-25/+30	-35/+35	-35/+40	-40/+45	-45/+50
TBD	SEPTE AHEAD on digital board	-25/+40	-30/+45	-35/+50	-35/+45	-45/+50
TBD	SEPTE BEHIND below the sensor aperture	-25/+30	-35/+35	-35/+40	-40/+45	-45/+50
TBD	SEPTE BEHIND on digital board	-25/+40	-30/+45	-35/+50	-35/+45	-45/+50
TBD	SEPTNS AHEAD below the sensor aperture	-25/+30	-35/+35	-35/+40	-40/+45	-45/+50
TBD	SEPTNS AHEAD on digital board	-25/+40	-30/+45	-35/+50	-35/+45	-45/+50
TBD	SEPTNS BEHIND below the sensor aperture	-25/+30	-35/+35	-35/+40	-40/+45	-45/+50
TBD	SEPTNS BEHIND on digital board	-25/+40	-30/+45	-35/+50	-35/+45	-45/+50

Table 3: Internal Component Telemetry (Flight Thermistors)

Component	**Cold Biased AHEAD S/C (^{O}C)**	**Cold Biased Behind S/C (^{O}C)**	**Hot Biased Ahead S/C (^{O}C)**	**Hot Biased Behind S/C (^{O}C)**	**Oper. Red Limits Cold/Hot (^{O}C)**
SIT					
DTOF Board	-9.2	-5.2	25.5	26.3	-35/+50
ATOF Board	-7.3	-3.4	27.2	28.0	-35/+50
Energy Board	-7.3	-3.4	27.1	27.9	-35/+50

Logic Board	-9.1	-5.2	25.1	25.8	-35/+50
DETECTOR	-11.1	-13.1	17.1	7.3	-35/+40
SEPTE					
Analog Board	-4.3	-4.2	34.4	35.1	-40/+50
Digital Board	-6.8	-6.7	35.0	35.6	-40/+50
DETECTORS	-19.3	-19.4	22.4	20.2	-45/+50
SEPNS					
Analog Board	-1.6	-1.6	21.1	21.1	-40/+50
Digital Board	-3.7	-3.7	22.0	22.0	-40/+50
DETECTORS	-23.9	-23.9	0.2	0.2	-45/+50

S/C Monitored Thermistors

Table 4: Predicted Operational Flight Temperatures

Component	Bakeout (^{O}C)	Hot Srv (^{O}C)	Hot Op (^{O}C)	Cold Srv (^{O}C)	Cold Op (^{O}C)	Control T/C #
SIT EBOX	45	45	40	-40	-30	TBD
SIT Telescope	35	35	30	-40	-30	TBD

