Record: Local date _____, Local time _____, (FM1, S/C A) _____, (FM2, S/C B) _____,

UTC date _____, UTC time _____, Initials _____, Temperature _____ ºC, 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: LET Comprehensive Performance Test

1.2 RESPONSIBLE SUBSYSTEM/INSTRUMENT LEAD: Branislav Kecman

1.3 AUTHOR: Branislav Kecman
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1.4 DATE CREATED:

	October 4, 2004	
Rev A	January 19, 2005	Checksum update and edit
Rev B	April 4, 2005	Checksum update and edit

2.0 DESCRIPTION

2.1 PROCEDURE DESCRIPTION:
The procedure verifies comprehensive performance of the Low Energy Telescope (LET) sensor as part of Solar Energetic Particles (SEP) instrument suite before and after the following activities: SEP bench and environmental tests, SEP integration with the IMPACT suite, IMPACT suite integration with the STEREO spacecraft, S/C environmental tests, pre-launch operations and in flight.
It exercises many aspects of LET operational modes and provides reliable means for their tracking over relatively long time period implied above.

2.2 PROCEDURE OUTLINE AND DOCUMENT REFERENCE NUMBER:

2.2.1	SEP Power On	STEREO-CIT-031.A
2.2.2	SEP_Central Aliveness Test	STEREO-CIT-034.A
2.2.3	Normal Mode (LET Aliveness Test)	STEREO-CIT-024.A
2.2.4	ADC Only Mode	*
2.2.5	Quiet Mode	*
2.2.6	Threshold Mode	*
2.2.7	LET Heater Mode	*
2.2.8	SEP Power Off	STEREO-CIT-032.A

2.3 TEST DURATION: 1 hour (maximum expected time).

3.0 INSTRUCTIONS FOR USE

- Obtain a double-sided hard copy of this procedure for record keeping during the test.
- Refer to SEP GSE User's Manual on how to log in and set up GSE computers and run GSE software.
- In this procedure all displays for data verification are based on a Linux PC, either desktop or laptop, which is commonly referred to as SEP GSE.
- To command LET go to SEP Command Center window on SEP GSE. Select ASCII Command option and enable LET-CMD button. Type LET command in CAPITAL letters. Verify spelling before hitting the RETURN key.
- Verify checksums and command responses in SEP Command Echo Monitor window on SEP GSE.
- Monitor LET operation on GSE displays as instructed by the procedure.

3.1 TEST SETUP REQUIREMENTS:

LET shall be installed on its bracket atop SEP Central Electronics box and set up on one of the following: environmental test fixture, clean flow-bench or STEREO spacecraft. LET 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 LN_2 purge shall be continuously supplied to LET except during T/V test. Monitor flow daily.
LET sensor shall be double-bagged in llumalloy bagging material before being taken out of cleanroom.

3.2 PARAMETERS REQUIRED:

In order to test LET operational heater at any given temperature the heater control parameter (Set Point) needs to be adjusted so that ambient temperature appears cold enough for the controller to start the heating. This parameter is featured in Section 2.2.7.

3.3 CRITICAL ACTIVITIES:

DO NOT send commands until LET 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.
In case of a vacuum loss LET power shall be immediately shut off via automatic relay.

3.4 SPECIAL CONSTRAINTS OR ACTIVITIES:

LET apertures shall be protected by their 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 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.

3.5 RECORDING REQUIREMENTS:

Prior to the execution of this procedure SEP GSE software shall be running, data logging enabled and pertinent LET data windows and displays open on 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 "LET Functional Tests".
LET data shall be stored on SEP GSE and backed up immediately on another Linux PC.

4.0 SAFETY

4.1 HAZARDS OR WARNINGS:
Hazard: Some sections of this procedure involve use of approved radiation sources that shall be handled by authorized LET 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 LET can reach up to +250VDC.

5.0 DATA ANALYSIS

5.1 TEST MEASUREMENTS:
LET measurements are made internally and displayed on SEP GSE for data analysis by LET team. SEP GSE and off-line computers shall be used to verify LET performance characteristics.

