

Record: Local date _____, Local time _____, (FM1, A S/C) _____, (FM2, B S/C) _____,
UTC date _____, UTC time _____, Initials _____, Temperature _____ °C, Rel. humidity _____ %.

List SEP sensors attached: LET _____, HET _____, SIT _____, SEPT-E _____ and SEPT-NS _____.

Describe test set-up configuration: _____

1.0 INTRODUCTION

1.1 TEST NAME: SEP Comprehensive Performance Test

1.2 RESPONSIBLE SUBSYSTEM/INSTRUMENT LEADS:

SEPT	Reinhold Müller-Mellin, Stephan Böttcher
SIT	Glenn Mason, Peter Walpole
HET	Tycho von Rosenvinge, Kristin Wortman
SEP Central/LET	Alan Cummings, Branislav Kecman

1.3 AUTHOR: Branislav Kecman
(626) 395-4264, kecman@srl.caltech.edu

1.4 DATE CREATED:	October 15, 2004	Initial release
Rev A	January 19, 2005	Checksum update and edit
Rev B	August 31, 2005	Combine procs, update checksums

2.0 DESCRIPTION

2.1 PROCEDURE DESCRIPTION:

The procedure verifies comprehensive performance of the Solar Energetic Particles (SEP) instrument suite before and after the following activities: bench and environmental tests, integration with the IMPACT suite, integration with the STEREO spacecraft, S/C environmental tests, pre-launch operations and in flight if necessary.

It exercises many aspects of the SEP suite operational modes and provides reliable means for their tracking over long time period.

2.2 PROCEDURE OUTLINE:

1. SEP Power On (10 minutes total)

2. SEP Aliveness Test (10 minutes total)
 Includes the following tests running in parallel to verify housekeeping data, CCSDS packets and singles rates:
 - 2a. SEP_Central Aliveness Test (5 minutes) _____ (√ when done)
 - 2b. SEPT Aliveness Test (5 minutes) _____ (√ when done)
 - 2c. LET Aliveness Test (5 minutes) _____ (√ when done)
 - 2d. HET Aliveness Test (5 minutes) _____ (√ when done)
 - 2e. SIT Aliveness Test (5 minutes) _____ (√ when done)

3. SEP Quiet Mode (10 minutes total)
 Includes verification of SEPT / SIT / HET / LET singles rates in the quiet state

4. SEP Event / Pulser Mode (2 hours total)
 Includes the following tests running in parallel:
 - 4a. LET ADC Only Mode (10 minutes) _____ (√ when done)
 - 4b. SIT Noisy Mode (10 minutes) _____ (√ when done)
 - 4c. HET Event Verification (30 minutes) _____ (√ when done)
 - 4d. SEPT ITPG Run (40 minutes) _____ (√ when done)
 - 4e. SIT Normal Mode – HV Off (10 minutes) _____ (√ when done)
 - 4f. LET Threshold Mode (10 minutes) _____ (√ when done)
 - 4g. SIT Ext. Test Pulser Mode (20 minutes) _____ (√ when done)
 - 4h. HET Test Pulser Mode (1 hour) _____ (√ when done)

5. SEP Heater Mode (15 minutes total)
 Includes the following tests running in series:
 - 5a. SEPT Heater Mode (10 minutes) _____ (√ when done)
 - 5b. LET Heater Mode (5 minutes) _____ (√ when done)

6. SEP Power Off (5 minutes total) _____ (√ when done)

2.3 TEST DURATION: 3.5 hours

2.4 INSTRUCTIONS FOR USE:

- Obtain a double-sided hard copy of this procedure for record keeping during the test.
- Refer to SEP User’s Manual on how to log in and set up GSE computers and run GSE software.
- In this procedure the SEP Central / SEPT / LET displays for data verification are viewed on a Linux PC, either desktop or laptop, referred to as SEP GSE. The HET and SIT displays are viewed on two Windows PC laptops, referred to as HET and SIT GSE respectively.
- To command any of the SEP sensors go to SEP Command Center window on SEP GSE. Select ASCII Command option and enable that sensor’s CMD button. Type SEP Central / SEPT / LET commands in CAPITAL letters, and SIT and HET commands in lower case letters. Verify spelling before hitting the RETURN key.
- Verify checksums and command responses in SEP Command Echo Monitor window on SEP GSE.
- Monitor SEP operation on GSE displays as instructed by the procedure.

2.5 TEST SETUP REQUIREMENTS:

SEP suite shall be installed on one of the following: environmental test fixture, clean flow-bench or STEREO spacecraft. SEP data shall go to SEP GSE either directly or via IMPACT GSE. Both GSEs shall be in their monitoring mode and mutually communicating before the test begins.

Boil-off LN₂ purge shall be continuously supplied to SEP except during T/V test. Monitor flow daily. SEP suite shall be double-bagged in Ilumalloy bagging material before being taken out of cleanroom.

2.6 PARAMETERS REQUIRED:

In order to test SEPT and LET operational heaters at room or any given temperature the heater control parameters (Set Points) need to be adjusted so that ambient temperature appears cold enough for the controller to start the heating. These parameters are featured in Sections 2.2.3 and 2.2.7.

2.7 CRITICAL ACTIVITIES:

DO NOT send commands until SEP representative conducting the procedure gives verbal OK.

In vacuum DO NOT power on SEP within the first 24 hours of reaching stable pressure of 10⁻⁶ torr. The same is true of the SIT HVPS.

In case of a vacuum loss SEP power shall be immediately shut off via automatic relay.

2.8 SPECIAL CONSTRAINTS OR ACTIVITIES:

SEP apertures shall be protected by their doors and red tag covers at all times except during environmental tests.

DO NOT touch exposed aperture windows and make sure nothing accidentally hits them while the doors are open and red tag covers are removed.

LET sensor weighs 0.85kg and sits on top of SEP Main Assembly which makes it top-heavy. Special care must be taken during stand-alone testing to firmly attach SEP Main Assembly to the mounting surface in order to prevent accidental tipping.

2.9 RECORDING REQUIREMENTS:

Prior to the execution of this procedure SEP GSE software shall be running, data logging enabled and pertinent SEP data windows and displays open on SEP GSE.

