National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058

December 2003

Electrical, Electronics, and Electromechanical Parts Screening, Burn-In, and Thermal Cycling Test Plan for the Human Research Facility (HRF) Surface, Water, and Air Biocharacterization (SWAB) Experiment Unique Equipment

LS-20444-2

PROJECT DOCUMENT APPROVAL SHEET

DOCUMENT NUMBER	DATE	NO. OF PAGES
LS-20444-2		

TITLE:

Electrical, Electronics, and Electromechanical
Parts Screening, Burn-In, and Thermal Cycling Test Plan
for the
Human Research Facility (HRF)
Surface, Water, and Air Biocharacterization (SWAB)
Experiment Unique Equipment

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DATE	PREPARED BY	CHANGE APPROVALS	CHANGE NUMBER

Report Number	LS-20444-2	**Date**

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Parts Screening, Burn-In, and Thermal Cycling Test Plan
for the
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Experiment Unique Equipment

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REVISION/CHANGE APPROVALS

Date	**Change Number**	**Prepared by**	**Approved by:**		
			Unit Manager	**SR&QA Manager**	**Projects Manager**

DOCUMENT NUMBER LS-20444-	**DOCUMENT CHANGE/ REVISION LOG**	PAGE 1 OF 1

CHANGE/ REVISION	DATE	DESCRIPTION OF CHANGE	PAGES AFFECTED
BASIC		Baseline Issue	All

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ACRONYMS AND ABBREVIATIONS

ºC	Degrees Celsius
ºF	Degrees Fahrenheit
ΔT	Delta Temperature
A	ampere
ASD	Air Sampling Device
BDC	Baseline Data Collection
CAL	Calibration
CCB	Configuration Control Board
CCV	Closed Circuit Voltage
COTS	Commercial Off-the-Shelf
DC	Direct Current
DGGE	Denaturing Gradient Gel Electrophoresis
DMM	Digital Multimeter
EEE	Electrical, Electronic, and Electromechanical
ESEM	Environmental Scanning Electron Microscope
EUE	Experiment Unique Equipment
EUT	Equipment Under Test
GSE	Ground Support Equipment
HRF	Human Research Facility
ISS	International Space Station
JSC	Johnson Space Center
L	Liter
L/min	Liters per minute
L/N	Lot Number
LAL	Limulus Amebocyte Lysate
LCD	Liquid Crystal Display
Li-BCX	Lithium/Bromine-Complexed Thionyl Chloride
MIL-ER	Military Established Reliability
min	Minute
MIP	Mandatory Inspection Point
NASA	National Aeronautics and Space Administration
NiMH	Nickel Metal Hydride

ACRONYMS AND ABBREVIATIONS (Cont'd)

OCV	Open Circuit Voltage
P/N	Part Number
PCR	Polymerase Chain Reaction
PDA	Pre-Delivery Acceptance
QAS	Quality Assurance Specialist
QPCR	Quantitative PCR
S/N	Serial Number
S&MA	Safety and Mission Assurance
sec	Second
SRV-K	Russian Pasteurization System
SVO-ZV	Water Supply System, Potable (Russian translation)
SVO-ZV	sistema vodoobespecheniya na ziapasakh vody
SWAB	Surface, Water, and Air Biocharacterization
TC	thermocouple
TPS	Task Performance Sheet
TRR	Test Readiness Review
USA	United Space Alliance
V	Volts
Vdc	Volts Direct Current
VOC	Volatile Organic Compound

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this Electrical, Electronic, and Electromechanical (EEE) Parts Screening, Burn-In and Thermal Cycling Test Plan is to describe the plan, process and implementation of those requirements and testing for the Surface, Water, and Air Biocharacterization (SWAB) Air Sampling Device (ASD) Part Number (P/N): SEG46119448-303 and SWAB ASD Battery Pack Assemblies P/N SEG46119450-301 and SEG46119449-301.

The information within this document is a culmination of information gathered from the manufacturer of the Commercial Off-the-Shelf (COTS) ASD, battery cell manufacturers, EEE Parts (EV), National Aeronautics and Space Administration (NASA) Energy Systems Division, Power System Branch (EP5) and NASA Safety and Mission Assurance (S&MA) in conjunction with the developing engineers for this experiment hardware. The test plan described here identifies a thermal cycling test that replaces previous separate burn-in and thermal cycle testing with a modern rigorous thermal cycling test that now replaces the 96-hour burn-in, 72-hour burn-in and thermal cycling into one complete test.

The applicability of this test plan was to assist the payload developers in satisfying thermal cycling and EEE parts screening requirements as described in "System Requirements Document for Human Research Facility (HRF) Surface, Water, and Air Biocharacterization (SWAB) Experiment System," LS-20444-1.

1.2 SCOPE

This EEE Parts Screening, Burn-In and Thermal Cycling Test Plan is applicable to the SWAB ASD and SWAB ASD Battery Packs. All other HRF hardware is excluded from this document because of the unique nature for each of these devices. The SWAB ASD and ASD Battery Packs have unique operating and environmental constraints that are specific to them and therefore may not be applicable to other devices.

These processes are necessary to perform acceptance level testing on end items that meet both the data collection requirements defined in Experiment Document 99E049 A Comprehensive Characterization of Microorganisms and Allergens in Spacecraft Environment," LS- 20444, and hardware functional requirements defined in "System Requirements Document Human Research Facility (HRF) Surface, Water, and Air Biocharacterization (SWAB) Experiment System," LS-20444-1.

The SWAB ASD Filter Unit Assemblies are not required to complete any of the EEE Parts Screening, Burn-In or Thermal Cycle testing nor is any of the SWAB water and surface sampling equipment.

2.0 APPLICABLE DOCUMENTS

The following applicable documents of the exact issue shown herein form a part of this specification to the extent specified herein. If a revision level or date is not cited, the latest version of the document should be used.

All specifications, standards, exhibits, drawings or other documents referenced in this specification are hereby incorporated as cited in the text of this document.

Any updated revisions to documents specified herein shall be reviewed to determine the impact to the design. Changes to the design or this document shall only be made upon the direction of the HRF Configuration Control Board (CCB).