Table 5: SIT Thermal Vacuum Temperature Settings

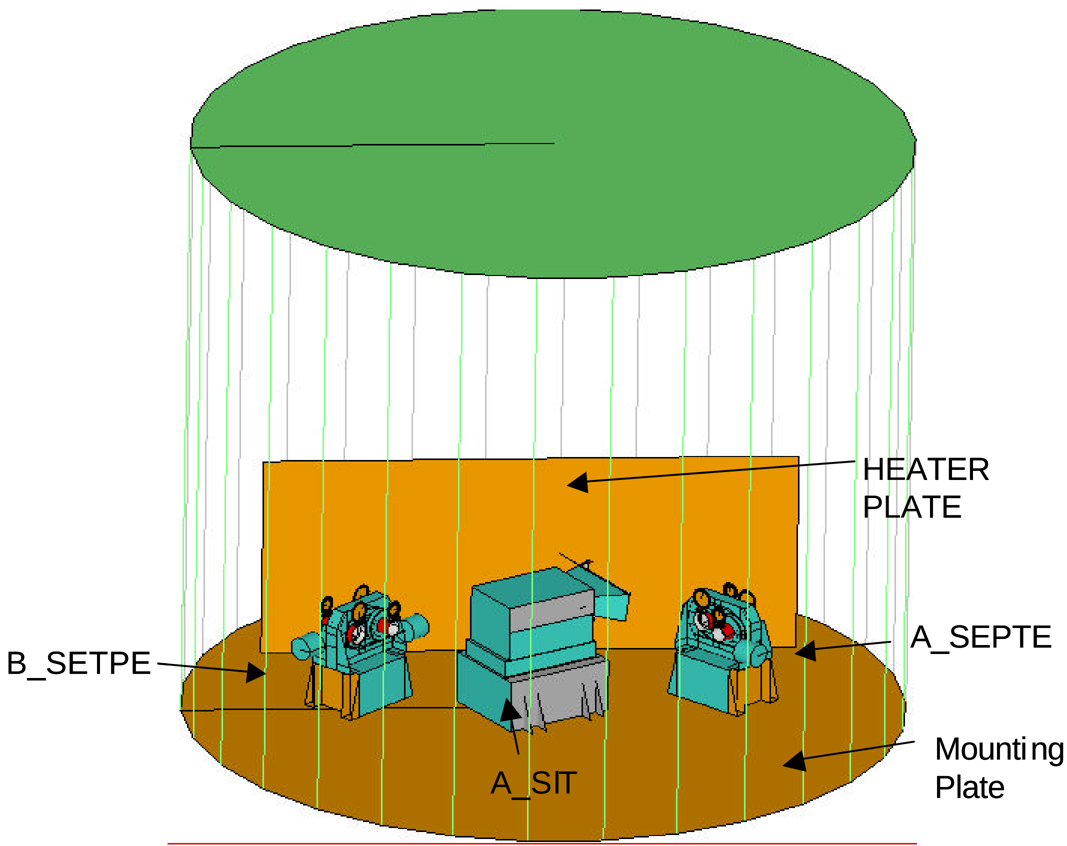


Figure 1 SIT/SEPT Phase 1 TB Test Set-up