Additional local or remote GSEs of some SEP sensors shall be connected to the main SEP GSE.

Test conductor shall follow the procedure steps and fill in the blanks on a hard copy of this procedure and snap GSE display windows as instructed by the procedure.

Hard copies shall be filed in the CPT section of a three-ring binder titled "SEP Functional Tests".

SEP data shall be stored on SEP GSE and backed up immediately on another Linux PC.

3.0 SAFETY

3.1 HAZARDS OR WARNINGS:

Hazards: Optional sections of this procedure involve use of approved radiation sources that shall be handled by authorized SEP team personnel. Post signs to that effect in the test area to limit access.

Warning: Although high voltage lines are NOT exposed, various bias voltage lines inside SEP can reach up to -80VDC and +250VDC. In vacuum SIT HVPS can produce high voltage of up to 3kV.

BEGINNING OF THE EXECUTABLE PORTION

_____ UTC **4g.1. Check SIT External Test Pulser and Install**

NOTE: This section may be performed independently of the state of SIT power. It is part of Step 4g and the set-up is usually done well ahead of the beginning of actual CPT.

- Switch Test Pulser's ON/OFF switch to ON. _____ (√ if OK)
- Press TEST push-button. The green BATTERY LED should light. _____ (√ if OK)
- The red LOW VOLTAGE LED should not light. _____ (√ if OK)
- Absence of green LED or presence of red LED indicates a worn out battery, so replace it.
- Switch Test Pulser's ON/OFF switch to OFF. _____ (√ if OK)
- Verify the SIT telescope cover is closed. _____ (√ if OK)
- Ground the Test Pulser chassis to the test setup and place the pulser in a secured location within 1 meter of the SIT instrument (length of cable is 1 m). _____ (√ if OK)
- Connect 3 signal coax cables from the pulser to SIT test inputs per Fig 1. _____ (√ if OK)

NOTE: In case the test pulser is not available – connect bench pulsers as in Fig 1A. The DG535 should be powered off for the beginning of the test.

_____ UTC **1. SEP Power On (10 minutes total)**

_____ UTC 1a. Verify power connections to SEP instrument (from lab P/S, IMPACT GSE or S/C). Verify that SEP GSE software is running _____ (√ if OK). If the SEP GSE software is not running, click on a dice icon (FM1, Ahead S/C) _____ (√ if OK) or (FM2, Behind S/C) _____ (√ if OK) to start the software and establish corresponding data recording channels on SEP GSE. Enable data logging on SEP GSE _____ (√ if OK), open all SEP GSE displays/windows _____ (√ if OK). Get ready to synchronize SEP power turn-on with IDPU I/F clock (within 5 seconds after power is turned on) in order to capture SEP Central boot checksums. _____ (√ if ready)

Begin logging of SIT data into a dated file on SIT GSE.
Log Filename _____

Begin logging of HET data into a dated file on HET GSE.
Log Filename _____

_____ UTC 1b. Turn on SEP power. Lab P/S _____, IMPACT GSE _____, S/C _____ (√ if used)

Verify SEP main +28V supply current _____ A
 (It can vary depending on how many SEP sensors are attached to SEP Central: for LET alone 0.188A, for LET/HET FM1 0.196A, for LET/HET FM2 0.191A, for complete SEP 0.252A. If operating at cold, the operational heaters will turn on/off periodically and draw a predictable amount of extra current. If SEPT is attached, its operational heaters will cycle on/off until Step 1e is executed.)

Verify SEP main +28V supply voltage _____ V (28V)

1c. Verify checksums after SEP Central boots (5-10 seconds following the power on).

On SEP Central FM1, Ahead S/C, verify these checksums:

B0B	_____	1018	_____	93831D	_____	(√ if OK)
1582	_____	1918	_____	51400A	_____	
191D	_____	1A37	_____	9019	_____	
2418	_____	4E50	_____	F4831F	_____	
RAM	D9D65F		_____			
PROM0	2CC50B		_____			
PROM1	2CC50B		_____			
BOTH	598A16		_____			

XX

On SEP Central FM2, Behind S/C, verify these checksums:

B0B	_____	1018	_____	93831D	_____	(√ if OK)
1582	_____	1918	_____	51400A	_____	
191D	_____	1A37	_____	9019	_____	
2418	_____	4E50	_____	F4831F	_____	
RAM	D9D65F		_____			
PROM0	7CC543		_____			
PROM1	7CC543		_____			
BOTH	F98A86		_____			

1d. The following command returns address at the end of FORTH dictionary in SEP Central memory:
 _____ UTC SEP> HERE . (Note there is a space between E and the dot) _____ (20048)

1e. Verify that SEP Central section of SEP Housekeeping display (bottom portion) has no indication of yellow/red limit violations for voltages and temperatures monitored. _____ (√ if OK)

Record SEP Central HK anomalies here: _____

Snap SEP GSE HK page display and file it at the back of this procedure. _____ (√ if OK)

Compare HK page display with a reference sample. Confirm there are no discrepancies. _____ (√ if OK)

1f. Select a proper command below (FM1 vs. FM2) to turn on positive and negative bias, enable SEPT PDFE circuits and SEPT operational heater control, then boot SIT, HET and LET sensors in that order. Command responses in this period consist of boot messages and checksums. It will take about 90 seconds to execute if all four sensors are attached. NOTE: SEND ONLY ONE COMMAND BELOW:

_____ UTC SEP> ALLON1 (for FM1, Ahead S/C) or _____ (√ echo)
 SEP> ALLON2 (for FM2, Behind S/C) _____ (√ echo)

Verify that SIT has booted and SIT> prompt was shown _____ (√ if OK)

Verify that HET has booted and HET> prompt was shown _____ (√ if OK)

Verify that LET has booted and LET> prompt was shown _____ (√ if OK)

_____ UTC **2. SEP Aliveness Test** **(10 minutes total)**

_____ UTC **2a. SEP Central Aliveness Test** **(5 minutes)**

Verify SEP main +28V supply current _____ A and SEP main +28V supply voltage. _____ V (28V)
(They should be the same as values recorded in Step 1g.)