2.1 DOCUMENTS

Document Number	Revision	Document Title
LS-20444	5/03	Experiment Document 99E049 A Comprehensive Characterization of Microorganisms and Allergens in Spacecraft Environment
LS-20444-1	9/03	System Requirements Document Human Research Facility (HRF) Surface, Water, and Air Biocharacterization (SWAB) Experiment System
MIL-PRF-19500		Performance Specification Semiconductor Devices, General Specification for
SSP 30423		Space Station Approved Electrical, Electronic and Electromechanical (EEE) Parts List
SSP 30512	C	Space Station Ionizing Radiation Design Environment
SSQ 25002		Supplemental List of Qualified Electrical, Electronic, Electromechanical (EEE) Parts, Manufacturers, and Laboratories (QEPM&L)

3.0 EXPERIMENT OVERVIEW

All previous microbial analysis of spacecraft utilized culture-based methodology, omitting greater than 90% of all microorganisms including pathogens such as Legionella and Cryptosporidium. Culture bacteria and fungi have been the only allergens studied; the more potent allergens, such as dust mites, have never been analyzed in spacecraft environments. Neither has any attempt to monitor microbial toxins been made. This experiment will utilize modern molecular biology, advanced microscopy and immunochemical techniques to study air, surface and water samples from spacecraft. These samples will be analyzed for bacteria and fungi (total composition and specific pathogens), pathogenic protozoa, specific allergens and microbial toxins. After the development of collection and processing technologies for flight, this study will provide a comprehensive analysis of the International Space Station (ISS) by:

- Monitoring the ISS modules prior to launch to develop a baseline of contamination.
- Monitoring launch vehicles to evaluate sources of new contamination.
- Direct sampling of the ISS.

During protocol and hardware development, surface, water, and air samples from the Johnson Space Center (JSC) and samples of known cultures will be evaluated. The results of these ground-based studies will be compared to culture-based results to use as a reference.

Surface samples will be collected using a damp swab and then contained in a swab tube designed with a sponge system to release a fixative agent when the swab compresses the sponge.

Potable water samples will be collected directly into one liter Teflon® bags currently approved for in-flight use. ISS water sampling sites will include the Russian pasteurization system (SRV-K), which regenerates water for potable use as well as the SVO-ZV dispensing ports. If available, free-floating condensate that accumulates during extended missions will be collected using a surface sampling swab.

Collection of air samples well collected via a COTS ASD manufactured by Sartorius AG Corporation. The ASD will draw air through a gelatin membrane filter, which will capture any airborne microbes. The membrane filters and adapters will be returned to the kit for stowage and returned to the ground for analysis.

Once the samples are returned to Earth, they will be analyzed by a combination of Polymerase Chain Reaction (PCR), Quantitative PCR (QPCR), Denaturing Gradient Gel Electrophoresis (DGGE) and 16S ribosomal analysis to enumerate and identify all bacterial species in every sample. In addition, the samples will be analyzed for endotoxin levels using the Limulus Amebocyte Lysate (LAL) endotoxin assay, and direct imaging for allergens will be performed using the Environmental Scanning Electron Microscope (ESEM) and Immunogold labeling. Initial analyses of all bacterial protocols will be compared to results using the standard culture-based methodologies of the JSC Microbiology Laboratory.

Finally, data analyses will be performed that compare inflight microbial contamination to Volatile Organic Compounds (VOCs) detected during flight. The JSC Toxicology Laboratory currently monitors VOCs, but no previous association with microbial flora has been investigated.

4.0 THERMAL CYCLING TEST PLAN

4.1 ITEM DEFINITION

The SWAB ASD is a COTS device manufactured by the Sartorius AG Corporation headquartered in Goettingen, Germany and will be modified here at NASA/JSC.

The device is designed for use in the pharmaceutical and food and beverage industries, and for biotechnology applications. Other areas of application include hospitals, environmental protection and the occupational safety sectors.

The portable air sampler is used in conjunction with disposable gelatin filter units for detection of airborne microorganisms and viruses in clean rooms. The portable system, which can be operated without line current, guarantees reliable, reproducible and quantitative results. Portable and battery-operated, the AirPort MD8 is particularly suited for all applications that require mobility and versatility.

The SWAB ASD Battery Pack(s) include two different types of Battery Packs that will be used to power the SWAB ASD. A primary cell pack configured with Lithium/Bromine-Complexed Thionyl Chloride (Li-BCX) C-size cells will be utilized for in-flight sampling sessions. The reusable Nickel Metal Hydride (NiMH) cell pack will be utilized for ground testing scenarios as well as baseline data collections (BDCs).

The Li-BCX Battery pack is configured using five 3.4 volt (V) Li-BCX C-size cells that are purchased from United Space Alliance (USA). These cells are certified for flight. In addition to the battery cells, a pair of shunt diodes per cell is incorporated into the design as well as two Raychem polyfuses for battery safety and short circuit protection.

The NiMH Battery Pack is configured using fourteen (14) 1.2 V NiMH cells that are assembled and delivered by the ASD manufacturer. The cells are also wired in series with a polyfuse.

4.2 APPLICABLE REQUIREMENTS

All applicable requirements for the SWAB ASD and ASD Battery Packs are from the "System Requirements Document Human Research Facility (HRF) Surface, Water, and Air Biocharacterization (SWAB) Experiment System," LS-20444-1. The purpose of this document is to describe the plan, process and implementation of those requirements. Prior to development of the hardware for the experiment, a System Requirements Review was conducted to baseline the applicable requirements set for the experiment hardware. Listed below are the requirements, which this test plan identifies and describes how the verification of those requirements is completed and the method used for completion.