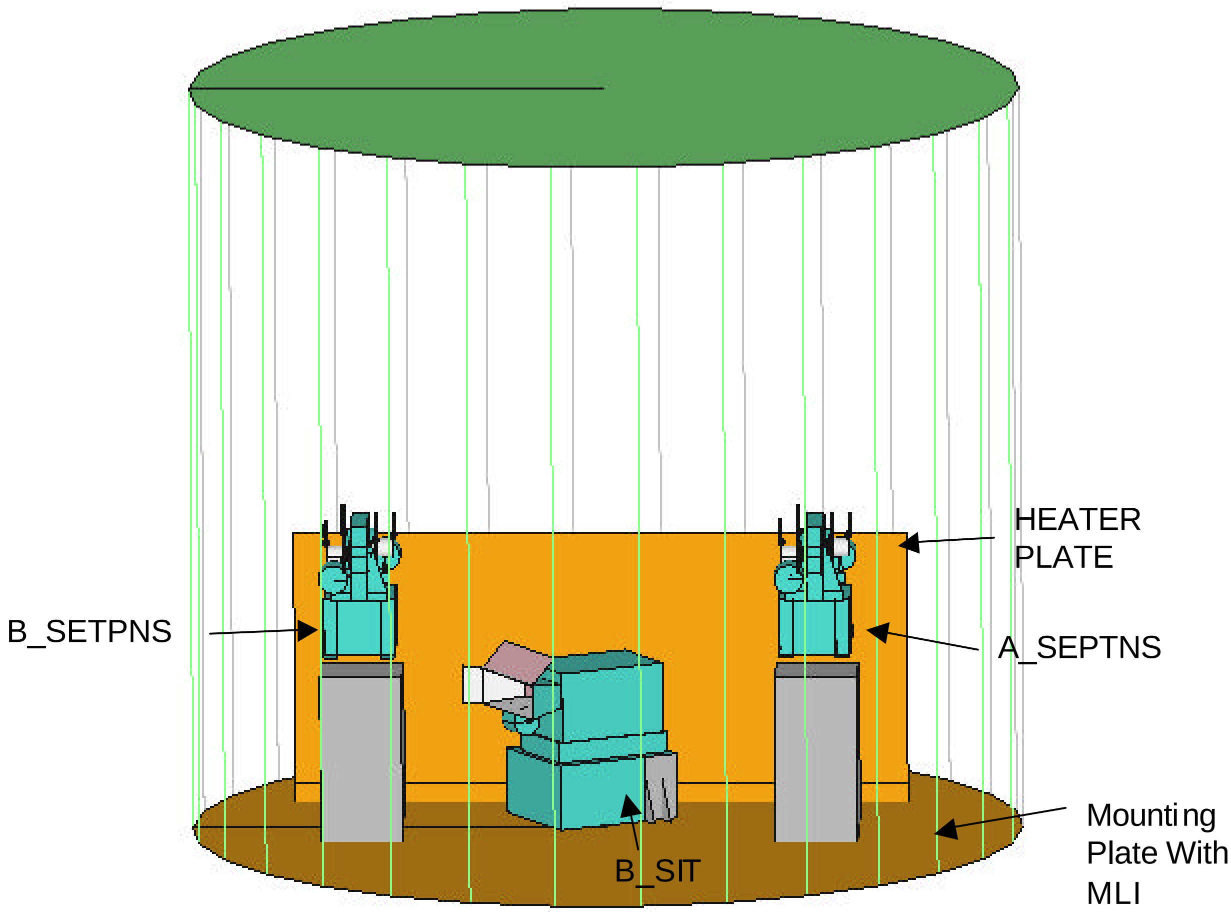


Figure 2 SIT/SEPT Phase 2 TB Test Set-up

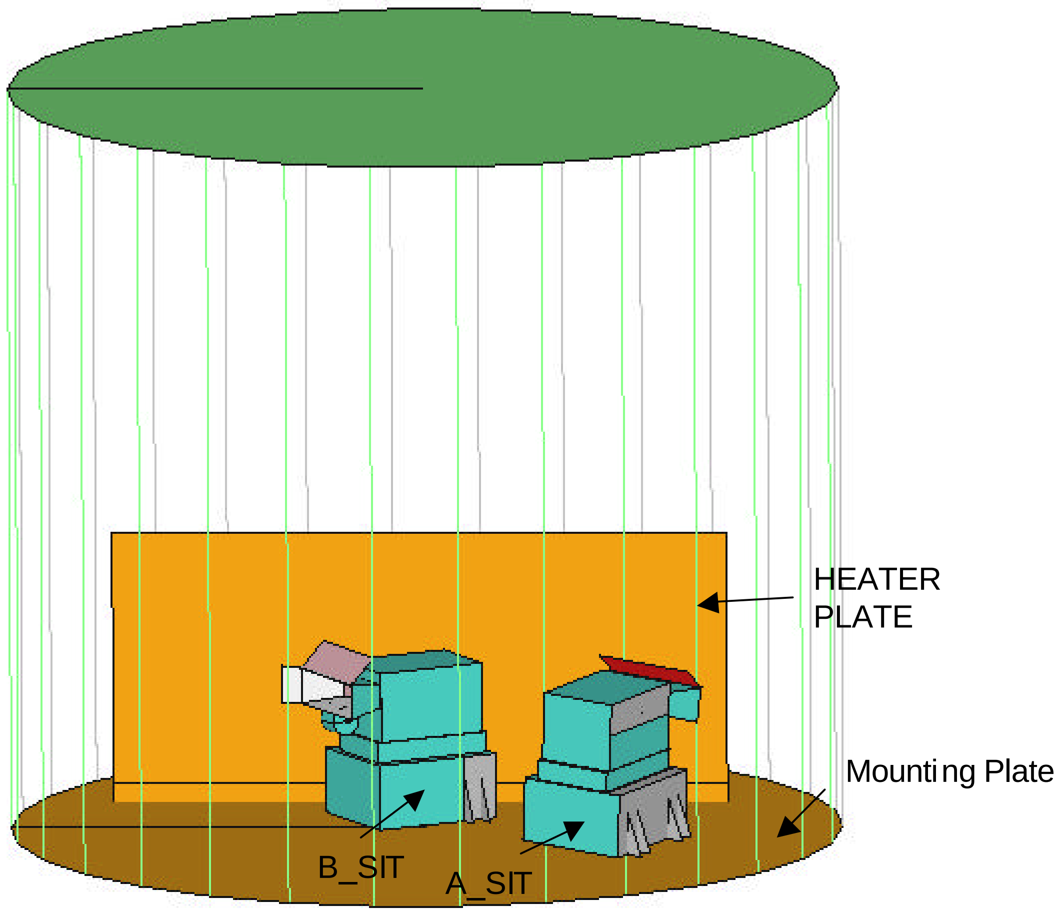


Figure 3 SIT TV Test Set-up

