SWAB EUE
CRITICAL DESIGN REVIEW
PACKAGE

E049
A Comprehensive Characterization of Microorganisms and Allergens in Spacecraft Environment
"SWAB"
(Surface Water and Air Biocharacterization)

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I. Experiment Overview

PURPOSE AND METHOD:

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. No attempt to monitor microbial toxins has been made as well. 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

To preserve the sample for microbial quantitation, the samples will be fixed in a 1% Sodium Dodecyl Sulfate (SDS) solution.

Surface samples will be collected using a modified COTS swab tube prepared by Charm Sciences for the SWAB experiment. The swab tubes have an lifetime of 1year from date of preparation by Charm Sciences. Specifically, a 25 cm^2 surface area is wiped with a swab (sponge) pre-moistened with water and then returned to the swab tube body containing a known amount of SDS fixative solution.

Potable water samples will be collected directly into 1-liter Teflon bags before and then transferred into another 1-liter bag containing the SDS. The inflight water samples will be obtained from the Russian pasteurization system (SRV-K) that regenerates water for potable use, and the two SVO-ZV dispensing ports. If present, free-floating condensate, which accumulates during extended missions, will be collected using a syringe.

Air samples will be collected via a NASA/EB modified COTS Air Sampling Device by Sartorius Co. The ASD will draw air through a gelatin membrane filter, which will capture any airborne microbes. The membrane filters will be returned to ground for analysis.

OBJECTIVES:

1. Provide a thorough analysis for microbial pathogens and allergens that may come into contact with the crew of the station
2. Evaluate the environmental ecology to asses potential threats to the ISS crew, its systems, and spacecraft integrity
3. Prepare molecular primers which facilitate microbial detection, which would advance the general detection capabilities of NASA and other earth-based laboratories

II. Experiment Hardware Overview

INTRODUCTION

The proposed experiment requires three different types of environmental sampling equipment: surface sampling equipment, water sampling equipment, and air sampling equipment. Protocols for obtaining surface and water specimen have already been developed, but the hardware that will be used to acquire these samples are newly developed Experiment Unique devices. There is one small component of the water sampling equipment that is shared between HRF and CHeCS and that is the potable water sampler adapters, which the experiment is working with CHeCS developers to coordinate the use of.

Finally, the protocols for obtaining air samples for the experiment are based on a new device/concept that will provide effective samples for advanced analysis required for this investigation.

HARDWARE OVERVIEW

The following are descriptions of the major hardware items needed to support the experiment.

SURFACE SAMPLING PROTOCOLS:

Surface samples will be obtained with a special developed swab tube manufactured by Charm Sciences Inc. of Massachusetts for the experiment use. The swab tube is composed of a swab tube body that utilizes a threaded handle to allow the user to thread the handle, which holds the swab, and penetrate through a foiled membrane to a microtube attached to the end of the swab tube containing a Sodium Dodecyl Sulfate (SDS) fixative solution. The swab is soaked in the fixative solution to inhibit excessive microbial growth and “fix” the sample at the present sample time. Each swab tube is individually wrapped in a resealable package and will be contained in the SWAB Tube Kit inside the SWAB Experiment Kit. See below in Figure 1 the Swab tube to be used for this experiment.

Figure 1 – Charm Sciences Swab Tube that will be used for the experiment surface sampling protocols

WATER SAMPLING PROTOCOLS:

In order to obtain a more comprehensive characterization of microorganism presence in spacecraft water, both potable water and free-floating condensate will be collected and analyzed. ISS potable water sites including the SRV-K and SVO-ZV water ports will be obtained as well as any Free-floating condensate that might have accumulated during extended missions. In addition, to preserve the collected samples for future analysis on ground, a SDS fixative solution is again utilized and approximately 10g of fixative will be used for each 1-liter water sample collected.

However, because of the assigned tox levels of the SDS solution, the experiment team anticipated that approval to sample directly from the water source would be denied so a two-bag system was developed. One water bag would be used to collect the water while a second bag would be used to store the water and be returned to earth. The second or "Final" water bag would contain the SDS fixative.

Below is the required hardware needed to acquire the various water samples.

Required Hardware:

Disinfectant Wipes

These will be used to clean the water port adapter prior to collection of water to prevent contamination of water sample with any surface contagion. The wipes are cellulose fiber towelettes soaked in a 1:250 solution of Benzalkonium chloride in water. Each wipe is packaged in a sealed foil and paper pouch and will be attached to the SWAB Temporary Water Bags.