TABLE 4.2-1. APPLICABLE REQUIREMENTS FROM SWAB EXPERIMENT SYSTEM REQUIREMENTS DOCUMENT LS-20444-1

Requirement Number	Description
3.4.1.A	The SWAB ASD Equipment shall operate nominally during exposure to 17 °C – 31 °C (63 °F – 87 °F).
3.4.1.B	SWAB ASD shall operate nominally following exposure to -20 °C – 50 °C (-4 °F – 122 °F).
EXCEPTION: The SWAB ASD Equipment is a COTS device that can be only operated for short durations due to battery life and functional characteristics of the device. Thermal cycle testing will be documented in a Thermal Cycle Test Plan for both qualification and acceptance level testing.	
3.4.4.A	Parts control shall be in accordance with "Electrical, Electronic and Electromechanical (EEE) and Mechanical Parts Management and Implementation Plan for Space Station Program," SSP 30312.
3.4.4.B	Parts selection for equipment shall be in accordance with: 1. "Space Station Approved Electrical, Electronic and Electromechanical (EEE) Parts List," SSP-30423. 2. "Supplemental List of Qualified Electrical, Electronic, Electromechanical (EEE) Parts, Manufacturers, and Laboratories (QEPM&L)," SSQ-25002. 3. Semiconductors shall be JANTXV in accordance with "Performance Specification Semiconductor Devices, General Specification for," MIL-PRF-19500. Diodes shall have a metallurgical bond. Passive parts shall be at least the second highest level of appropriate Military Established Reliability (MIL-ER). 4. "Space Station Ionizing Radiation Design Environment," SSP-30512C. Where no alternative is available, nonmilitary parts, components, and subassemblies may be used, but burn-in screening of these items shall be performed per Requirement 3.4.4C.
3.4.4.C	Burn-in screening shall be completed (100%) on all flight hardware (units).

4.3 TESTING FACILITIES

The testing facilities required for implementing this test plan include any NASA/JSC facility as well as an external facility that can support testing of the SWAB ASD and ASD Battery Packs and meet the testing requirements and levels identified in Section 4.5.

The testing facility shall produce and provide a facility Task Performance Sheet (TPS) or similar documentation in order to complete the test, identifying the testing levels per this document. In addition, a facility Test Readiness Review (TRR) will be required prior to each test unless a blanket TRR or similar is conducted prior to this testing.

4.4 EQUIPMENT UNDER TEST CONFIGURATION

This section of this test plan describes the configuration of the Equipment Under Test (EUT) during the actual testing as well as other functional testing following the completion of the thermal cycle testing.

4.4.1 ASD Configuration During Testing

Because each hardware item can be used standalone, the testing shall be completed separately for each item. The SWAB ASD shall be powered by a direct current (DC) power supply during the thermal cycling testing through the use of a Ground Support or Ground Support Equipment (GSE) power cable. The DC power supply does not have to be calibrated but before testing begins the voltage shall be set and verified with a calibrated digital multimeter (DMM).

There are two reasons for conducting ASD thermal cycle testing using a power supply as opposed to the ASD Battery Packs.

1. The SWAB ASD Battery Packs have different maximum storage/operating temperature ranges than the ASD itself.
2. Powering the ASD from the Battery Packs will unnecessarily drain power from the Battery Packs that will be required for flight. Especially for the Li-BCX Battery Pack (SEG46119450-301), which is a primary cell pack and cannot be recharged.

For thermal cycle testing, the ASD Jacket Assembly shall be removed from the ASD because it is not required for this test. In addition, the rear battery access panel may be removed in order to allow the GSE Power Cable to be plugged into the mating ASD power plug. Also for each functional test (full or abbreviated) an SWAB ASD Filter Unit (SEG46119451-301) must be placed on the SWAB ASD before the testing can begin.

Once the SWAB ASD has been placed inside the testing chamber, thermocouple(s) (TCs) shall be placed on the device housing per the testing engineers discretion.

4.4.2 ASD Battery Packs Configuration During Testing

As mentioned in previous sections of this test plan, there are two configurations of the SWAB ASD Battery Packs that will be used to power the ASD for experiment operations. The NiMH Battery Pack will be used for ground-based BDC sampling sessions where as the Li-BCX Battery Pack will be used for on-board ISS sampling during experiment operations. The purpose for two different Battery Packs is to assist in operational streamlining and cost reduction.

For both Battery Packs, the configuration of the hardware during the test will allow for standalone testing. Each Battery Pack shall be placed inside the thermal chamber unloaded. Multiple Battery Packs of the same cell type can be tested simultaneously to reduce testing time and cost. However, there shall be no mixing of cell types during testing, and each Battery Pack must have a TC attached to surface of the pack to monitor temperature.

4.5 TEST DESCRIPTION AND TEST PARAMETERS

4.5.1 SWAB ASD Test Description

The SWAB ASD test is based on a 5-1/2 thermal cycle test. The temperature ranges for the test were developed through discussions between the payload developer, EEE parts engineers and the ASD manufacturer. A graphical representation of the written description below is shown in Figure 4.5-1.

The highest temperature range for **exposure** is determined by analysis of all the components on the ASD and determining which component has the lowest high thermal limit for storage. This temperature is identified in Figure 4.5-1 as Test Point "A."

The lowest temperature range for **exposure** is determined by analysis of all the components on the ASD and determining which component has the highest low thermal limit for operation and for storage. This temperature is identified in Figure 4.5-1 as Test Point "B."

The **operational** temperature limits are determined from analysis of the **operational** temperature limits of the components in the ASD. The highest **operational** temperature limit is identified on Figure 4.5-1 as Test Point "C." The lowest operational temperature limit is identified on Figure 4.5-1 as Test Point "D."

Successful completion of this entire test shall be determined when all functional testing has been completed and all have passed Mandatory Inspection Point (MIP) steps.

The testing engineer shall be able to terminate and continue this thermal cycle test at another point in time in the event of time constraints or possible thermal chamber failure. Prior thermal cycles shall still be used in the final 5-1/2-cycle count.

NOTE: When coming out of each hot/cold soak at the temperature at which the unit is to be turned on, the device may need to be held at that temperature until the unit has also reached the set thermal chamber temperature point.

4.5.1.1 Thermal Cycle Test Point "E"

The test begins at the ambient air temperature of the thermal chamber at Test Point "E" and completes the thermal cycle testing at Test Point "E." At the very beginning of the test at Test Point "E," a full functional test, as described in Section 5.1.1, shall be completed for the SWAB ASD.