Send the following commands (pay attention to command pointers SEP> vs. SIT>)

- To display elapsed time in hours/minutes/seconds/sub-seconds since the last reboot of SEP Central:

_____ UTC SEP> TIME. _____ (record)

- To initiate SIT:

_____ UTC SIT> immed 1 causes all commands to be executed upon receipt _____ (√ echo)

Verify that SEP Central section of SEP Housekeeping display (bottom portion) has no indication of yellow/red limit violations for voltages and temperatures monitored. _____ (√ if OK)

Record SEP Central HK anomalies here: _____

Verify that two bias voltage monitors are showing approx. -120V and +330V. _____ (√ if OK)

Snap SEP GSE HK page display and file it at the back of this procedure. _____ (√ if OK)

Compare HK page display with a reference sample. Confirm there are no discrepancies. _____ (√ if OK)

Verify that all of SEP CCSDS data packets flow regularly on a minute by minute basis as follows:

- SIT 12 science packets/minute - ApId 605 - 616 _____ (√ if OK)
- HET 6 science packets/minute - ApId 590, 591, 592, 593, 594 _____ (√ if OK)
- LET 16 science packets/minute - ApId 580 _____ (√ if OK)
- SEPT-NS 1 science packet/minute - ApId 600 _____ (√ if OK)
- SEPT-E 1 science packet/minute - ApId 601 _____ (√ if OK)
- Beacon data 1 science packet/minute - ApId 624 _____ (√ if OK)
- HK data 1 packet/minute - ApId 577 _____ (√ if OK)

If testing w/o IDPU or off S/C, verify that SEP Unknown CCSDS Packet window is empty. _____ (√ if OK)

If not, record how many packets ApId 224 there are (since the last SEP reboot): _____

Verify that Unprocessed LET Science Packet window is empty. _____ (√ if OK)

If not, record how many packets ApId 580 there are (since the last LET reboot): _____

Verify that SIT and HET sequence counts are reasonable and that the major frame number advances. Use their respective GSEs. _____ (√ if OK on SIT GSE) _____ (√ if OK on HET GSE)

_____ UTC **2b. SEPT Aliveness Test** (5 minutes)

Verify that SEPT section of SEP Housekeeping display (upper portion) has no indication of yellow/red limit violations for leakage currents and temperatures monitored. Subtract 166 from the raw SEPT temperature readings to get °C. A raw temperature reading of zero indicates that SEPT is not (yet) sending data. A valid reading confirms that SEPT is responding to commands. _____ (√ if OK)

In SEP HK packets, verify that the raw leakage current readings do not overflow to the value 255. A reading different from 255 indicates that the bias voltage is present. Raw readings between 50 and 150 are expected. _____ (√ if OK)

In the SEPT science packets for SEPT-NS and SEPT-E verify that the spectra contain only noise counts in the lower five energy bins, and only a few sporadic counts in the higher bins of the 32-bin histogram. _____ (√ if OK on SEPT-NS) _____ (√ if OK on SEPT-E)

Record SEPT HK and singles rates anomalies here: _____

_____ UTC **2c. LET Aliveness Test** (5 minutes)

The following command returns address at the end of FORTH dictionary in LET memory.
_____ UTC LET> HERE . (Note: there is a space before the dot) _____ (46122)

The following command returns elapsed time in hours/minutes/seconds/sub-seconds since the last LET boot:
_____ UTC LET> TIME. (Note: there is NO space before the dot) _____ (record)

Verify that LET section of SEP Housekeeping display (lower middle portion) has no indication of yellow/red limit violations for leakage currents and temperatures monitored. _____ (√ if OK)

Verify that four LET temperature monitors are showing similar values within 1-2 °C. _____ (√ if OK)

Compare HK page display with a reference sample. Confirm there are no discrepancies. _____ (√ if OK)

Print snapshots of two LET singles rates and events page displays on a double-sided paper, label it and file at the back of this procedure. _____ (√ if OK)

Compare LET singles rates and events page displays with reference samples. Check for stim box rates, single detector rates and event totals by priority. Confirm there are no discrepancies. _____ (√ if OK)

Record LET HK, singles rates and events observations or anomalies here: _____

_____ UTC **2d. HET Aliveness Test** (5 minutes)

Record HK data for 7 detectors from HET GSE. It takes 5-6 minutes for data to come through after HET boots.

Start Time: _____ **HET Temperature #1** _____ **HET Temperature #2** _____

Data from HET HK (dec) page on HET GSE:

	H1i	H1o	H2	H3	H4	H5	H6
PHASIC							
Channel							
Preamp							
HG Thresh							
LG Thresh							
Leakage							
DAC							

The following are the expected HET HK values for HET FM1 and FM2. Compare them to the actual values above and pay attention to FM1 vs. FM2 values. Report discrepancies in the area below.

	H1i	H1o	H2	H3	H4	H5	H6
PHASIC	0	0	1	1	1	1	1
Channel (FM1)	1	11	3	5	7	9	12
Channel (FM2)	1	10	2	5	7	10	13
Preamp (volts)	~4.40	~4.40	~4.40	~4.40	~4.40	~4.40	~4.40
HG Thresh (FM1)	284	220	36	188	140	180	100
HG Thresh (FM2)	192	244	124	120	68	68	30
LG Thresh (FM1)	176	192	112	8	96	112	248
LG Thresh (FM2)	192	192	44	56	64	52	52
Leakage (uA)	<0.5	<0.5	<0.5	<2.0	<2.0	<2.0	<1.0

Record HET HK observations or anomalies here: _____

_____ UTC Record the H1-H6 singles rates (low gain and high gain) for three consecutive major frames. The high-gain singles rates should be < 100/min., and the low-gain singles rates should be < 5/min.