Potable Water Adapter Probes

The Potable Water Adapter Probes are used to allow water transfer from the water ports of the ISS (SRV-K and SVO-ZV ports) to the SWAB Temporary Water Bags without spillage. Each probe consist of a Teflon adapter that mates to the Hot/Cold or SVO-ZV dispenser probe as appropriate and a stainless steel male luer lock fitting that mates with collection bags. These samplers have been sealed in a Teflon bag and sterilized prior to flight, and will be attached via Velcro to the SWAB Temporary Water Collection Bags. The potable water adapter probes are previously certified hardware and will be borrowed from the CHeCS division.

SWAB Temporary Water Bags

The SWAB Temporary Water Bags actually consist of three different 1-liter Teflon water bags that only differ in their label/decal and water port adapter. Because there are three different potable water samples to acquire (SRV-K Hot, SRK-K Warm and SVO-ZV) each bag is configured with a different label specifying which bag as well as the respective water port. For all cases however, American Fluoroseal Corp. manufactures the Teflon water bags. AFC water bags are manufactured in a Class 100,000 clean room in compliance with cGMP and the International Standards Organization (ISO). Each container is individually pressure tested and visually inspected to assure the highest possible quality. In addition, each bag is sealed using a patented laser manufacturing system, which is capable of making water bags of many different sizes and shapes. The process produces containers with exceptional strength and durability which can withstand

temperatures above +200° C, and below -196° C. These bags are currently being used by CHeCS environmental water collections and widely accepted for flight applications. Each bag is configured with a Qosina luer lock mechanical activated two-way check valve that is secured to the stem of the water bag via luer lock and approved epoxy adhesive. The whole luer adapter system is then sealed with heat shrink tubing. Reference *Figure 2* for a picture of both the SWAB Temporary Water Bag connected to the SWAB Final Water Bag inside the Water Kit (Bitran Bag)

SWAB Final Water Bags/Kits

After the SWAB water sample is collected in the SWAB Temporary Water Bags, the water will be transferred (squeezed) to the respective SWAB Final Water Bags. The primary difference between the Final Water Bags and the Temporary Water Bags is that the final bags contain the SDS fixative inside each bag. The fixative is added to each Final Water Bag during the assembly process of the water bag at AFC. In addition, the Final Water Bags are configured with a non-mechanical one-way pressure activated check valve and then a male-to-male luer adapter, which allows connection between both the temporary and final bag. Again, all final water bag adapters are secured to the stem of the water bag via luer lock and approved epoxy adhesive. The whole luer adapter system is then sealed with heat shrink tubing. There are four SWAB Final Water Bags assemblies consisting of the SRV-K Hot, SRK-K Warm, SVO-ZV, and Condensate bags. Finally, the SWAB Final Water Bags will be stowed and always maintained inside a waterproof Bitran bag to configure the SWAB Final Water Kit. The extra Bitran bag enclosing each Final water bag is to maintain adequate tox level containment.

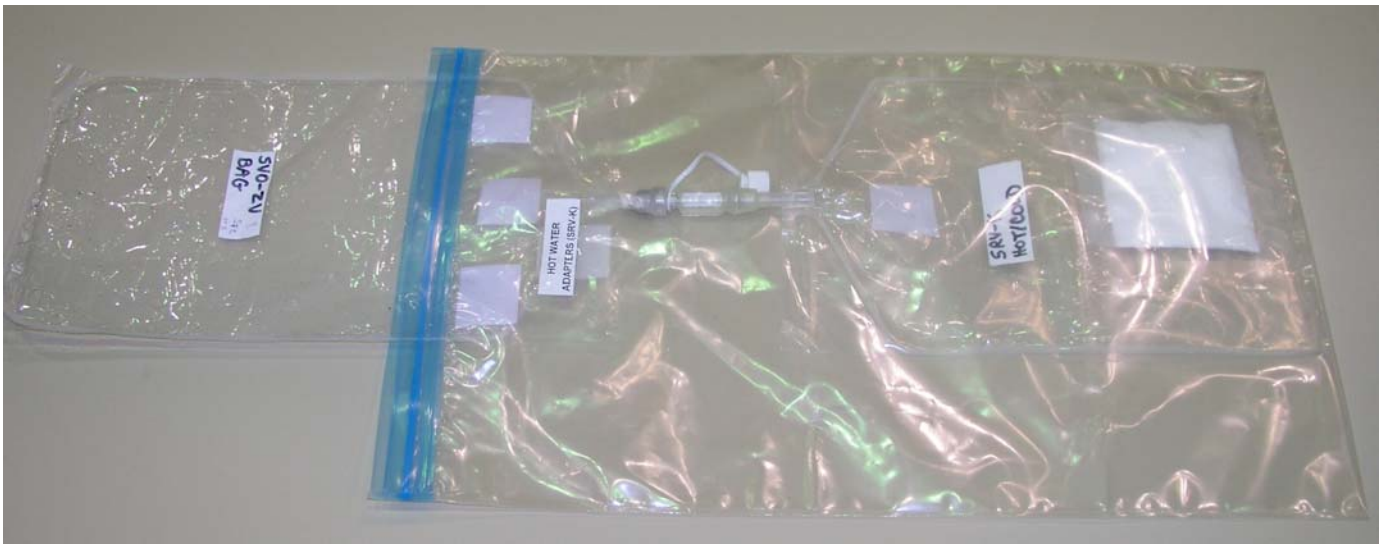


Figure 2 – SWAB Temporary Water Bag (left) connected to the SWAB Final Water Bag (Right)

Syringe

To acquire any free-floating condensate, a syringe will be utilized that has the mating luer adapter to the SWAB Final Water Bag Condensate.