4.5.1.2 Thermal Cycle Test Point "E" to Test Point "C"

Following successful completion of the functional test, the SWAB ASD shall be turned on and running while the thermal chamber begins a steady temperature increase at no

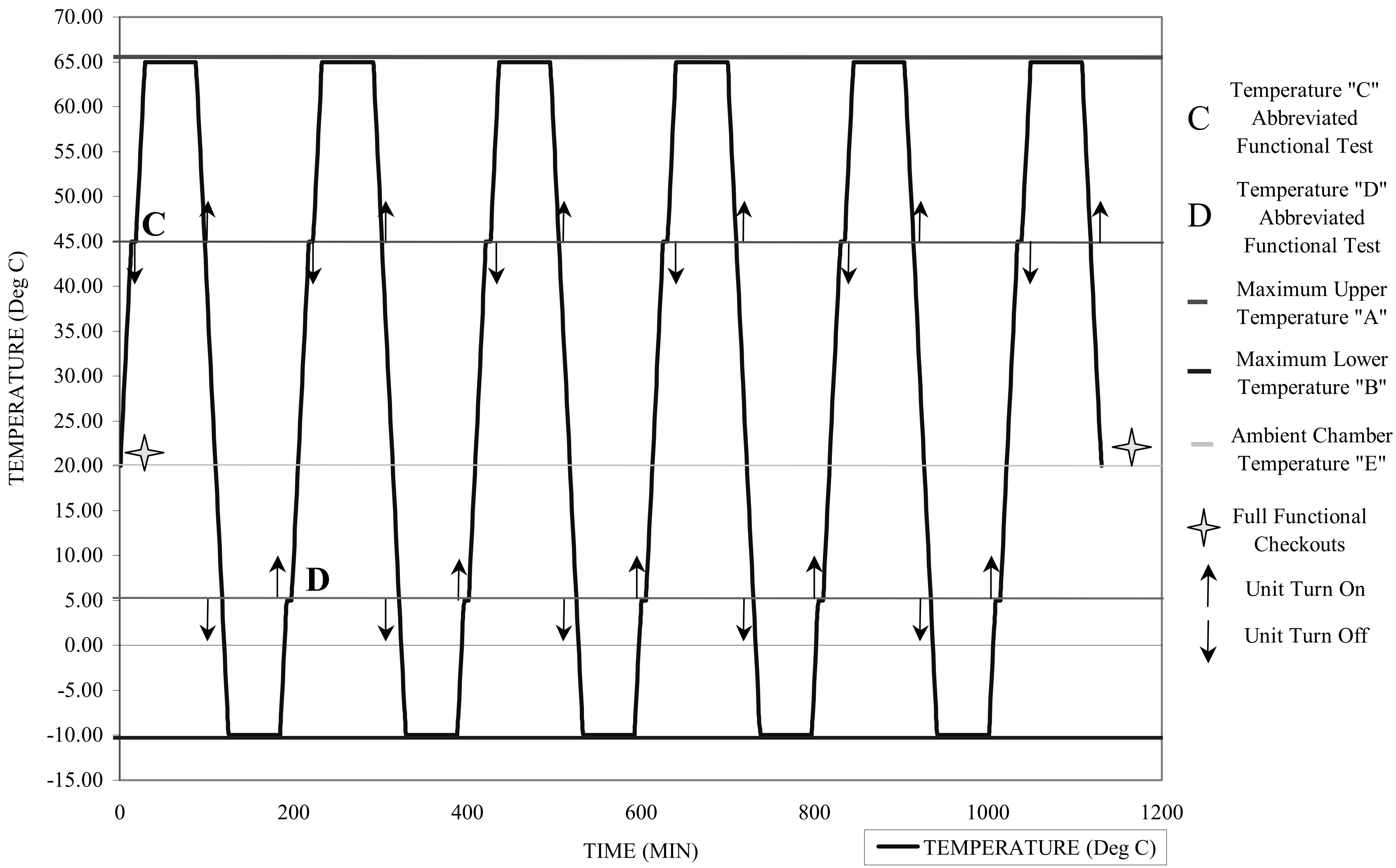

Figure 4.5-1. SWAB ASD Thermal Cycle Testing Graphical Representation

greater than delta temperature (ΔT) of up to 5 °C per minute (min). The temperature rate increase shall be identified on the facility TPS or facility testing document, but will be dependent on the thermal chamber capabilities and be no greater than the specified ΔT. Once the upper operational temperature limit is reached (Test Point "C"), the thermal chamber temperature increase will be stopped and a series of three consecutive abbreviated functionals as described in Section 5.1.2 shall be completed with the SWAB ASD at the Test Point "C" temperature.

4.5.1.3 Thermal Cycle Test Point "C" to Test Point "A"

Upon successful completion of the three abbreviated functionals, the unit will remain off (all power disconnected from the ASD) for the next rise in temperature to Test Point "A." The temperature rate increase shall not exceed ΔT. Once Test Point "A" is reached, the temperature shall be held for one hour (± 1 min tolerance) to allow the SWAB ASD to soak at that temperature.

4.5.1.4 Thermal Cycle Test Point "A" to Test Point "C"

After the one-hour soak is complete, the temperature will be decreased at the same rate (ΔT) back to the Test Point "C" temperature. Once the operational temperature limit, Test Point "C," is reached, the chamber will be opened and the SWAB ASD will be turned on.

4.5.1.5 Thermal Cycle Test Point "C" to Test Point "D"

The unit will be turned on and left running while the thermal chamber continues a steady decrease in temperature at ΔT until the minimum operating temperature, Test Point "D," is reached and held steady. At Test Point "D" the SWAB ASD shall be turned off and unpowered to prepare for the cold soak.

4.5.1.6 Thermal Cycle Test Point "D" to Test Point "B"

The SWAB ASD will remain off and unpowered for the next decrease in temperature to Test Point "B." Once Test Point "B" is reached, the temperature shall be held for one hour (± 1 min tolerance) to allow the SWAB ASD to soak at that temperature.

4.5.1.7 Thermal Cycle Test Point "B" to Test Point "D"

After the one-hour soak is complete, the temperature will be increased again at a rate of ΔT back to Test Point "D." Once Test Point "D" is reached, the thermal chamber is opened and a series of three consecutive abbreviated functionals, as described in Section 5.1.2, shall be completed with the SWAB ASD at the Test Point "D" temperature.

4.5.1.8 Thermal Cycle Test Point "D" to Test Point "C"

Following successful completion of the abbreviated functional test, the SWAB ASD shall be turned on and running while the thermal chamber temperature is increased at ΔT past Test Point "E" back to Test Point "C."