	High-Gain Singles Rates for 3 major frames			Low-Gain Singles Rates for 3 major frames		
Mjr Fr #						
H1i						
H1o						
H2						
H3						
H4						
H5						
H6						

Record the following rates for one major frame. **Major Frame #:** _____

Rate Counter	Expected Counts	Actual Counts	Rate Counter	Expected Counts	Actual Counts
Livetime	~12 x 10 ⁶		Stop heavies	0	
Trigger	<300		Pen H	0	
Coincidence	0		Pen He	0	
Events	0		Pen heavies	0	
Singles que	0		Invalid	0	
Stop que	0		H1 I and O	0	
Pen que	0		Inconsist.	0	
Stop H	0		H1 not first	0	
Stop He	0		Stim evt cnt	0	

Record HET singles rates observations or anomalies here: _____

_____ UTC 2e. SIT Aliveness Test (5 minutes)

2e.1. Verify the following singles rates on SIT GSE match expected values:

Description	Expected Value	Actual Value	Comments
SRT	0		
STP	0		
VS	0		
SSD	<20		
VSE	0		
Matrix Rates (ApId 605)	All 0		
Beacon Rates (ApId 619)	All 0		
Pulse Height Events (ApId 606-617)	All 0		

2e.2. Verify the following status information has been returned on SIT GSE and matches expected values:

Description	Expected Value	Actual Value	Comments
SW Ver	0903		
SW error	0 = (no error)		
HV Step	00		
Toferror	1 = error events		
HV Status	0 = off		
Eonly	0 = ET coincidence required		
Junk (Events)	0 = junk events ignored		
LIMHI	500		
calib gain	9 - 11		
calib offset	-14 to -65, should settle at -15 but may take as much as an hour (don't wait for it!).		
calib error	0x08, should settle to 0x00		

2e.3. Verify the following status information has been returned on SIT GSE and matches expected values:

Description	Expected Values	Actual Values	Comments
HV	0-100 V		
Tof T	25-35 C		
Foil T	20-25 C		
SSD T	20-25 C		
+3.3 V monitor	3.3 V		
+2.5 V monitor	2.5 V		
+5 V monitor	5 V		
+6 V monitor	6 V		

Record SIT HK and singles rates observations or anomalies here: _____

____ UTC 2f. If there are no anomalies above, SEP Aliveness Test procedure is complete.
 Record its total running time and any observations or anomalies here: _____

____ **UTC 3. SEP Quiet Mode (10 minutes)**

3a. The following commands put SEP sensors in their respective quiet mode. Note that SEPT is already in the quiet mode following power-on:

- ____ UTC LET> QUIET _____ (√ echo)
- ____ UTC SIT> immed 1 causes all commands to be executed upon receipt _____ (√ echo)
- ____ UTC SIT> hvenable 0 ensures that the SIT HVPS is disabled _____ (√ echo)
- ____ UTC SIT> junk 1 causes SIT to respond to all events, even illegals _____ (√ echo)
- ____ UTC SIT> eonly 1 removes TOF coincidence requirement for events _____ (√ echo)
- ____ UTC SIT> toferror 1 processes events including TOF errors _____ (√ echo)
- ____ UTC SIT> limhi 100 limits high-priority events to 256/major frame _____ (√ echo)

Wait 2-3 minutes for the new telemetry. In the meantime, continue with other Step 3 activities in parallel.

____ UTC 3b. LET Quiet Mode verification:

On two LET singles rates page displays all counts per minute should be near zero. Exceptions are allowed at extreme cold and hot soaks during T/V test. Print snapshots of both page displays on a double-sided paper, label it and file at the back of this procedure. Compare the rate page displays with reference samples.

Confirm there are no discrepancies and no noisy detectors. _____ (√ if OK)

Record LET singles rates observations or anomalies here: _____

____ UTC 3c. SIT Quiet Mode verification:

Description	Expected Value	Actual Value	Comments
Toferror	1		
HV Status	0		
Eonly	1		
Junk	1		
Limhi	256		

Record SIT singles rates observations or anomalies here: _____

_____ UTC 3d. HET Quiet Mode verification:
Same as in 2d. HET Aliveness Test verification above. _____ (√ if OK)
Record HET singles rates observations or anomalies here: _____

_____ UTC 3e. SEPT Quiet Mode verification:
Same as in 2b. SEPT Aliveness Test verification above. _____ (√ if OK)
Record SEPT singles rates observations or anomalies here: _____

_____ UTC 3f. If there are no anomalies above, SEP Quiet Mode procedure is complete.
Record its total running time and any observations or anomalies here: _____

_____ UTC **4. SEP Event / Pulser Mode** **(2 hours)**

_____ UTC **4a. LET ADC Only Mode** **(10 minutes)**

The following command puts LET in ADC Only Mode by disabling Livetime stimulus pulse and adjusting ADC pulse rate in order to read out events from all 32 DAC levels per each ADC:

_____ UTC LET> ADCMODE _____ (√ echo)

Wait 2-3 minutes for the new telemetry. In the meantime, continue with other Step 4 activities in parallel.

_____ UTC Open 2-D plots of L1 vs. L2 and L1 vs. L3 for both A and B sides. _____ (√ if OK)

Monitor single detector rates and event totals by priority. Snap LET page displays and file at the back of this procedure. Compare 2-D plots, event and rate page displays with reference samples. _____ (√ if OK)

Fit and analyze data off-line. Person(s) responsible for the analysis _____.
Analysis results will be available: date _____, location _____.

_____ UTC If there are no anomalies above, LET ADC Only Mode procedure is complete.
Record its total running time and any observations or anomalies here: _____

_____ UTC **4b. SIT Noisy Mode** (5 minutes)

Send the following HAZARDOUS COMMANDS. **Double-check the commands before sending them.**

SIT> hvenable 1 enables the SIT HVPS _____ (√ echo)
 SIT> hvlevel 10 sets the HVPS output to about 300V _____ (√ echo)

Wait 2-3 minutes for the new telemetry. In the meantime, continue with other Step 4 activities in parallel.

4b.1. Verify the following status information has been returned on SIT GSE and matches expected values:

Description	Expected Value	Actual Value	Comments
HV Step	10		
Toferror	1		
HV status	1		
Eonly	1		
Junk	1		
HV (see note*)	300-350V		

*Note: Housekeeping for the **HV Monitor should read 300-350V** if converted to engineering units. This will probably cause a Yellow Limit alarm on the GSE monitoring SIT housekeeping, but no corrective action is required.