SWAB Water Bag Kit(s)

To house all the empty water bags, a SWAB Water Bag Kit will be developed to hold one sample sessions worth of water sampling hardware. This would include: SWAB Syringe, SWAB Temporary Water Bag SRV-K Hot, SWAB Temporary Water Bag SRV-K Warm, SWAB Temporary Water Bag SVO-ZV, SWAB Final Water Bag SRV-K Hot, SWAB Final Water Bag SRV-K Warm and SWAB Final Water Bag SVO-ZV.

AIR SAMPLING PROTOCOLS:

The Air Sampling protocol will utilize the HRF ASD to acquire air samples from strategic locations of the ISS. The ASD is a COTS device manufactured by Sartorius AG in Germany that is modified by EB to become flight ready. The device is battery operated to allow portability and the current battery pack is a Lithium Bromine Complex Pack (Li-BCX). In addition, a gelatin membrane filter is used to actually capture airborne microorganisms and allergens, and is attached to the front of the ASD.

Required Hardware:

SWAB ASD

This unit is a COTS environmental Air Sampling System from Sartorius Co that is slightly modified by EB/NASA for flight readiness. The ASD is powered by a custom configured battery pack as described below. The ASD operates by drawing air across the ASD Filter via an integrated impeller/motor system that is electronically controlled by an opto-electronical anemometer that measures the flow rate of the air passing through the inlet port of the ASD. The flow rate is precisely controlled at the set flow rate, which is selected by the user. If the flow rate is reduced or accelerated by obstruction or holes in the filter, the system compensates for the change and will reduce or increase the current to the impeller/motor system. With a precisely controlled flow rate, the volume of air acquired and time required will allow precise measurements of the air samples. The amount of air and sample rate that the ASD will be operated at is $1m^3$ (1000 l) at 50 l/min.

ASD Lithium Battery

To power the SWAB ASD for extended increments, a unique battery pack was designed utilizing five (5) Li-BCX “C” sized cells constructed in a series configuration. Each cell is a 3.4V OCV battery cell that is purchased from USA as flight approved and tested battery cells. The Battery pack is configured with advanced safety features including reverse current protection diodes (2 per cell) as well as a polyswitch to prevent over discharge and excessive heat generation. The battery pack has been tested to operate up to about 10 hours of use, which will provide enough time to acquire the proposed 8 hours of use per increment. For precaution however, an extra pack will be flown with the hardware.

SWAB ASD Filter

The SWAB ASD Filter is a COTS gelatin membrane filter that is used with the Sartorius ASD. The filter is double bagged, each sterilized for use. For the experiment’s

application, the COTS product will be slightly modified with just a label and Velcro patches to stack multiple filters together for ease of operation.

SWAB ASD Filter Kit and ASD Stowage Foam
Each air sample session requires a new ASD Filter therefore there will be a large number of filters flown per increment. The filters will be housed in four (4) SWAB ASD Filter Kits for ease of operation and stowage.
The ASD and spare battery pack will be stowed in a custom fitted foam cutout; both reside in the SWAB Experiment Kit.

SWAB Kits

The SWAB kit was designed to be modular, separating each type of sample media, therefore allowing more efficiency & ease for the crew when completing experiment operations and to accommodate refills if necessary.

The SWAB experiment will utilize numerous kits containing subkits, to stow the required hardware for the experiment. On ascent there will be one main kit, the SWAB Experiment Kit containing all the subkits:.

1. Four (4) ASD Filter Kits
2. Four (4) Water Bag Kits
3. One (1) SWAB Tube Kit and
4. The ASD with ASD battery pack.
5. Two empty SWAB Return Kits (hold all the collected samples and be returned to earth on the first available shuttle flight following a shuttle docking to ISS.

SOFTWARE DESCRIPTION:

There is currently no planned experiment-unique software for E049. However, the ASD does have an LCD screen for readouts regarding the Flow Rate and Sampling Volume as well as other displays. See attached menu diagram *Menu System Layout and Instruction* in Appendix B for a complete look at all display screens that would be seen.