4.5.1.9 Thermal Cycle Test Process Repeat

At Test Point "C," the process above is repeated for 4-1/2 more iterations as shown in Figure 4.5-1. At the last temperature decrease from Test Point "C" to Test Point "D," the ASD Thermal Cycle testing shall be stopped once Test Point "E" is reached. A final full functional test, as described in Section 5.1.1, shall be completed with the SWAB ASD, thus concluding the test with all 5-1/2 cycles completed.

4.5.2 SWAB ASD Battery Pack(s) Test Description

The SWAB ASD Battery Pack(s) test is based upon a 5-1/2 thermal cycle test. The temperature ranges for the test were developed through discussions between the payload developer, EEE parts engineers and JSC/EP5 power specialists. A graphical representation of the written description below is shown in Figure 4.5-2.

The highest temperature range for **exposure** is determined by analysis of all the components on the SWAB ASD Battery Pack(s) and determining which component has the lowest high thermal limit for storage. This temperature is identified in Figure 4.5-2 as Test Point "F."

The lowest temperature range for **exposure** is determined by analysis of all the components on the SWAB ASD Battery Pack(s) and determining which component has the highest low thermal limit for operation and for storage. This temperature is identified in Figure 4.5-1 as Test Point "G."

The **operational** temperature limits are determined from analysis of the **operational** temperature limits of the components in the SWAB ASD Battery Pack(s). The highest **operational** temperature limit is identified on Figure 4.5-2 as Test Point "H." The lowest **operational** temperature limit is identified on Figure 4.5-2 as Test Point "J."

Successful completion of this entire test shall be determined when all functional testing is complete and all equipment has passed MIP steps.

The testing engineer shall be able to terminate and continue this thermal cycle test at another point in time in the event of time constraints or possible thermal chamber failure. Prior thermal cycles shall still be used in the final 5-1/2-cycle count.

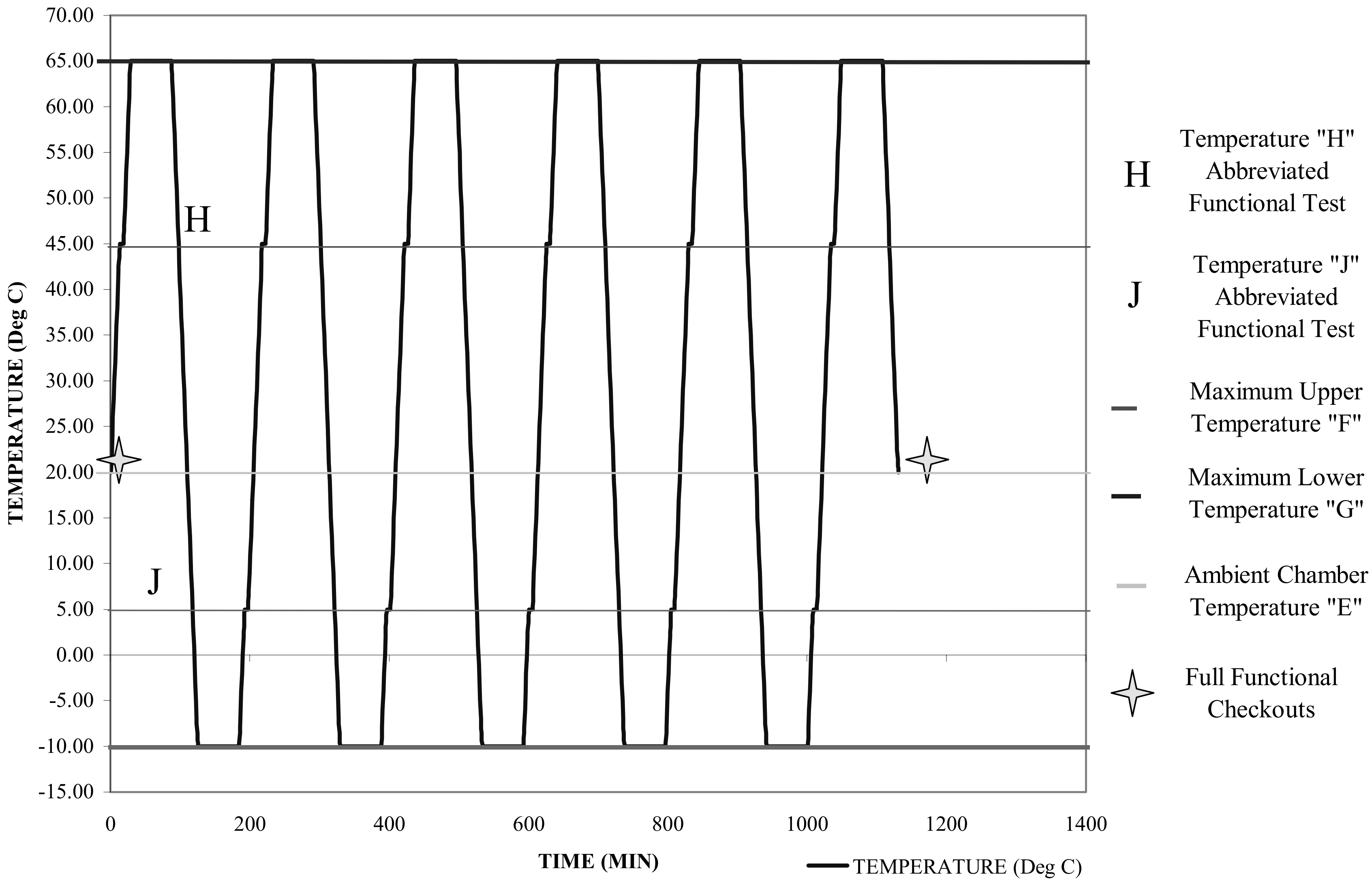

Figure 4.5-2. SWAB ASD Battery Pack(s) Thermal Cycle Testing Graphical Representation

4.5.2.1 Thermal Cycle Test Point "E"

The test begins at the ambient air temperature of the thermal chamber at Test Point "E" and completes the thermal cycle testing at Test Point "E." At the very beginning of the test at Test Point "E," a closed circuit voltage (CCV) check as described in Section 5.1.3, shall be completed for the SWAB ASD Battery Pack(s).