5.2 APPROVAL PROCESS:
Discrepancies between expected and measured results shall be highlighted on the hard copy and brought to the attention of the responsible person(s) listed in Section 1.2 for eventual approval or disposition by the LET team.

6.0 REFERENCE MATERIAL

6.1 REFERENCE DOCUMENTS:
- 6.1.1 SEP GSE User's Guide
- 6.1.2 Test procedures listed in Section 2.2 (If document no. or * is shown that means its executive portion is folded in the main procedure below)
- 6.1.3 SEP GSE display snapshots used for LET functional test comparison purposes

6.2 REFERENCE DRAWINGS: None.

##########
Some examples of typical record keeping required in this procedure:

_____ UTC Record UTC time on this line if available in the procedure step.
UTC time can be found on SEP GSE computer in the lower right corner.
Make sure to compare and synchronize personal watches with UTC time.

Verify that command echo was received on SEP GSE. ____ (√ echo)

Type command as shown below (but without SEP> prompt) and record instrument response on the line provided. Compare the response with the expected value given in parentheses:

SEP> HERE . (Note there is a space between E and the dot) _____ (20024)

##########

BEGINNIG OF EXECUTIVE PORTION

_____ UTC 2.2.1 SEP Power On STEREO-CIT-031.A

If SEP power is on and LET has already booted, skip this procedure and go directly to 2.2.3. ____ (√ if so)

_____ UTC 1a. Be sure that either lab P/S or IMPACT GSE or S/C power is properly connected to SEP. Click on the preferred dice icon (FM1, S/C Ahead) ____ or (FM2, S/C Behind) ____ on SEP GSE to start the corresponding software and establish proper data recording channel on GSE.
Enable data logging ____ (√ if OK), open all SEP GSE displays/windows of interest ____ (√ if OK) and get ready to synchronize switching of SEP power and enabling of IDPU I/F clock within 5 seconds after power is turned on in order to capture SEP Central boot checksums. ____ (√ if OK and ready to continue)

_____ UTC 1b. Verify SEP Central checksums after booting (10-15 seconds following the power on).
On SEP Central FM1 unit verify these:

B0B	____	1018	____	93831D	____	(√ if OK)
1582	____	1918	____	51400A	____	
191D	____	1A37	____	9019	____	
2412	____	4E38	____	F6EF2	____	

RAM	F4C232	____
PROM0	F52F4B	____
PROM1	F52F4B	____
BOTH	EA5E96	____

On SEP Central FM2 unit verify these:

B0B	____	1018	____	93831D	____	(√ if OK)
1582	____	1918	____	51400A	____	
191D	____	1A37	____	9019	____	
2412	____	4E38	____	F6EF2	____	

RAM	F4C232	____
PROM0	425E6F	____
PROM1	1923DA	____
BOTH	5B8249	____

_____ UTC 1c. 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 1f is executed.)

_____ UTC 1d. Verify SEP main +28V supply voltage _____ V (28V)

1e. 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) _____ (20024)

1f. The following command turns on bias voltages, enables SEPT PDFE circuits and SEPT operational heater control, and boots SIT, HET and LET sensors in that order. Command responses consist of boot messages and checksums. It takes about 60 seconds to execute if all four sensors are attached:

_____ UTC SEP> ALLON1 (for FM1, S/C A) ____ or SEP> ALLON2 (for FM2, S/C B) ____ (√ 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 1g. After LET has booted 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.)

_____ UTC 1h. Verify LET checksums. On LET FM1 unit verify these:

AF3	____	1000	____	9197FF	____	(√ if OK)
10FC	____	12DC	____	990383	____	
12E6	____	23FC	____	E2FAC3	____	
4876	____	937F	____	F5487F	____	
937F	____	B428	____	1ABF06	____	
1D9DCA	____					

On LET FM2 unit verify these:

AF3	____	1000	____	9197FF	____	(√ if OK)
10FC	____	12DC	____	990383	____	
12E6	____	23FC	____	E2E5CD	____	
4876	____	937F	____	F5487F	____	
937F	____	B428	____	1ABF06	____	
1D88D4	____					

1i. The following command sets various firmware flags in their proper state:

_____ UTC SEP> INITRCHK ____ (√ echo)

_____ UTC 1j. If there are no anomalies above, SEP Power On procedure is complete.
Record its total running time and any observations or anomalies here: _____
_____
_____
_____

_____ UTC 2.2.2 SEP_Central Aliveness Test STEREO-CIT-034.A

2a. Open all SEP displays on SEP GSE. ____ (√ if OK and ready to continue)

_____ UTC 2b. 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.)

_____ UTC 2c. Verify SEP main +28V supply voltage _____ V (28V)

2d. The following command returns elapsed time in hours/minutes/seconds/sub-seconds since the last booting.
_____ UTC SEP> TIME. (Note there is no space between E and the dot) _____ (record)

2e. 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: _____

2f. Verify that two bias voltage monitors are showing approx. –120V and +330V. ____ (√ if OK)

2g. Snap SEP GSE HK page display and file it at the back of this procedure. ____ (√ if OK)

2h. Compare HK page display with a reference sample. Confirm there are no discrepancies. ____ (√ if OK)

2i. Observe and verify that all sensors' CCSDS packets are flowing regularly on a minute by minute basis:

SIT	12 science packets/minute	____ (√ if OK)
HET	6 science packets/minute	____ (√ if OK)
LET	16 science packets/minute	____ (√ if OK)
SEPT-E	1 science packet/minute	____ (√ if OK)
SEPT-NS	1 science packet/minute	____ (√ if OK)
Beacon data	1 science packet/minute	____ (√ if OK)

2j. Verify that SEP Unknown CCSDS Packet window is empty. ____ (√ if OK)
If not, record how many packets there are and their APID: _____

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

_____ UTC 2.2.3 Normal Mode (LET Aliveness Test) STEREO-CIT-024.A

3a. Open all LET displays on SEP GSE. Use Single Sample for rate displays and arrange them on the same workspace screen. In SEP Command Center window select LET_CMD button to prepare for sending commands to LET. ____ (√ if OK and ready to continue)

_____ UTC 3b. Record SEP main +28V supply current _____ A

3c. If SEP power was just turned on, this step is unnecessary because LET starts up in Normal Mode. Skip this step and go to 3d. ____ (√ if so)
If LET was previously in some other mode, the following command will put it in Normal Mode by enabling slow ADC and Livetime stimulus pulsing:
_____ UTC LET> NORMAL ____ (√ echo)

3d. The following command returns address at the end of FORTH dictionary in LET memory.
_____ UTC LET> HERE . (Note there is a space between E and the dot) _____ (46120)

3e. The following command returns elapsed time in hours/minutes/seconds/sub-seconds since the last booting:
_____ UTC LET> TIME. (Note there's no space between E and the dot) _____ (record)

3f. 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)
Record LET HK anomalies here: _____

3g. Verify that four LET temperature monitors are showing similar values within 1ºC. ____ (√ if OK)

3h. If 2e skipped, snap SEP GSE HK page display and file it at the back of this procedure. ____ (√ if OK)

3i. Compare HK page display with a reference sample. Confirm there are no discrepancies. ____ (√ if OK)

3j. Verify that 16 LET CCSDS packets/minute with APID 580 are flowing regularly (check either LET CCSDS Packet or LET Payload Telemetry Packet window). ____ (√ if OK)

3k. Verify that Unprocessed LET Science Packet window is empty. ____ (√ if OK)
If not, record how many packets there are and their APID: _____

3l. Snap LET page displays on SEP GSE and file them at the back of this procedure. ____ (√ if OK)

3m. Compare LET 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)

_____ UTC 3n. If there are no anomalies above, LET Aliveness Test procedure is complete.
Record its total running time and any observations or anomalies here: _____

_____ UTC 2.2.4 ADC Only Mode (minimum running time ~10 minutes)

4a. 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)

_____ UTC 4b. Wait at least 2 minutes for new telemetry, then open 2-D plots of L1 vs. L2 and L1 vs. L3 for both A and B sides of the telescope. Use log-log scale and "dither". ____ (√ if OK)

4c. Monitor single detector rates and event totals by priority. Snap LET page displays, label and file them at the back of this procedure. Compare 2-D plots, event and rate page displays with reference samples. ____ (√)

4d. Fit and analyze data off-line. Person(s) responsible for the analysis _____.
Analysis results will be available: date _____, location _____.