III. CDR Package Products

SWAB Experiment Unique Equipment Product Listing

Op Nom	Part Number	QTY (Per Experiment Kit)
SWAB EXPERIMENT KIT	**SJG46120227-301**	**1**
SWAB TUBE KIT	**SJG46120230-301**	**1**
SWAB Tube	SEG46119457-301	48
SWAB Tube Kit Pouch	SDG46119898-301	1
SWAB WATER BAG KIT	**SJG46120231-301**	**4**
SWAB WATER BAG KIT POUCH	SDG46119899-301	4
SWAB TMPRY WATER BAG SVO-ZV	SEG46119456-301	4
SWAB TMPRY WATER BAG SRV-K HOT	SEG46119456-302	4
SWAB TMPRY WATER BAG SRV-K WARM	SEG46119456-303	4
SWAB FINAL WATER BAG SVO-ZV	SEG46119455-301	4
SWAB FINAL WATER BAG SRV-K HOT	SEG46119455-302	4
SWAB FINAL WATER BAG SRV-K WARM	SEG46119455-303	4
SWAB FINAL WATER BAG CONDENSATE	SEG46119455-304	4
SWAB SYRINGE	SEG46119459-301	4
SWAB ASD FILTER KIT	**SJG46120229-301**	**4**
SWAB ASD FILTER KIT POUCH	SDG46119897-301	4
SWAB ASD FILTER	SEG46119451-301	32
SWAB ASD STOWAGE FOAM	SEG46119895-301	1
SWAB ASD	SEG46119901-301	1
SWAB ASD LITHIUM BATTERY	SEG46119450-301	1
SWAB RETURN KIT	**SJG46120228-301**	**2**
SWAB RETURN KIT POUCH	SDG46119896-301	2

SWAB DRAWING PACKAGE

Reference the following list for the drawings included in Appendix B:

ASD Unit Altered Item	SEG46119448
NiMH Battery Pack Assembly	SEG46119449
Li-BCX Battery Pack Assembly	SEG46119450
ASD Filter Unit Drawing	SEG46119451
ASD Battery Guide Assembly	SEG46119453
SWAB Final Water Bags	SEG46119455
SWAB Temporary Water Bags	SEG46119456
SWAB Tube Assembly	SEG46119457
SWAB Final Water Kit	SEG46119458
SWAB Syringe	SEG46119459
SWAB Label and Decal Drawing	SEG46119460
ASD Decal Drawing	SEG46119462
ASD Jacket Assembly	SEG46119715
SWAB ASD Top Assembly	SEG46119901

The various SWAB Kit drawings and pouch drawings have not yet been developed but are currently in work. Prototype SWAB Kits have been developed using flight like components from the above list to determine the proper size and dimensions for each subkit/pouch required

to hold the various sample media. Reference the attached block diagram/picture for the proper layout and design consideration of the SWAB Experiment Kit and other subkits in Appendix C.

Safety Data Package Information

The experiment as a whole has completed Phase I safety. and a safety TIM to review the SWAB water collection and surface sampling hardware designs for containment of the SDS fixative. . The phase II safety package is in development , however at this time t the SWAB ASD and ASD Battery pack are at the phase II level. The phase II package is scheduled for release shortly after the hardware CDR as per direction from the HRF safety engineer and the EB project manager. Hazard Analysis and associated documentation have been completed and are attached (appendix D).

Design Analysis Reports

As part of this critical design review, detailed analysis reports are included in this package. All design reports were generated on behalf of the SWAB ASD/ASD Lithium Battery, as the SWAB water and surface sampling hardware do not require extensive analysis for their designs. The list below includes all design analysis reports generated for the experiment and are included in this package in Appendix E.

- Initial Assessment of Criticality
- Strength and Fracture Assessment of the HRF SWAB ASD
- Thermal Analysis of the HRF ASD
- Micro-Gravity Assessment for the HRF SWAB ASD
- Offgas Test Results of the SWAB ASD
- EMI Test Results of the SWAB ASD
- Human Factors Analysis Report