5 minutes after beginning of SIT Noisy Mode go to Step 4e and turn off SIT HV. _____ (√ if OK)

HET FM1 on Ahead S/C

or

HET FM2 on Behind S/C

HET> tpfbse1 0 1 6 _____ (√ echo)
 HET> tpfbse1 0 b 116 _____ (√ echo)
 HET> tpfbse1 1 5 11c _____ (√ echo)
 HET> testp 4e2 179 3d _____ (√ echo)

HET> tpfbse1 0 1 6 _____ (√ echo)
 HET> tpfbse1 0 a 116 _____ (√ echo)
 HET> tpfbse1 1 5 11c _____ (√ echo)
 HET> testp 4e2 179 3d _____ (√ echo)

Wait 2-3 minutes for the new telemetry. In the meantime, continue with other Step 4 activities in parallel.
 _____ UTC Record the following HET rates counters:

Major HET Frame # _____

Rate Counter	Expected Counts	Actual Counts
Coincidence	~600	
Stop que	~600	
Stop heavies	~600	
Stim evt cnt	~600	

_____ UTC All other HET rate counters should read 0. _____ (√ if OK)
 Record any observations or anomalies here: _____

_____ UTC 4c.4. Send the following HET commands to verify the **Penetrating H Events**:

HET FM1 on Ahead S/C

or

HET FM2 on Behind S/C

HET> tpfbse1 1 3 126 _____ (√ echo)
 HET> tpfbse1 1 7 11c _____ (√ echo)
 HET> tpfbse1 1 9 11c _____ (√ echo)
 HET> tpfbse1 1 c 116 _____ (√ echo)
 HET> testp 4e2 17 b _____ (√ echo)

HET> tpfbse1 1 2 126 _____ (√ echo)
 HET> tpfbse1 1 7 11c _____ (√ echo)
 HET> tpfbse1 1 a 11c _____ (√ echo)
 HET> tpfbse1 1 d 116 _____ (√ echo)
 HET> testp 4e2 16 a _____ (√ echo)

Wait 2-3 minutes for the above commands to take effect. In the meantime, continue with other Step 4 activities.
 _____ UTC Record the following HET rates counters:

Major HET Frame # _____

Rate Counter	Expected Counts	Actual Counts
Coincidence	~600	
Pen que	~600	
Pen H	~600	
Stim evt cnt	~600	

_____ UTC All other HET rate counters should read 0. _____ (√ if OK)
 Record any observations or anomalies here: _____

_____ UTC **4d. SEPT In-flight Test Pulse Generator Run** (40 minutes)

SEPT sensor has a simple in-flight test pulse generator for testing of analog electronics and coincidence logic. Serious detector noise problems can also be revealed using ITPG which injects pulses of 4 different amplitudes into charge-sensitive amplifiers. A 4-bit mask defines the set of inputs subjected to the pulses. SEP Central has a table of test configurations (amplitude, mask, coincidence mode) to be performed. The first 10 entries in the table are preloaded with a set of tests that reasonably cover all detector channels and coincidence conditions with a single pulse amplitude. The remaining 30 entries repeat these tests with different amplitudes. A short test runs through 10 entries, and a full test runs through all 40. Each test requires a 1-minute accumulation cycle. After a 10- or 40-minute ITPG run, SEPT will automatically return to the nominal mode.

The following commands activate long ITPG run in SEPT-E and SEPT-NS, respectively:

_____ UTC SEP> 40 SPETEST _____ (√ echo)
 _____ UTC SEP> 40 SPNTEST _____ (√ echo)

Over the next 40 minutes

Identify the SEPT science packets with non-zero test-pulser configuration.

(Current versions of the flight software keep the pulser configuration unchanged when the pulse generator run finished. In that case, the previous data packet must show the value 0x4f hex in the mode flags byte.)

All test pulser packets must show about 1 047 000 counts in the single detector counter.

The sixth column in Table 1 tells which spectra should show a corresponding peak. The peaks should be mostly contained in a single energy bin of the spectra.

Table 1: Inflight test pulse generator mode table

seq	pdfc	filter	counter	pulse	peak
0	anti nominal	(0)	Main 0 (0x28)	Main even	even
1	anti nominal	(1)	Main 1 (0x22)	Main odd	odd
2	anti nominal	(2)	Main 2 (0x2A)	Main even/odd	none
3	anti nominal	(4)	Guard 0 (0x2C)	Main/Guard even	none
4	anti nominal	(5)	Guard 1 (0x23)	Main/Guard odd	none
5	anti nominal	(7)	Guard 3 (0x29)	Main even, Guard odd	none
6	anti nominal	(6)	Guard 2 (0x26)	Main odd, Guard even	none
7	coinc test	(3)	Main 3 (0x2A)	Main even/odd	all
8	coinc test	(4)	Guard 0 (0x2E)	Main/Guard even, Main odd	all
9	coinc test	(7)	Guard 3 (0x2B)	Main even, Main/Guard odd	all

pdfc: PDFE operation mode, external coincidence (mode 5) or anti-coincidence (mode 4).
 filter: External coincidence filter mode. nominal: all other signals contribute (0xAA), or
 test: only the other Main channel contributes (0xFF).
 counter: Single detector counter number. Main channels: 0–3, Guard channels 4–7.
 pulse: Which PDFE inputs the generated pulse is applied to. The pulser configuration specifies the amplitude in bits 5:4. The value 0 is the highest, 3 the lowest amplitude. For a short run the amplitude is 2, as shown in the table. The bits 3:0 indicate which detector inputs to stimulate. Bit 3: even main, bit 2: even guard, bit 1: odd main, bit 0: odd guard. The A and B sides of the telescopes receive the same stimulation.
 peak: Which spectra must show the pulser peak.

_____ UTC **4e. SIT Normal Mode – HV Off (10 minutes)**

Send the following sequence of commands to put SIT in its Normal Mode – HV Off:

	SIT> hvenable 0	ensures that the SIT HVPS is disabled	_____ (√ echo)
	SIT> hvlevel 0	sets HV level to 0	_____ (√ echo)
	SIT> junk 0	causes instrument to reject illegal events	_____ (√ echo)
	SIT> eonly 0	removes TOF coincidence requirement for events	_____ (√ echo)
	SIT> toferror 0	processes events including TOF errors	_____ (√ echo)
_____ UTC	SIT> limhi 1f4	limits high-priority events to 500/major frame	_____ (√ echo)

Wait 2-3 minutes for the new telemetry. In the meantime, continue with other Step 4 activities in parallel.