_____ UTC 4e. If there are no anomalies above, ADC Only Mode procedure is complete.
Record its total running time and any observations or anomalies here: _____

_____ UTC 2.2.5 Quiet Mode (minimum running time ~5 minutes)

5a. The following command puts LET in Quiet Mode by disabling ADC and Livetime stimulus pulse in order to check for noisy detectors:
_____ UTC LET> QUIET ____ (√ echo)

_____ UTC 5b. Wait at least 2 minutes for new telemetry, then snap LET page displays, label and file them at the back of this procedure. Compare rate page displays with reference samples. Confirm there are no discrepancies and no noisy detectors. ____ (√ if OK)

_____ UTC 5c. If there are no anomalies above, Quiet Mode procedure is complete.
Record its total running time and any observations or anomalies here: _____

_____ UTC 2.2.6 Threshold Mode (minimum running time ~10 minutes)

6a. The following command puts LET in Threshold Mode by disabling Livetime stimulus pulse and running ADC pulser using a table of low DAC levels designed to bracket the ADC thresholds:
_____ UTC LET> THRMODE ____ (√ echo)

_____ UTC 6b. Wait at least 2 minutes for new telemetry, then use the same 2-D plots of L1 vs. L2 and L1 vs. L3 for both A and B sides of the telescope like in 5b. ____ (√ if OK)

6c. Monitor single detector rates in both 1-min Single Sample and Running Total accumulation display. Snap LET page displays, label and file them at the back of this procedure. Compare 2-D plots, event and rate page displays with reference samples. ____ (√ if OK)

6d. Fit and analyze data off-line. Person(s) responsible for the analysis _____.

Analysis results will be available: date _____, location _____.

6e. The following command puts LET back in Normal Mode:
_____ UTC LET> NORMAL ____ (√ echo)

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

_____ UTC 2.2.7 LET Heater Mode (minimum running time ~5 minutes)

_____ UTC 7a. Record SEP main +28V supply current _____ A

_____ UTC 7b. Verify SEP main +28V supply voltage _____ V (28V)

7c. The following command artificially raises LET operational heater control set point in order to enable the heater verification at room temperature.
_____ UTC LET> 50 TEMPGOAL ! ____ (√ echo)

7d. Wait one minute for the command to take effect, then watch for periodic increase in SEP main current that amounts to 0.030A (30mA) @ 28V on LET FM1, or 0.022A (22mA) @ 28V on LET FM2. Note that this predicted current increment is different if SEP main supply voltage is other than 28V.

_____ UTC 7e. Record the periodic peak value of SEP main +28V supply current _____ A

7f. Subtract 7a from 7e and record the result _____ A

The increment should agree with the amount predicted in 7d ____ (√ if OK)

7g. The following command restores LET operational heater control set point to flight value (–10 ºC):
_____ UTC LET> 157 TEMPGOAL ! ____ (√ echo)

7h. Wait one minute for the command to take effect.

_____ UTC 7i. Record SEP main +28V supply current _____ A

If voltage is same as in 7b, the current should go back to the same value as in 7a ____ (√ if OK)

_____ UTC 7j. If there are no anomalies above, LET Heater Mode procedure is complete.
Record its total running time and any observations or anomalies here: _____

_____ UTC 2.2.8 SEP Power Off STEREO-CIT-032.A

_____ UTC 8a. 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.)

_____ UTC 8b. Verify SEP main +28V supply voltage _____ V (28V)

8c. If SEP is not operating in vacuum skip this step and go to 8e. ____ (√ 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> hvpsoff ____ (√ echo)

_____ UTC 8d. Wait 30 seconds and record SEP main +28V supply current _____ A

_____ UTC 8e. Turn off SEP main +28V supply ____ (√ if OK)

_____ UTC 8f. Verify SEP main +28V supply current is zero _____ A (0A)

_____ UTC 8g. If there are no anomalies above, SEP Power Off procedure is complete.
Record its total running time and any observations or anomalies here: _____

_____ UTC LET Comprehensive Performance Test procedure is complete.

END OF EXECUTIVE PORTION

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