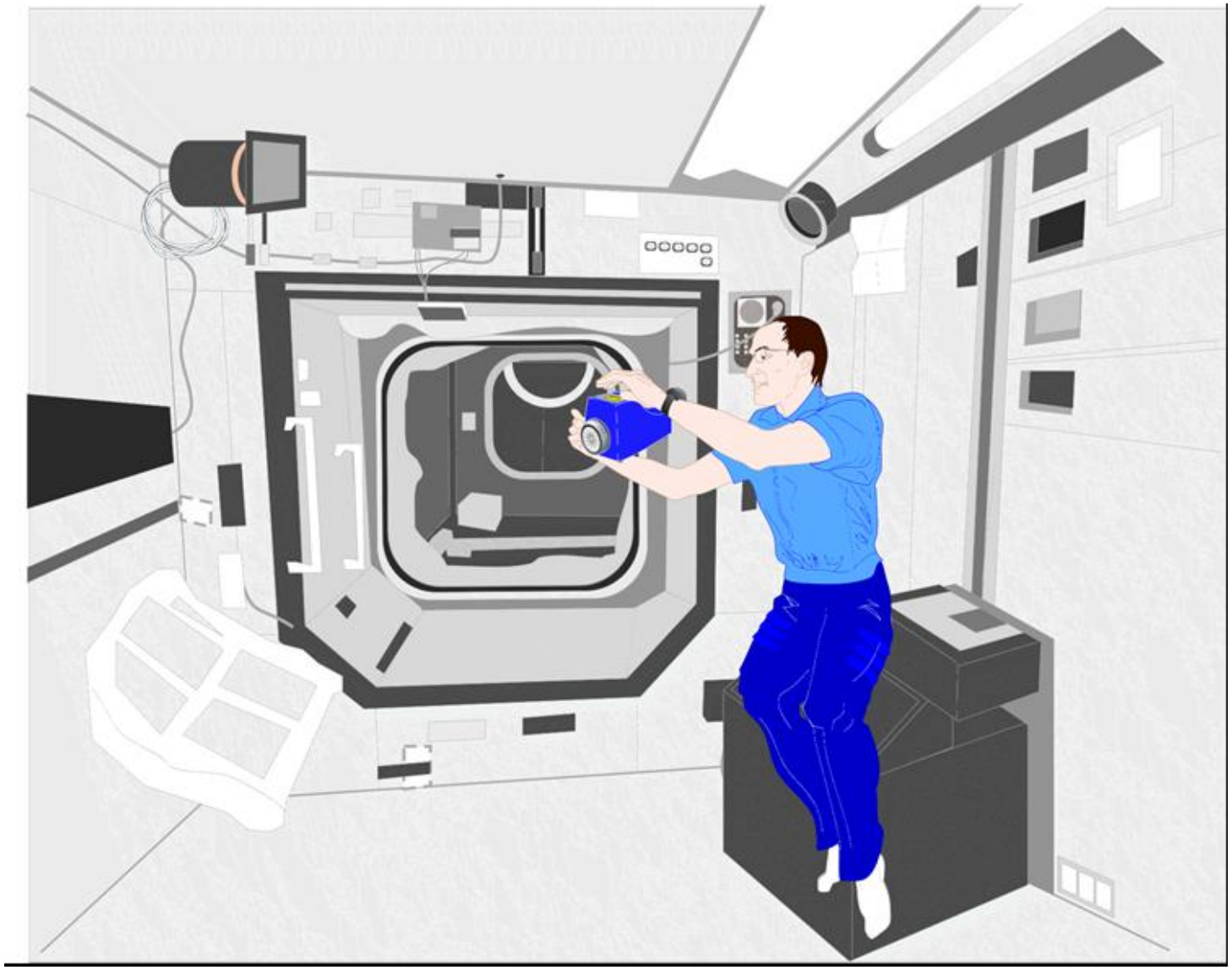
SWAB Developmental Testing and Design Results and Reports

Following the completion of the System Requirements Review (SRR) and the Experiment Preliminary Design Review (PDR) the experiment team began critical design development, which included a number of designs testing, and development especially for the more complex ASD and ASD Lithium Battery. Although the ASD came in as a COTS unit, it required some additional design and testing to derive the unit as flight ready. In addition, developmental testing was completed for the SWAB water bags and surface sampling equipment. Reference Appendix F for all the various testing/analysis completed for the development of the SWAB EUE is described with results.