4.5.2.2 Thermal Cycle Test Point "E" to Test Point "H"

Following successful completion of the CCV check of the SWAB ASD Battery Pack(s), the thermal chamber temperature is steadily increased at no greater than a delta of 5 °C per min (ΔT). The temperature rate increase shall be identified on the facility TPS or facility testing document, but will be dependent on the thermal chamber capabilities and be no greater than the specified ΔT. Once the upper operational temperature limit is reached (Test Point "H"), the thermal chamber temperature increase will be stopped and an open circuit voltage (OCV) check, as described in Section 5.1.4, shall be completed with the SWAB ASD Battery Pack(s) at the Test Point "H" temperature.

4.5.2.3 Thermal Cycle Test Point "H" to Test Point "F"

Upon successful completion of the OCV check, the temperature is again increased to Test Point "F." The temperature rate increase shall again not exceed ΔT. Once Test Point "F" is reached, the temperature shall be held for one hour (±1 min tolerance) to allow the SWAB ASD Battery Pack(s) to soak at that temperature.

4.5.2.4 Thermal Cycle Test Point "F" to Test Point "H"

After the one-hour soak is complete, the temperature will be decreased at the same rate back to the Test Point "H" temperature.

4.5.2.5 Thermal Cycle Test Point "H" to Test Point "J"

Here, the temperature in the thermal chamber continues a steady decrease in temperature at ΔT until the minimum operating temperature Test Point "J" is reached and held steady.

4.5.2.6 Thermal Cycle Test Point "J" to Test Point "G"

The thermal chamber temperature is decreased to Test Point "G." Once Test Point "G" is reached, the temperature shall be held for one hour (±1 min tolerance) to allow the SWAB ASD Battery Pack(s) to soak at that temperature.

4.5.2.7 Thermal Cycle Test Point "G" to Test Point "J"

After the one-hour soak is complete, the temperature will be increased again at a rate of ΔT back to Test Point "J." Once Test Point "J" is reached, the thermal chamber is opened and an OCV check, as described in Section 5.1.4, shall be completed with the SWAB ASD Battery Pack(s).

4.5.2.8 Thermal Cycle Test Point "J" to Test Point "H"

Following successful completion of the OCV check, the thermal chamber temperature is increased at a rate of ΔT past Test Point "E" back to the Test Point "H" temperature.

4.5.2.9 Thermal Cycle Test Process Repeat

At Test Point "H," the above process is repeated for four more iterations as shown in Figure 4.5-2. At the last temperature decrease from Test Point "H" to Test Point "J," the ASD Thermal Cycle testing shall be stopped once Test Point "E" is reached. A final CCV check shall be completed for the SWAB ASD Battery Pack(s), thus concluding the test with 5-1/2 cycles completed.

4.6 TESTING MEASUREMENTS

The thermal chamber temperatures shall be recorded by the testing facilities at all times during testing. TCs also should be mounted to the EUT in strategic locations per the engineer's discretion. Temperature measurements should be recorded in degrees Celsius (ºC). In addition, an accurate time log for the thermal cycle test indicating significant testing events including all functional checks shall be recorded by the testing facility.

4.7 EXPERIMENT UNIQUE EQUIPMENT (EUE) FUNCTIONAL TESTING VERIFICATION

The following sections describe the functional tests to be performed on the EUT before, during and after the environmental testing. The following testing can be completed for all environmental testing and not just thermal cycling. Each device has two different functional tests. The two tests include a full end-to-end functional checkout and an abbreviated functional checkout. This test plan calls out a specific sequence for full and abbreviated functionals, but ultimately it will be up to the test engineer to determine which test to run.

5.0 SWAB ASD END-TO-END FULL FUNCTIONAL TEST

5.1 INTRODUCTION

5.1.1 Purpose

The purpose for this SWAB ASD End-to-End Full Functional Test is to baseline a standard series of testing to determine the functionality of any or all Class I or Class II SWAB ASD hardware. The procedures within this section describe the process for a full functional that is to be used before and after successful completion of any environmental testing or a standalone functional if necessary.

5.1.2 Scope

These procedures cover the setup, required equipment, actual testing and tear down for the testing of the SWAB ASD. This End-to-End Full Functional Test should not be used for troubleshooting any and all Class I and II ASDs in the event of the error detection during the functional procedures.

5.2 TEST OBJECTIVE

The objective for the End-to-End Full Functional Test of the SWAB ASD is to verify full operation of the SWAB ASD before and after successful environmental testing as well as a standalone test for functional certification of the device. This test will determine that all nominal systems are operating correctly including but not limited to device turn on, setup, start-up, stop and shutdown.

5.3 TEST SELECTION CRITERIA

The SWAB ASD End-to-End Full Functional testing shall be completed before and after successful environmental testing as well as a standalone test for functional certification of the device. This test should also be completed after the device has been assembled for flight as part as the Pre-Delivery Acceptance (PDA) functional.

5.4 REQUIRED TEST EQUIPMENT

There are three configurations that this test can be completed under but each configuration is only different by the source, which is powering the device.

REQUIRED HARDWARE FOR FULL FUNCTIONAL TEST

A. SWAB Air Sampling Device,

P/N SEG46119448-3XX, Record S/N _____________

NOTE: The -3XX represents the fact that the ASD configuration changes depending on which power source is powering the ASD.

B. SWAB ASD Filter Unit,
P/N SEG46119451-301, Record L/N ________

C. POWER OPTIONS

1. SWAB ASD Li-BCX Battery Pack
   P/N SEG46119450-301 or SEG38118102-301,
   Record S/N __________
2. SWAB ASD NiMH Battery Pack
   P/N SEG46119449-301 or SEG38118103-301,
   Record S/N _________
3. DC POWER SUPPLY
   Model No. ______________
   With Special ASD Power Cable P/N SEG38118105-301

D. DMM or Equivalent
Model No. __________
Calibration No. ______________
Due Date ________________

E. Any commercially available time-piece that has timing capabilities accurate to seconds only.

5.5 TEST PROCEDURES

5.5.1 Assemble the SWAB ASD using the HRF Filter Unit and HRF Battery Pack or a power supply per attached sketch.

NOTE: The responsible engineer shall provide the attached sketch.