2e.4. Verify the following status information has been returned on SIT GSE and matches expected values:

Description	Expected Value	Actual Value	Comments
HV Step	00		
Toferror	0		
HV Status	0		
Eonly	0		
Junk	0		
Limhi	500		

Record SIT Normal Mode observations or anomalies here: _____

_____ UTC **4g. SIT External Test Pulser Mode** **(20 minutes)**

_____ UTC 4g.2. Switch Test Pulser's ON/OFF switch to ON, _____ (√ if OK)
 or if bench pulser used, turn DG535 power ON. _____ (√ if OK)

Wait 2-3 minutes for the new telemetry. In the meantime, continue with other Step 4 activities in parallel.

_____ UTC 4g.3. Verify the following singles rates on SIT GSE match expected values:

Description	Expected Value	Actual Value	Comments
SRT	720		
STP	6000		
VS	6000		
SSD	6000 - 6020		
VSE (Event)	~6000		
SRTE (Artificial Stop)	0-5		
STPE (Error)	0-5		

Record Typical Pulse Height Event (ApId 606-617):

tofch range: _____

ssdch range: _____

Record Non-zero Matrix Rates (ApId 605) : _____

Record Beacon Rates (ApId 619): all 0s _____

_____ UTC 4g4. After about 10 minutes of stable data observation, _____ (√ if OK)
 switch Test Pulser's ON/OFF switch to OFF, _____ (√ if OK)
 or if bench pulser used, turn DG535 power OFF.

_____ UTC 4g.5. Disconnect Test Pulser from SIT and store. _____ (√ if OK)

_____ UTC **4h. HET Test Pulser Mode** **(1 hour)**

_____ UTC 4h.1. Send the following commands to put HET in the Test Pulser Mode:

<u>HET FM1 on Ahead S/C</u>	or	<u>HET FM2 on Behind S/C</u>	
HET> gwrite 9 32	_____ (√ echo)	HET> gwrite 9 32	_____ (√ echo)
HET> tmode 3	_____ (√ echo)	HET> tmode 3	_____ (√ echo)
HET> hgorsel 1 0 12a8	_____ (√ echo)	HET> hgorsel 1 0 24a4	_____ (√ echo)
HET> lgorsel 1 0 12a8	_____ (√ echo)	HET> lgorsel 1 0 24a4	_____ (√ echo)

The next section has been designed to pulse all the channels (H1i, H1o, H2, H3, H4, H5, H6). After the set of commands is sent, the data values should be reviewed and recorded at each configuration as directed. Note that the expected pulse height value range may not be exact, but the values should lie very close to this range.

- _____ UTC 4h.2. Send the following HET commands to configure the channels as follows:
- enable the test pulser for all channels
 - set the feedback capacitor to 30pF for H1i, H1o, H2 and H6
 - set the feedback capacitor to 60pF for H3, H4 and H5
 - set the test input capacitor to 18pF for H1i, H1o, H2 and H6
 - set the test input capacitor to 36pF for H3, H4 and H5

<u>HET FM1 on Ahead S/C</u>		or	<u>HET FM2 on Behind S/C</u>	
HET> tpfbssel 0 1 166	_____ (√ echo)		HET> tpfbssel 0 1 166	_____ (√ echo)
HET> tpfbssel 0 b 166	_____ (√ echo)		HET> tpfbssel 0 a 166	_____ (√ echo)
HET> tpfbssel 1 3 166	_____ (√ echo)		HET> tpfbssel 1 2 166	_____ (√ echo)
HET> tpfbssel 1 5 1cc	_____ (√ echo)		HET> tpfbssel 1 5 1cc	_____ (√ echo)
HET> tpfbssel 1 7 1cc	_____ (√ echo)		HET> tpfbssel 1 7 1cc	_____ (√ echo)
HET> tpfbssel 1 9 1cc	_____ (√ echo)		HET> tpfbssel 1 a 1cc	_____ (√ echo)
HET> tpfbssel 1 c 166	_____ (√ echo)		HET> tpfbssel 1 d 166	_____ (√ echo)

- _____ UTC 4h.3. Send commands to disable the high-gain and enable the low-gain ADC for all channels:

<u>HET FM1 on Ahead S/C</u>		or	<u>HET FM2 on Behind S/C</u>	
HET> phacont 0 1 7	_____ (√ echo)		HET> phacont 0 1 7	_____ (√ echo)
HET> phacont 0 b 7	_____ (√ echo)		HET> phacont 0 a 7	_____ (√ echo)
HET> phacont 1 3 7	_____ (√ echo)		HET> phacont 1 2 7	_____ (√ echo)
HET> phacont 1 5 7	_____ (√ echo)		HET> phacont 1 5 7	_____ (√ echo)
HET> phacont 1 7 7	_____ (√ echo)		HET> phacont 1 7 7	_____ (√ echo)
HET> phacont 1 9 7	_____ (√ echo)		HET> phacont 1 a 7	_____ (√ echo)
HET> phacont 1 c 7	_____ (√ echo)		HET> phacont 1 d 7	_____ (√ echo)

- _____ UTC 4h.4. Send the following HET command to configure the following:

- set the test pulser frequency to 10 pulses per second
- set the Phasic 0 DAC setting to 5V
- set the Phasic 1 DAC setting to 5V on FM1 or 4.71V on FM2

<u>HET FM1 on Ahead S/C</u>		or	<u>HET FM2 on Behind S/C</u>	
HET> testp 4e2 1ff 1ff	_____ (√ echo)		HET> testp 4e2 1ff 1f0	_____ (√ echo)

Wait 2-3 minutes for the new telemetry. In the meantime, continue with other Step 4 activities in parallel. After 2-3 minutes record the range of raw data observed (a 6-digit hex number, the last three of which represent the actual pulse height) using raw data (pulse heights from packet ApId 597):