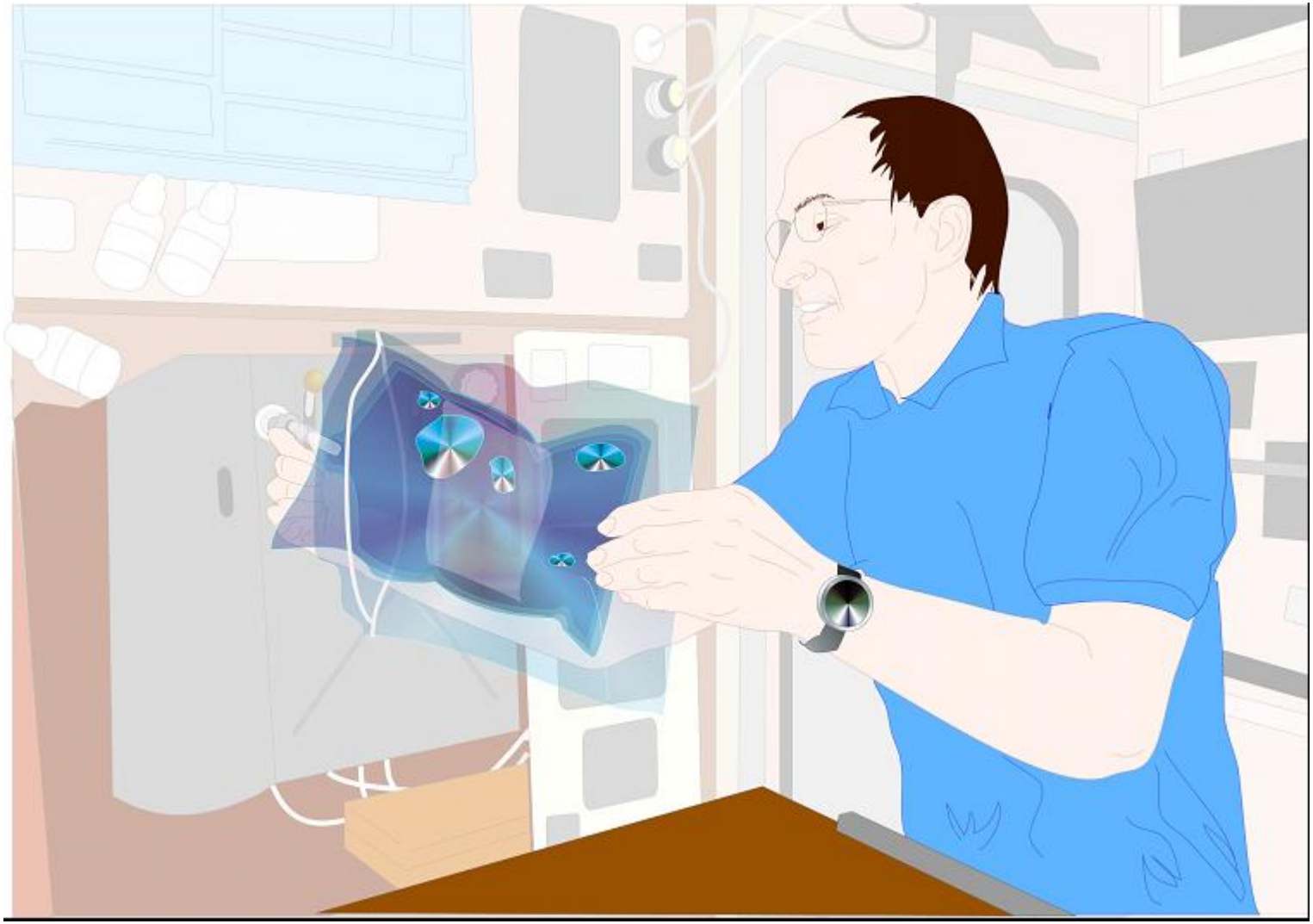
SWAB Deployed Envelope Sketches

The following pages include some experiment high-level deployed envelope sketches for the equipment to get a true relationship of the size of the SWAB EUE in relation to the ISS and surroundings.

