STEREO
IMPACT

Observatory Thermal Vac Test Plan

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Date Run:_____

Document Revision Record

Rev.	Date	Description of Change	Approved By
A	2005-Dec-5	Preliminary Draft	-
B	2005-Dec-19	Update SEP temperatures per John Hawk	
C	2005-Jan-6	Add bakeout temps, change door openings, change SIT op heater to thermostat	

Table of Contents

1. Overview

1.1. *Introduction*

This document describes the test plan for the IMPACT instrument suite during Observatory-level thermal balance and thermal vac tests. It forms an addendum to the observatory test plans (reference 1 and 2), describing the instrument-specific plans for operations during the observatory tests.

1.2. *Document Conventions*

In this document, TBD (To Be Determined) means that no data currently exists. A value followed by TBR (To Be Resolved) means that this value is preliminary. In either case, the value is typically followed by a code such as UCB indicating who is responsible for providing the data, and a unique reference number.

1.3. *Applicable Documents*

The following documents are closely interrelated with this specification. All documents can be found on the Berkeley STEREO/IMPACT FTP site unless otherwise indicated:

http://sprg.ssl.berkeley.edu/impact/dwc/

1. 7381-9155 – STEREO Observatory Thermal Balance Test Plan (on APL web site)
2. 7381-9156 – STEREO Observatory Thermal Vac Test Plan (On APL web site)
3. 7381-9003 – STEREO Environmental Test Spec (on APL web site)
4. 7381-9012 – IMPACT ICD (on APL web site)
5. TestProcs/IMPACT-BOOM_CPT – Boom Suite Comprehensive Performance Test
6. TestProcs/SEP_CPT – SEP Suite CPT
7. TestProcs/IMPACT-BOOM-Aliveness – Boom Suite Aliveness Test Proc
8. TBD – SEP Suite Aliveness Test Proc
9. ICD/IMPACT_CTM (command & telemetry database)

2. Thermal Balance

The instrument suite has already been through thermal balance and verified its thermal model. Since the instruments are mostly thermally isolated from the spacecraft, their temperatures are not critical to the spacecraft thermal balance. On the other hand, this balance cold and hot soaks are considered one of the qualification cycles of the instruments, so we shall control the instrument temperatures during these tests to approximately the predicted hot and cold operating temperatures to the extent we can in the thermal balance configuration.

2.1. *Configuration*

The instrument shall be configured as listed in the IMPACT-related items I reference 1 section 4.3. Note that the SWEA and SIT high voltage plugs shall be configured to enable those supplies, the SWEA and STE purge manifolds will be removed, and all red-tag aperture covers shall be removed. No instrument stimulus shall be connected (SIT test pulser or SWEA radiation sources) for this phase of the test.

2.2. *Instrument Operation*

The instrument will start out on survival heaters and will transition to operational mode as called out in reference 1. The MAG heater supply shall remain enabled for all modes except for short tests. Power-on shall use the IMPACT Aliveness test procedures (reference 7 and 8) to configure the instrument into a nominal operating mode. Other than as listed below, there is no significant difference in instrument power dissipation with mode, and so no hot and cold case instrument modes.

2.2.1. Operational Heaters

2.2.1.1 SEP Operational Heaters

The SEP operational heaters are software controlled to achieve programmable temperature set points. The set points for each thermal balance mode are shown in Table 2-1.

2.2.1.2 SWEA Operational Heater

The SWEA Operational heater is software controlled to a programmable power level (in 10% increments, with full power being ~2.5W at 28V). The set point for each thermal balance case are shown in Table 2-1.

2.2.2. Instrument Doors

The SEPT, SIT, STE, and SWEA doors shall start out closed. At some point when it is believed to be safe from a contamination point of view those doors shall be open (current plan is to open all doors Cold B2 except one of the SEPT-E doors – the TBD one in sunlight that will warm during on-orbit actuation - which we will open during Hot C1). The spacecraft actuates the SIT and SEPT doors. The instrument actuates the SWEA and STE doors. The STE doors are reclosable and shall be commanded closed prior to venting (during phase INSTDN).

2.2.3. High Voltage Supplies

The SIT and SWEA instruments contain high voltage power supplies. Operating the supplies in inadequate vacuum could damage the instruments, so they will not be left powered on for long periods of time to minimize the risk of damage caused by pressure transients in the chamber. The high voltage will not be operated unless the chamber pressure has been below 1E-5 Torr for at least 12 hours continuously. In addition, the spacecraft will automatically and immediately shut down the high voltage supplies by issuing a power-down warning to the IMPACT instruments if the chamber pressure exceeds 1E-5 Torr. Also the SWEA high voltage supply cannot be operated unless the SWEA door has been opened for at least 12 hours.