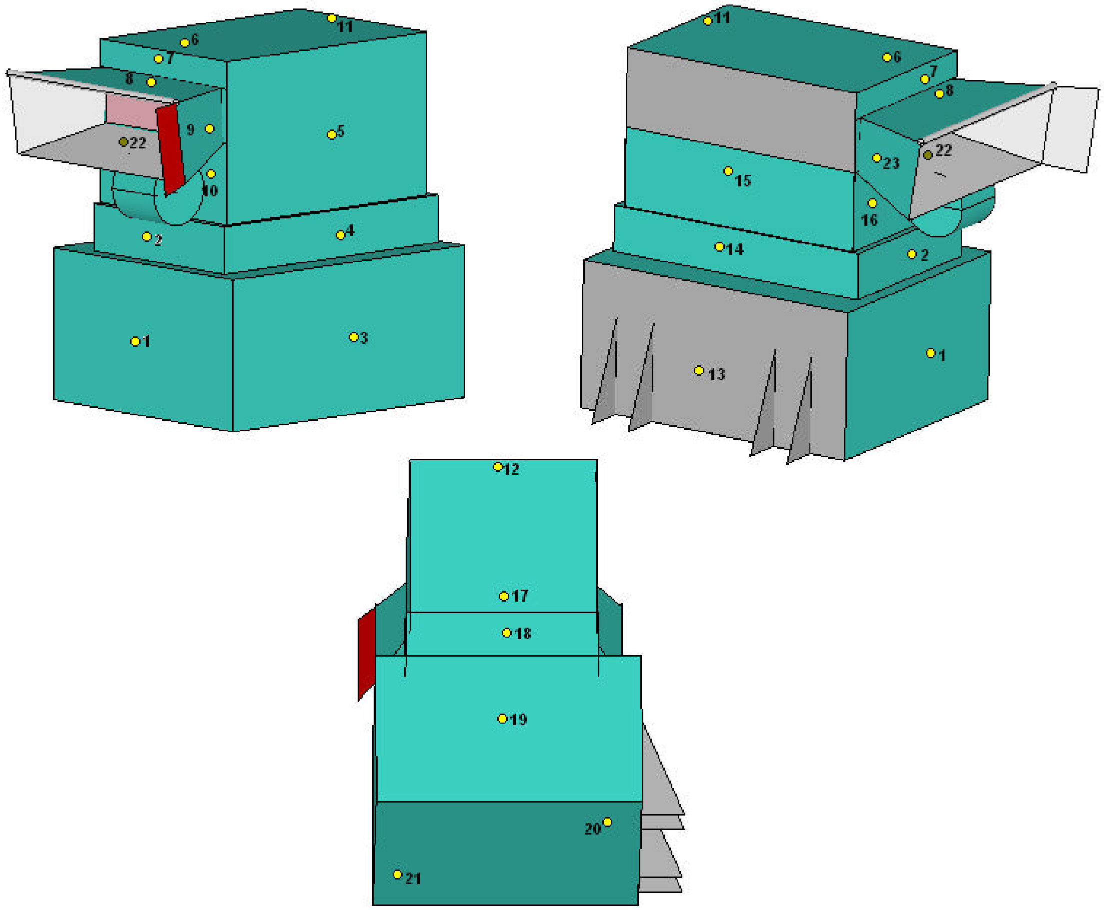


Figure 4: SIT TB T/C Locations

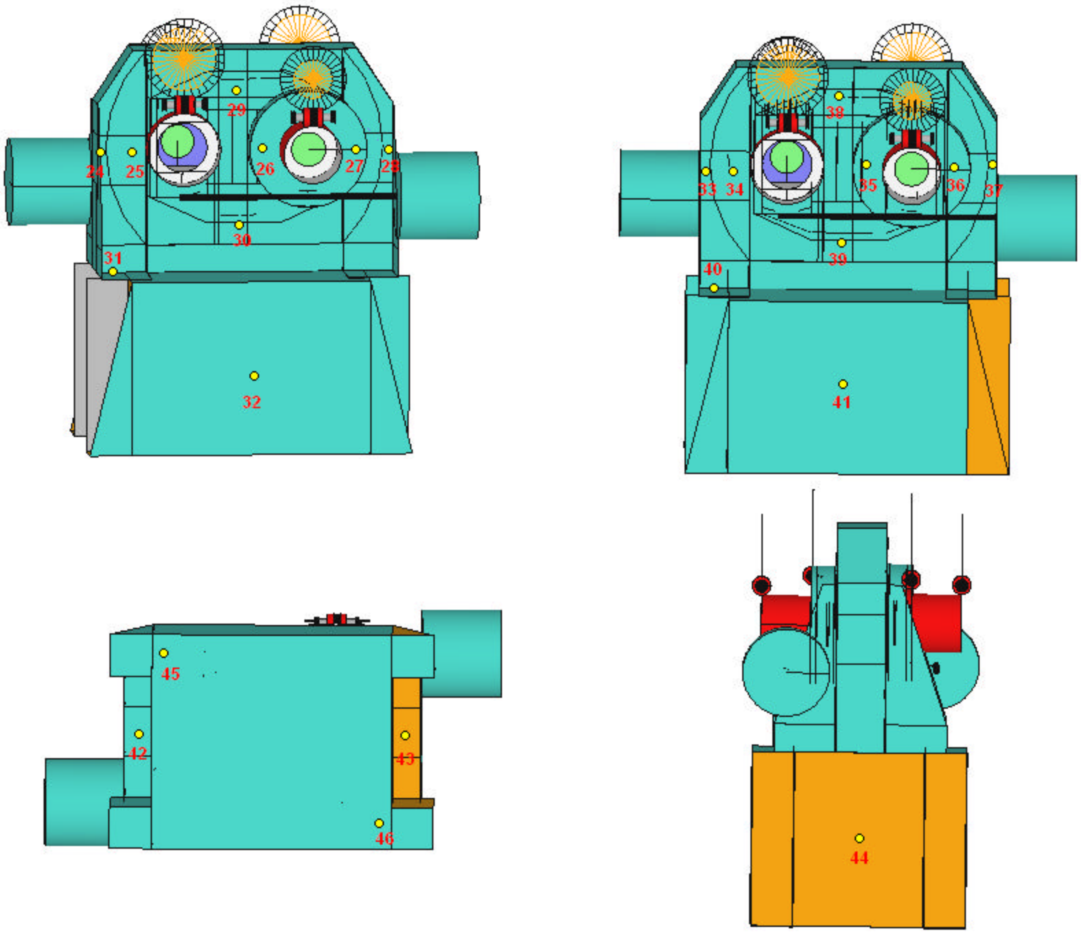


Figure 5: SEPTA T/C Locations