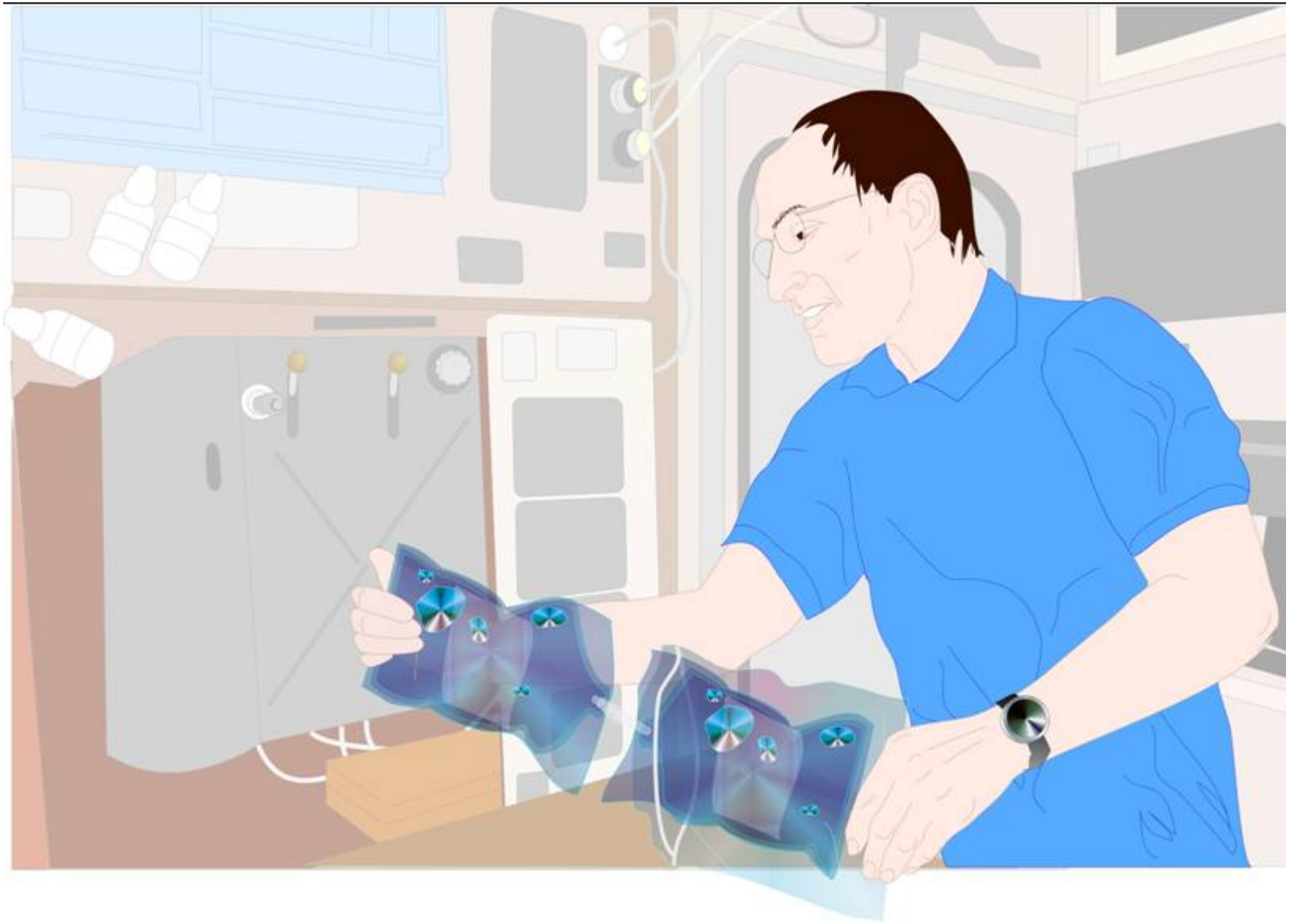
SWAB Air Sampling Device Deployed Envelope Drawing



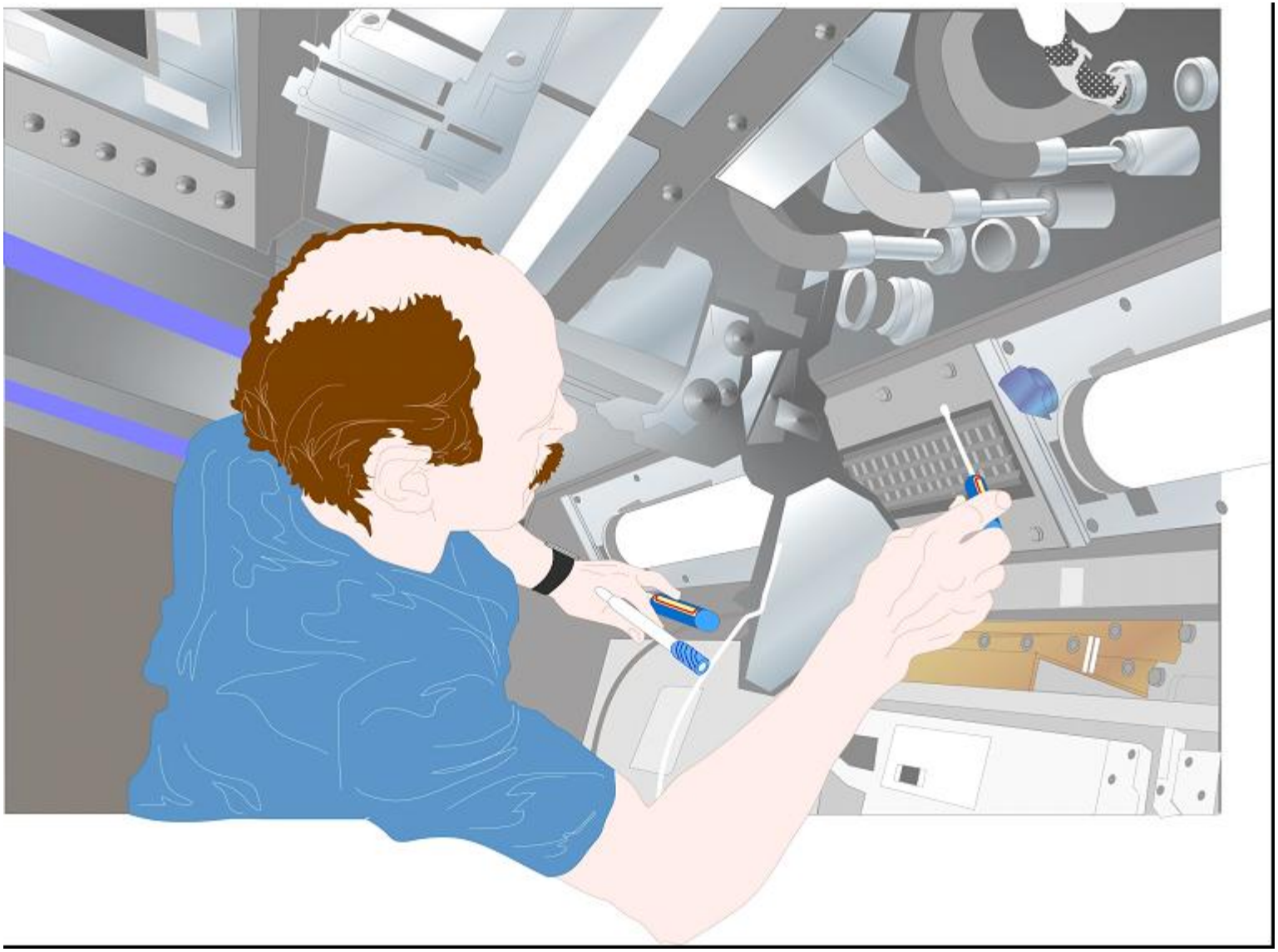
SWAB Temporary Water Bag Deployed Envelope Drawing (During Water Collection)