HET FM1 on Ahead S/C:

Channel	Expected Range	Actual Range	Mjr Fr #s
H1i	08c813 – 08c818		
H1o	05c80b – 05c80f		
H2	11c804 – 11c808		
H3	12c830 – 12c834		
H4	13c818 – 13c81d		
H5	14c824 – 14c828		

H6	96481c – 964821		
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HET FM2 on Behind S/C:

Channel	Expected Range	Actual Range	Mjr Fr #s
H1i	08c816 – 08c818		
H1o	054808 – 05480d		
H2	1147e8 – 1147ed		
H3	12c7ea – 12c7ef		
H4	13c7f0 – 13c7f5		
H5	1547ea – 1547ef		
H6	96c7dc – 96c7e1		

_____ UTC 4h.5. Send the following HET command to configure the following:

- set the test pulser frequency to 10 pulses per second
- set the Phasic 0 DAC and Phasic 1 DAC setting to 2.51V

HET> testp 4e2 180 180 _____ (√ echo)

Wait 2-3 minutes for the new telemetry. In the meantime, continue with other Step 4 activities in parallel. After 2-3 minutes record the range of raw data observed (a 6-digit hex number, the last three of which represent the actual pulse height) using raw data (pulse heights from packet ApId 597):

HET FM1 on Ahead S/C:

Channel	Expected Range	Actual Range	Mjr Fr #s
H1i	08c423 – 08c425		
H1o	05c41d – 05c420		
H2	11c41a – 11c41c		
H3	12c42e – 12c430		
H4	13c422 – 13c425		
H5	14c428 – 14c42a		
H6	964425 – 964427		

HET FM2 on Behind S/C:

Channel	Expected Range	Actual Range	Mjr Fr #s
H1i	08c423 – 08c426		
H1o	05441c – 05441e		
H2	11444b – 11444e		
H3	12c44c – 12c44e		
H4	13c44f – 13c451		
H5	15444c – 15444e		

H6	96c444 – 96c447		
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_____ UTC 4h.6. Send the following HET commands to configure the following:

- enable the high gain ADC for all channels
- enable the low gain ADC for all channels
- verbose mode off

HET FM1 on Ahead S/C

or

HET FM2 on Behind S/C

HET> phacont 0 1 d	_____ (√ echo)	HET> phacont 0 1 d	_____ (√ echo)
HET> phacont 0 b d	_____ (√ echo)	HET> phacont 0 a d	_____ (√ echo)
HET> phacont 1 3 d	_____ (√ echo)	HET> phacont 1 2 d	_____ (√ echo)
HET> phacont 1 5 d	_____ (√ echo)	HET> phacont 1 5 d	_____ (√ echo)
HET> phacont 1 7 d	_____ (√ echo)	HET> phacont 1 7 d	_____ (√ echo)
HET> phacont 1 9 d	_____ (√ echo)	HET> phacont 1 a d	_____ (√ echo)
HET> phacont 1 c d	_____ (√ echo)	HET> phacont 1 d d	_____ (√ echo)

_____ UTC 4h.7. Send the following HET command to configure the following:

- set the test pulser frequency to 10 pulses per second
- set the Phasic 0 DAC setting to .25V
- set the Phasic 1 DAC setting to .25V on FM1 or .235V on FM2

HET FM1 on Ahead S/C

or

HET FM2 on Behind S/C

HET> testp 4e2 ff ff	_____ (√ echo)	HET> testp 4e2 ff f0	_____ (√ echo)
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Wait 2-3 minutes for the new telemetry. In the meantime, continue with other Step 4 activities in parallel. After 2-3 minutes record the range of raw data observed (a 6-digit hex number, the last three of which represent the actual pulse height) using raw data (pulse heights from packet ApId 597):

HET FM1 on Ahead S/C:

Channel	Expected Range	Actual Range	Mjr Fr #s
H1i	0887e7 – 0887eb		
H1o	0587cb – 0587d0		
H2	1187eb – 1187f0		
H3	1287ec – 1287f0		
H4	1387e8 – 1387ed		
H5	1487de – 1487e2		
H6	9607f6 – 9607fb		

HET FM2 on Behind S/C:

Channel	Expected Range	Actual Range	Mjr Fr #s
H1i	0887cc – 0887d1		
H1o	0507d2 – 0507d6		
H2	1107c9 – 1107cd		

H3	1287ad – 1287b1		
H4	1387af – 1387b4		
H5	1507b4 – 1507b8		
H6	9687a3 – 9687a8		

_____ UTC 4h.8. Send the following HET command to configure the following:

- set the test pulser frequency to 10 pulses per second
- set the Phasic 0 DAC setting to 0.125V
- set the Phasic 1 DAC setting to 0.125V

HET> testp 4e2 80 80 _____ (√ echo)

Wait 2-3 minutes for the new telemetry, then verify pulse heights from packet ApId 597 as before.

HET FM1 on Ahead S/C:

Channel	Expected Range	Actual Range	Mjr Fr #s
H1i	08840b – 088410		
H1o	0583fd – 058401		
H2	11840c – 118410		
H3	12840c – 128410		
H4	13840a – 13840f		
H5	148405 – 148409		
H6	960411 – 960416		

HET FM2 on Behind S/C:

Channel	Expected Range	Actual Range	Mjr Fr #s
H1i	0883fd – 088402		
H1o	0503ff – 050404		
H2	110439 – 11043e		
H3	12842a – 12842f		
H4	13842b – 138430		
H5	15042e – 150432		
H6	968425 – 968429		

_____ UTC 4h.9. Send the following HET command to configure the following:

- set the test pulser frequency to 10 pulses per second
- set the Phasic 0 DAC setting to .002V
- set the Phasic 1 DAC setting to .002V

HET> testp 4e2 2 2 _____ (√ echo)

Wait 2-3 minutes for the new telemetry, then verify pulse heights from packet ApId 597 as before.