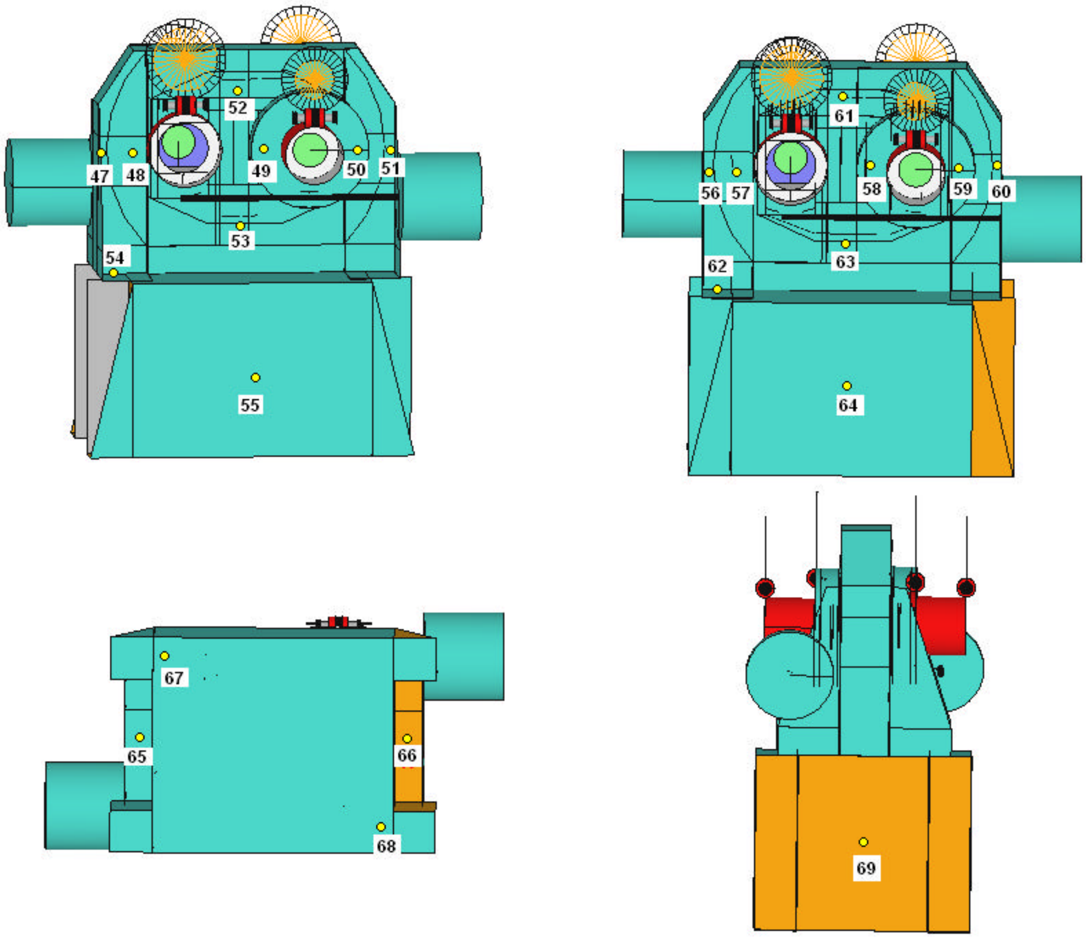
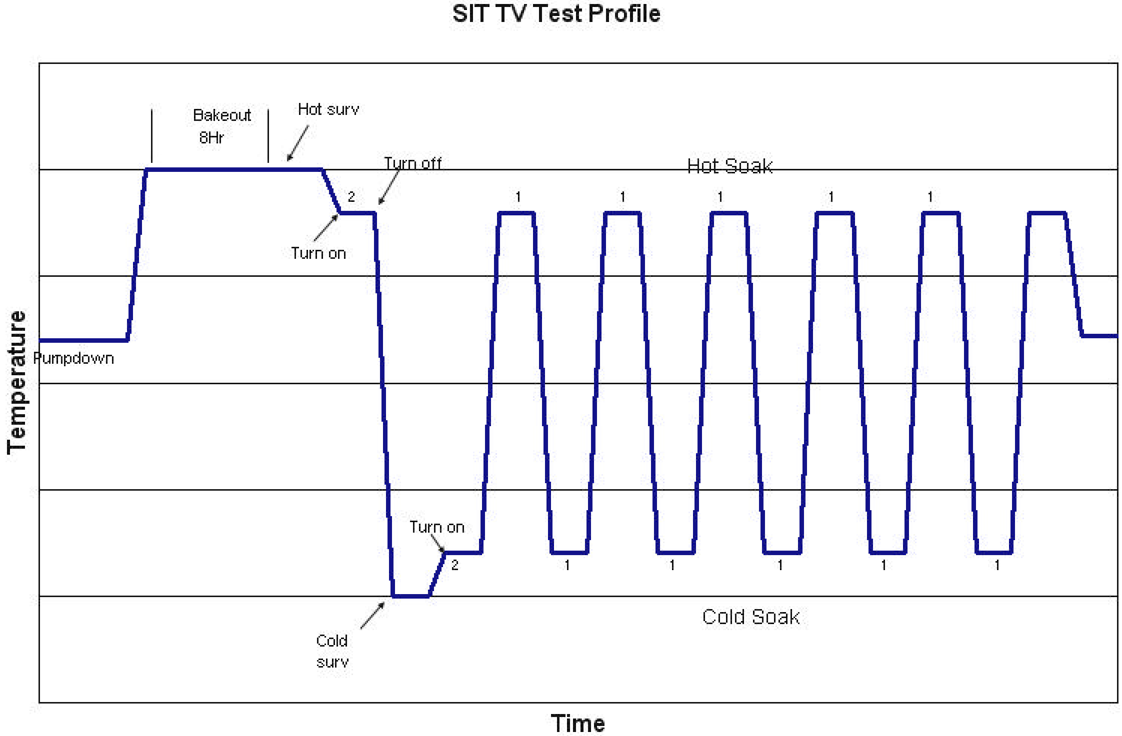


Figure 6: SEPTB T/C Locations



1 = Stabilize, Soak 1Hour and Test Concurrently.
2 = Stabilize, Turn On, Soak 1Hour and Test Concurrently.

Figure 7: SIT Thermal Vacuum Test Temperature Profile