_____ QAS

5.5.2 Choose ASD Power Option from Step 5.4 C.

POWER OPTION 1 ________
POWER OPTION 2 ________
POWER OPTION 3 ________

_____ QAS

5.5.3 If POWER OPTION 3 is used, verify voltage is set to 18.0 Vdc (±0.5 Vdc) and a current limit of 3.0 (±0.2 A).

Check the voltage with the DMM from Step 5.4 C.

________ Vdc
________ A (Current Set)

_____ QAS

5.5.4 Power ON the SWAB ASD by pressing the "ON/START/STOP" button on the ASD Control Panel. Verify display shows "Sartorius Airport MD8" at turn-on.

______ QAS

5.5.5 After the ASD is on, Press and hold the "MENU" button and within 1 sec also press the "ON/START/STOP" button and then let go. This may take a few tries but once completed, verify that "Service Programme" is displayed on the ASD.

______ QAS

5.5.6 Once in the "Service Programme" menu, press the "MENU" button to cycle through the menu items. Set and verify the following items:

1. Set language to English
2. "Switch-off time" is set to 60 sec
3. "LCD Contrast" is set to 50 and is visible on the display

______ QAS

5.5.7 Press the "MENU" button to the "CALIBRATION" menu and record but **DO NOT CHANGE** the current "K" value.

K = _____________

Once recorded, press the "MENU" button and to the menu "Service Programme" and press the "ON/START/STOP" button to exit. Verify that the ASD display has returned to "Sartorius Airport MD8."

______ QAS

5.5.8 Press the "MENU" button to cycle through the menu options till the sampling volume default menu is selected. Press either "CYCLE SETTINGS" button to set the set volume to 1000 liters (L). Verify 1000 L is set.

______ QAS

5.5.9 After the sampling volume is set press the "MENU" button again to go to the airflow rate menu. Press either "CYCLE SETTINGS" button to set the set the flow rate to 50 Liters per minute (L/min). Verify 50 L/min is set.

______ QAS

5.5.10 Press the "MENU" button to go back to the main header "Sartorius Airport MD8."

5.5.11 Press the "ON/START/STOP" button on begin a sampling session. Verify that the ASD motor has started. To verify this check the display that shows the volume of air to be sampled and the actual air flow rate.

______ QAS

5.5.12 After about 10 sec, verify that the airflow rate has stabilized at 50 L/min (±.5 L/min).

NOTE: If the flow rate has not reached the set flow rate check the gelatin membrane filter for clogs. If the flow rate exceeds the set rate then check the to see if the filter unit is installed correctly or has any holes. If the filter unit has holes or was not seated correctly, replace and retry to verify 50 L/min. If this does not work only then is this a discrepancy.

_____
QAS

5.5.13 As the device is running, verify the following by pressing the "MENU" button:

1.0 "Time Remaining" is decreasing in time
2.0 "Battery Percentage" is displayed as percentage

_____
QAS

5.5.14 Let the ASD complete the sampling session. The time remaining is indicated by the "Time Remaining" menu selection but the test will take 20 min (±20 sec).

Record time required for sampling session ____: ____ (min:sec)

_____
QAS

5.5.15 Once the ASD has completed the sampling session, verify that the motor has shut off and the display is showing previously set Sample Volume and Flow Rate.

_____
QAS

5.5.16 Wait approximately 60 sec immediately after the ASD has stopped running and verify that the SWAB ASD has shut off. This is verified from no display shown in the control Liquid Crystal Display (LCD) screen.

_____
QAS

5.5.17 Once the device has shutdown, remove the filter unit from the front of the device and disconnect the power source from the SWAB ASD. Return hardware to packaging material/box.

_____
QAS

5.5.18 This concludes the End-to-End Full Functional Test for the SWAB ASD.

6.0 SWAB ASD ABBREVIATED FUNCTIONAL TEST

6.1 INTRODUCTION

6.1.1 PURPOSE

The purpose for this SWAB ASD Abbreviated Functional Test is to baseline a standard series of testing to determine the functionality of any or all Class I or Class II SWAB ASD hardware. The procedures within this section describe the process for an abbreviated test that is to be used during completion of any environmental testing or after any device shipment or non-environmental test where the device was removed from JSC/B36 bond.

6.1.2 SCOPE

These procedures cover the setup, required equipment, actual testing and tear down for the testing of the SWAB ASD. This Abbreviated Functional Test should not be used for troubleshooting any and all Class I and II ASDs in the event of the detection of an error during the functional procedures.

6.2 TEST OBJECTIVE

The objective for the Abbreviated Functional Test of the SWAB ASD is to verify that the device is somewhat operational during environmental testing (turns on and off and runs) as well as a standalone test after device shipment or after other random non-environmental testing. This test will determine that the device can be turned on, started, stopped and shutdown.

6.3 TEST SELECTION CRITERIA

The SWAB ASD Abbreviated Functional testing shall be completed during the environmental testing test points as well as a standalone test for a short/fast functional checkout of the device. This test should also be completed after any engineering evaluations or after the hardware was pulled from Bond to support photo-shoots, media day events, etc.

6.4 REQUIRED TEST EQUIPMENT

There are three configurations that this test can be completed under but each configuration is only different by the source, which is powering the device.

REQUIRED HARDWARE FOR ABBREVIATED FUNCTIONAL TEST

A. SWAB Air Sampling Device
P/N SEG46119448-3XX, Record S/N _____________

NOTE: The -3XX represents the fact that the ASD configuration changes depending on which power source is powering the ASD.

B. SWAB ASD Filter Unit,

P/N SEG46119451-301, Record L/N ________

C. POWER OPTIONS

1. SWAB ASD Li-BCX Battery Pack

   P/N SEG46119450-301 or SEG38118102-301,

   Record S/N __________

2. SWAB ASD NiMH Battery Pack

   P/N SEG46119449-301 or SEG38118103-301,

   Record S/N _________

3. DC POWER SUPPLY

   Model No. ______________

   With Special ASD Power Cable P/N SEG38118105-301

D. DMM or Equivalent

Model No. ___________

Cal No. ______________

Due Date ________________

6.5 TEST PROCEDURES

6.5.1 Assemble the SWAB ASD using the HRF Filter Unit per attached sketch.

NOTE: The responsible engineer shall provide the attached sketch.