It is desirable to run the SWEA and SIT high voltage supplies some time during Thermal Balance to get a background measurement of the instruments with no stimulation. High voltage ramp-up, test, and ramp-down will take 1-2 hours.

Since the high voltage supplies will typically not be running, the instruments will dissipate a bit less power than normal (the operational heaters will tend to make up the difference), which must be taken into account in the post-test analysis. The SWEA instrument takes ~0.5W more power with the high voltage on, and SIT takes ~TBD W more with the high voltage on.

2.3. *Instrument Thermal Control*

In addition to the instrument operational heat dissipation, externally-controlled test heaters shall be used to control the instrument temperatures. The temperature set points for each test heater for each thermal balance case are shown in Table 2-1.

During survival tests, test heaters are generally set at the yellow low limit. Where instrument survival heaters are present they will typically keep the instrument warmer than this level, so the test heaters will act as backup. For parts without survival heaters (Boom +X, MAG tray) which are normally heated only by the sun, heaters are set to provide the cold case predict temperature.

During Cold case B2, the test heaters will be set to the mission predicted low temperature and the operational heaters will be off. During cold case B3, the operational heaters will be set to 10C above predict to verify their operation (50% power for SWEA). This will test the heaters and also provide another data point for the instrument thermal model verification. During Hot case C1 and C2 the operational heaters will be off and the test heaters will be set to the predicted hot case temperature for the instrument.

Table 2-1, Thermal Balance Profile

System	Thermal Balance Test					
	Bakeout	**Survival A1, A2**	**Cold B1**	**Cold B2**	**Cold B3**	**Hot C1, C2**
Survival Heaters	On	On	On	Off	Off	Off
Instrument Power	Off	Off	Off	On	On	On
MAG Heater	On	On	On	On	On	On
Boom Deploy Htr	Off	Off	Off	Off	Off	Off
Operational Heaters:						
SWEA	Off	Off	Off	Off	50%	Off
HET	Off	Off	Off	Off	-7C	Off
LET	Off	Off	Off	Off	-7C	Off
SIT (Thermostat)	Off	Off	Off	On	On	On
SEPT-E	Off	Off	Off	Off	-5C	Off
SEPT-NS	Off	Off	Off	Off	-2C	Off
Test Heaters:						
Boom +X	+40 C	-10 C	-10 C	-10 C	-10 C	+40 C
SWEA	+40 C	-35 C	-30 C	-30 C	-30 C	+10 C
MAG Tray	+40 C	-50 C	-50 C	-50 C	-50 C	-5 C
LET Top	+35 C	-35 C	-35 C	-17.5 C	-17.5 C	+15 C
SEP Central	+35 C	-35 C	-35 C	-18 C	-18 C	+14.5 C
SIT Top	+30 C	-40 C	-40 C	-11.5 C	-11.5 C	+7.5 C
SIT Ebox	+45 C	-40 C	-40 C	-12.5 C	-12.5 C	+17.5 C
SEPT E Base	+40 C	-40 C	-40 C	-15.5 C	-15.5 C	+12 C
SEPT NS Base	+40 C	-40 C	-40 C	-12.5 C	-12.5 C	0 C
Doors	Closed	Closed	Closed	Open*	Open*	Open
SIT, SWEA HV	Off	Off	Off	On	On	On

Open* - all except one of SEPT-E doors.

3. Thermal Vac

During observatory thermal vac cycling the plan is to cycle the instruments at the same time to the same limits used for the instrument level thermal vac tests (predicts plus margin) using the test heaters plus instrument dissipation.

3.1. *Configuration*

The instrument shall be configured as listed in the IMPACT-related items I reference 2 section 4.3. Note that the SWEA and SIT high voltage plugs shall be configured to enable those supplies, the SWEA and STE purge manifolds will be removed, and all red-tag aperture covers shall be removed. Instrument stimulus shall be connected (SIT test pulser and SWEA radiation sources) for this phase of the test.

3.2. *Instrument Operation*

The instrument will start out on survival heaters and will transition to operational mode as called out in reference 2. The MAG heater supply shall remain enabled for all modes except for short tests. Power-on shall use the IMPACT Aliveness test procedures (reference 7 and 8) to configure the instrument into a nominal operating mode. During the first cycling hot and cold plateaus the instruments will perform a CPT.