HET FM1 on Ahead S/C:

Channel	Expected Range	Actual Range	Mjr Fr #s
H1i	08803d - 088040		
H1o	05803b – 05803f		
H2	11803b – 11803e		
H3	12803a – 12803e		
H4	13803b – 13803e		
H5	14803a – 14803e		
H6	96003a – 96003e		

HET FM2 on Behind S/C:

Channel	Expected Range	Actual Range	Mjr Fr #s
H1i	08803c – 08803f		
H1o	05003b – 05003e		
H2	11003d – 110041		
H3	12803d – 128041		
H4	13803d – 138040		
H5	15003d – 150040		
H6	96803c – 96803f		

_____ UTC 4h.10. Send the following HET commands to reconfigure the sensor in normal state:
 or reboot HET to achieve the same effect – to reboot use command SEP> 14000 HET-BOOT _____ (√ echo)

<u>HET FM1 on Ahead S/C</u>	or	<u>HET FM2 on Behind S/C</u>
HET> testp 4e2 0 0 _____ (√ echo)		HET> testp 4e2 0 0 _____ (√ echo)
HET> gwrite 9 30 _____ (√ echo)		HET> gwrite 9 30 _____ (√ echo)
HET> tmode 0 _____ (√ echo)		HET> tmode 0 _____ (√ echo)
HET> hgorsel 1 0 8 _____ (√ echo)		HET> hgorsel 1 0 4 _____ (√ echo)
HET> lgorsel 1 0 8 _____ (√ echo)		HET> lgorsel 1 0 4 _____ (√ echo)
HET> tpfbssel 0 1 6 _____ (√ echo)		HET> tpfbssel 0 1 6 _____ (√ echo)
HET> tpfbssel 0 b 6 _____ (√ echo)		HET> tpfbssel 0 a 6 _____ (√ echo)
HET> tpfbssel 1 3 6 _____ (√ echo)		HET> tpfbssel 1 2 6 _____ (√ echo)
HET> tpfbssel 1 5 c _____ (√ echo)		HET> tpfbssel 1 5 c _____ (√ echo)
HET> tpfbssel 1 7 c _____ (√ echo)		HET> tpfbssel 1 7 c _____ (√ echo)
HET> tpfbssel 1 9 c _____ (√ echo)		HET> tpfbssel 1 a c _____ (√ echo)
HET> tpfbssel 1 c 6 _____ (√ echo)		HET> tpfbssel 1 d 6 _____ (√ echo)

_____ UTC 5. SEP Heater Mode (15 minutes)

_____ UTC 5a. SEPT Heater Mode (10 minutes)

5a.1. Record SEP main +28V supply current _____ A

5a.2. Verify SEP main +28V supply voltage _____ V (28V)

5a.3. The following command artificially raises SEPT-E operational heater control set point to +20 °C in order to enable heater verification at room temperature.

_____ UTC SEP> 191 SPE-TGOAL ! _____ (√ echo)

5a.4. Wait up to one minute for the commands to take effect, then watch for the cyclic changes in SEP main current amounting to 0.045A @ 28V (installed heater power 1.25W) on SEPT-E (for either FM1 or FM2).

_____ UTC 5a.5. Record the cyclic peak value of SEP main +28V supply current _____ A

5a.6. Verify installed heater power from the following formula:

(5a.5 – 5a.1) * 5a.2 = 1.25W _____ W

5a.7. The following command sets SEPT-E operational heater control set point to -20 °C:

_____ UTC SEP> 150 SPE-TGOAL ! _____ (√ echo)

5a.8. Wait up to one minute for the commands to take effect and for the SEP main current to return to normal.

_____ UTC Record SEP main +28V supply current _____ A

If voltage is same as in 5a.2, the current should go back to the same value as in 5a.1. _____ (√ if OK)

5a.9. The following command artificially raises SEPT-NS operational heater control set point to +20 °C in order to enable heater verification at room temperature.

_____ UTC SEP> 191 SPN-TGOAL ! _____ (√ echo)

5a.10. Wait up to one minute for the commands to take effect, then watch for the cyclic changes in SEP main current amounting to 0.082A @ 28V (installed heater power 2.3W) on SEPT-NS (for either FM1 or FM2).

_____ UTC 5a.11. Record the cyclic peak value of SEP main +28V supply current _____ A

5a.12. Verify installed heater power from the following formula:

(5a.11 – 5a.1) * 5a.2 = 2.3W _____ W

5a.13. The following command sets SEPT-NS operational heater control set point to -20 °C:

_____ UTC SEP> 150 SPN-TGOAL ! _____ (√ echo)

5a.14. Wait up to one minute for the commands to take effect and for the SEP main current to return to normal.

_____ UTC Record SEP main +28V supply current _____ A

If voltage is same as in 5a.2, the current should go back to the same value as in 5a.1. _____ (√ if OK)

_____ UTC 5a.15. If there are no anomalies above, SEPT Heater Mode procedure is complete.

Record its total running time and any observations or anomalies here: _____

_____ UTC **6. SEP Power Off** (5 minutes)

_____ UTC 6a. Verify SEP main +28V supply current _____ A
(It can vary depending on how many SEP sensors are attached to SEP Central: for LET alone 0.215A, for LET/HET FM1 0.228A, for LET/HET FM2 0.226A, for complete SEP 0.307A. If operating at cold, the operational heaters will turn on/off periodically and draw a predictable amount of extra current.)

Verify SEP main +28V supply voltage _____ V (28V)

6b. If SEP is not operating in vacuum skip this and go to Step 6d. _____ (√ if OK)

If SEP is operating in vacuum and SIT HVPS is turned on, the following command will bring the HVPS down gradually:

_____ UTC SIT> hvenable 0 _____ (√ echo)

_____ UTC 6c. Wait 30 seconds and record SEP main +28V supply current _____ A

_____ UTC 6d. Turn off SEP main +28V supply _____ (√ if OK)

_____ UTC 6e. Verify SEP main +28V supply current is zero _____ A (0A)

_____ UTC 6f. If there are no anomalies above, SEP Power Off procedure is complete.
Record its total running time and any observations or anomalies here: _____

_____ UTC **SEP Comprehensive Performance Test procedure is complete.**

END OF THE EXECUTABLE PORTION

Record the total running time and any observations or anomalies here: _____