_____ QAS

6.5.2 Choose ASD Power Option from Step 6.4 C.

POWER OPTION 1 ________
POWER OPTION 2 ________
POWER OPTION 3 ________

_____ QAS

6.5.3 If POWER OPTION 3 is used, verify voltage is set to 18.6 Vdc (±0.5 Vdc) and a current limit of 3.0 (±0.2 A).

Check the voltage with the DMM from Step 6.4 C.

________ Vdc
________ A (Current Set)

_____ QAS

6.5.4 Power ON the SWAB ASD by pressing the "ON/START/STOP" button on the ASD Control Panel. Verify display shows "Sartorius Airport MD8" at turn-on.

______ QAS

6.5.5 Press the "ON/START/STOP" button again and begin a sampling session. Verify that the ASD motor has started. To verify this check the display that shows the volume of air to be sampled and the actual air flow rate.

______ QAS

6.5.6 After about 1 min, verify that the airflow rate has stabilized at 50 L/min (±.5 L/min). Then press the "ON/START/STOP" button to stop the sample session.

NOTE: If the flow rate has not reached the set flow rate check the gelatin membrane filter for clogs. If the flow rate exceeds the set rate then check the to see if the filter unit is installed correctly or has any holes. If the filter unit has holes or was not seated correctly, retry and verify 50 L/min. If this does not work only then is this a discrepancy.

______ QAS

6.5.7 Once the ASD has stopped, verify that the motor has shut off and the display is showing previously set Sample Volume and Flow Rate.

______ QAS

6.5.8 Wait and verify that the SWAB ASD has shut off. This is verified from no display shown in the control LCD screen.

______ QAS

6.5.9 Once the device has shutdown, remove the filter unit from the front of the device and disconnect the power source from the SWAB ASD. Return hardware to packaging material/box.

______ QAS

6.5.10 This concludes the Abbreviated Functional Test for the SWAB ASD.

7.0 SWAB ASD BATTERY PACK(S) CLOSED CIRCUIT VOLTAGE TEST

7.1 INTRODUCTION

7.1.1 Purpose

The purpose for this SWAB ASD Battery Pack CCV Test is to baseline a standard series of testing to determine the functionality of any or all Class I or Class II (GSE) SWAB ASD Battery Packs. The procedures within this section describe the process for a CCV test that is to be used before and after completion of any environmental testing or as a standalone full functional is needed.

7.1.2 Scope

These procedures cover the setup, required equipment, actual testing and tear down for the testing of the SWAB ASD Battery Packs. This CCV test should not be used for troubleshooting any and all Class I and II Battery Packs in the event of error detection during the functional procedures.

7.2 TEST OBJECTIVE

The objective for the CCV test of the SWAB ASD Battery Pack(s) is to verify that the Battery Packs are fully operational and are maintaining their charge capacity before and after environmental testing as well as any possible required standalone test.

7.3 TEST SELECTION CRITERIA

The SWAB ASD Battery Packs CCV testing shall be completed before and after successful environmental testing as well as a standalone functional test for the PDA functional.

7.4 REQUIRED TEST EQUIPMENT

There are two configurations that this test can be completed under but each configuration is only different by the type of Battery Pack.

REQUIRED HARDWARE FOR CCV TEST

A. SWAB ASD Li-BCX Battery Pack

   P/N SEG46119450-301 (or SEG38118102-301 for GSE Pack)

   Record S/N _____________

OR

   SWAB ASD NiMH Battery Pack

   P/N SEG46119449-301 (or SEG38118103-301 for GSE pack)

   Record S/N ________

B. Resistive Load (10 Ohm) ±3%

C. DMM or Equivalent

Model No. ____________

Cal No. _______________

Due Date _________________

7.5 TEST PROCEDURES

7.5.1 Connect the DMM and Resistive Load to the ASD Battery Pack

______ QAS

7.5.2 Apply the 50-Ohm resistive load to the Battery Pack for 90 sec (±5 sec).

______ QAS

7.5.3 Record the voltage at the beginning of the 90 sec and at the end of the 90-sec period.

0 Sec Voltage: ___________________ V

90 Sec Voltage: __________________ V

______ QAS

7.5.4 Disconnect the test setup.

______ QAS

7.6 This concludes the CCV Test for the SWAB ASD Battery Packs

8.0 SWAB ASD BATTERY PACK(S) OPEN CIRCUIT VOLTAGE TEST

8.1 INTRODUCTION

8.1.1 Purpose

The purpose for this SWAB ASD Battery Pack OCV test is to baseline a standard series of testing to determine the functionality of any or all Class I or Class II (GSE) SWAB ASD Battery Packs. The procedures within this section describe the process for an OCV test that is to be used to check the voltage of the Battery Pack during environmental testing or for a quick voltage check and cell integrity.

8.1.2 Scope

These procedures cover the setup, required equipment, actual testing and tear down for the testing of the SWAB ASD Battery Packs. This OCV test should not be used for troubleshooting any and all Class I and II Battery Packs in the event of error detection during the functional procedures.

8.2 TEST OBJECTIVE

The objective for the OCV test of the SWAB ASD Battery Pack(s) is to verify that the Battery Packs are retaining a charge and that a cells are working correctly and are maintaining their charge capacity during environmental testing as well as any possible required standalone test.

8.3 TEST SELECTION CRITERIA

The SWAB ASD Battery Packs OCV testing shall be completed during environmental testing.

8.4 REQUIRED TEST EQUIPMENT

There are two configurations that this test can be completed under but each configuration is only different by the type of Battery Pack.

REQUIRED HARDWARE FOR OCV TEST

A. SWAB ASD Li-BCX Battery Pack
   P/N SEG46119450-301 (or SEG38118102-301 for GSE Pack)
   Record S/N _____________
   OR
   SWAB ASD NiMH Battery Pack
   P/N SEG46119449-301 (or SEG38118103-301 for GSE pack)
   Record S/N ________

B. DMM or Equivalent

Model No. ___________

Cal No. ______________

Due Date ________________

8.5 TEST PROCEDURES

Connect (Probe) the ASD Battery Pack connector using the DMM and record the OCV.

OCV: ________________ V

_____
QAS

8.6 This concludes the OCV Test for the SWAB ASD Battery Packs

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