3.2.1. Operational Heaters

3.2.1.1 SEP Operational Heaters

The SEP operational heaters are software controlled to achieve programmable temperature set points. The set points for each thermal balance mode are shown in Table 3-1.

3.2.1.2 SWEA Operational Heater

The SWEA Operational heater is software controlled to a programmable power level (in 10% increments, with full power being ~2.5W at 28V). The set point for each thermal balance case are shown in Table 3-1.

3.2.2. Boom Deployment Heater

The boom deployment heater is only planned to be used during the mission to ensure that the boom actuator is warm enough for deployment. It comes on 30 minutes prior to deployment and is the powered off for the rest of the mission. It is powered by spacecraft command and is thermostatically controlled, with a set point of zero C (the boom has been actuated at the assembly level in vacuum at +40 and –33C). To verify the heater circuit works it should be powered on during the first transition from Cold to Hot for at least half an hour, or until the thermostat has cycled 3 times, which ever comes last.

3.2.3. Instrument Doors

The SEPT, SIT, STE, and SWEA doors shall start out closed. At some point when it is believed to be safe from a contamination point of view (probably the first hot soak) the

instrument-controlled doors will be opened (STE and SWEA). The spacecraft-controlled doors will remain shut. The STE doors are reclosable and shall be cycled as part of the instrument CPT and closed prior to venting.

3.2.4. High Voltage Supplies

The SIT and SWEA instruments contain high voltage power supplies. Operating the supplies in inadequate vacuum could damage the instruments, so they will not be left powered on for long periods of time to minimize the risk of damage caused by pressure transients in the chamber. The high voltage will not be operated unless the chamber pressure has been below 1E-5 Torr for at least 12 hours continuously. In addition, the spacecraft will automatically and immediately shut down the high voltage supplies by issuing a power-down warning to the IMPACT instruments if the chamber pressure exceeds 1E-5 Torr. Also the SWEA high voltage supply cannot be operated unless the SWEA door has been opened for at least 12 hours.

It is desirable to run the SWEA and SIT high voltage supplies as part of the instrument CPTs during Thermal Vaccuum. For SWEA this will provide and end-to-end test using the attached source. High voltage ramp-up, test, and ramp-down will take 1-2 hours.

3.3. *Instrument Thermal Control*

In addition to the instrument operational heat dissipation, externally-controlled test heaters shall be used to control the instrument temperatures. The temperature set points for each test heater for each thermal balance case are shown in Table 3-1.

During survival tests, test heaters are generally set at the yellow low limit. Where instrument survival heaters are present they will typically keep the instrument warmer than this level, so the test heaters will act as backup. For parts without survival heaters (Boom +X, MAG tray) which are normally heated only by the sun, heaters are set to provide the cold case predict temperature.

During Hot case D1 the operational heaters will be off and the test heaters will be set to the predicted hot case temperature for the instrument. During thermal vac cycling hot and cold cases the test heaters shall be set to the test limit temperatures as called out in table 3-1.

Table 3-1, Thermal Cycling Profile

System	Thermal Vac Test			
	Survival	Balance D1	Hot	Cold
Survival Heaters	On	On	Off	Off
Instrument Power	Off	Off	On	On
MAG Heater	On	On	On	On
Boom Deploy Htr	Off	Off	Off	On*
Operational Heaters:				
SWEA	Off	Off	Test	Test
HET	Off	Off	Test	Test
LET	Off	Off	Test	Test
SIT	Off	Off	Test	Test
SEPT-E	Off	Off	Test	Test
SEPT-NS	Off	Off	Test	Test
Test Heaters:				
Boom +X	-10 C	+40 C	+40 C	-20 C
SWEA	+35 C	+35 C	+35 C	-30 C
MAG Tray **	-5 C	-5 C	+40 C	-50 C
SWEA Source	+35C	+35C	+35C	-30 C
LET Top	-35 C	+15 C	+35 C	-25 C
SEP Central	-35 C	+14.5 C	+35 C	-25 C
SIT Top	-40 C	+7.5 C	+30 C	-30 C
SIT Ebox	-40 C	+17.5 C	+45 C	-30 C
SEPT E Base	-40 C	+12 C	+40 C	-30 C
SEPT NS Base	-40 C	0 C	+40 C	-30 C
SIT, SEPT Doors	Closed	Closed	Closed	Closed
SWEA, STE Doors	Closed	Closed	Open	Open
SIT, SWEA HV	Off	Off	Test	Test

- * On during transition from cold to hot.
- ** Adjust MAG Tray to achieve indicated MAG sensor temperature during hot soaks
- ‘Test’ means on as part of functional only.