SWAB Temporary Water Bag and SWAB Final Water Bag Deployed Envelope Drawing (During Water Transfer)



SWAB Tube Deployed Envelope Drawing



SWAB System Engineering

Since the Systems Requirement Review (SRR) and during the development of the SWAB EUE, there have been requirement updates/changes from the baselined SRD LS-20444-1 that must be incorporated/changed for the experiment system. Since the SRR, the inclusion of custom developed water and surface sampling equipment require updates to the document. Enclosed in Appendix G are the original SRD developed for the SWAB Experiment system, FROM/TO changes to the document that are being presented and will be included pending approval at CDR. In addition to the SRD updates, also in Appendix G is the final Verification Plan for the SWAB System which includes all applicable requirements, closure method, closure due date and suggested/proposed closure documentation or test.

IV. Experiment Operations and Development

Operational Overview

Preflight	Crew Time (l g)	In-flight	Crew Time (l g)	Postflight	Crew Time (l g)
ISS Operations: 15-20 days prior to hatch closure: air and surface sampling of the ISS modules and/or MPLM's launched during the experiment lifetime. **Launch Vehicle Operations:** L-15days: potable water samples from all water transport vehicles launched to ISS. L-15days: air and surface sampling of all vehicles launched to ISS.	NA	**ISS Operations:** Air, surface and water samples acquired onboard ISS, preferably 48 hours before docked operations with all launch vehicles.	240 min (~4hrs)*	**NO POSTFLIGHT OPERATIONS**	
Total Crew Time	*NA^*		*240min (~4hrs)*		*NA*

^ No crew time for pre and post flight operations is required because the PI team will conduct all these sessions.
* Note: the total inflight time per increment is dependent upon the number of dockings. Additionally, the time can be reduced if air, water and surface sample sessions are combined because time in/out of kit can be reduced. The above time reflects xxxxxx

Operational Details

PREFLIGHT
Preflight BDC samples are required from all launch vehicles traveling to ISS. Samples from the launch vehicles will include surface, water as applicable, and air at L-15 to 20 days, or as close to hatch closure as possible.

- Surface sampling consists of swabbing 10 locations determined by the PI at the time of sampling.
- Air sampling of 2 locations, forward and aft positions (Middeck and flight deck).
- Water collection from launch vehicle (if applicable).

Samples from all available ISS module(s) or MPLMs will include surface and air between 15-20 days prior to hatch closure.

- Surface sampling consists of swabbing 10 locations determined by the PI at the time of sampling. Predetermined locations include the air inlet surface, air outlet surface and the hatch handle.
- Air sampling of 2 locations, forward and aft positions.

Preflight samples must be maintained within a temperature range of 20-30° C and be shipped to JSC for analysis within 72 hours of collection.

INFLIGHT

Inflight samples should be collected within 48 hours of all launch vehicle docking with ISS.

- Collection of four (4) water samples: SRV-K hot water, SRV-K Warm water, SVO-ZV potable water and any free floating condensate.
- Collection of two (2) surface samples for each available ISS moduleon orbit.
- Sample of 1 m^3 of air for each available ISS module.
- Stow all samples to the SWAB Return Kit for return on next shuttle flight.

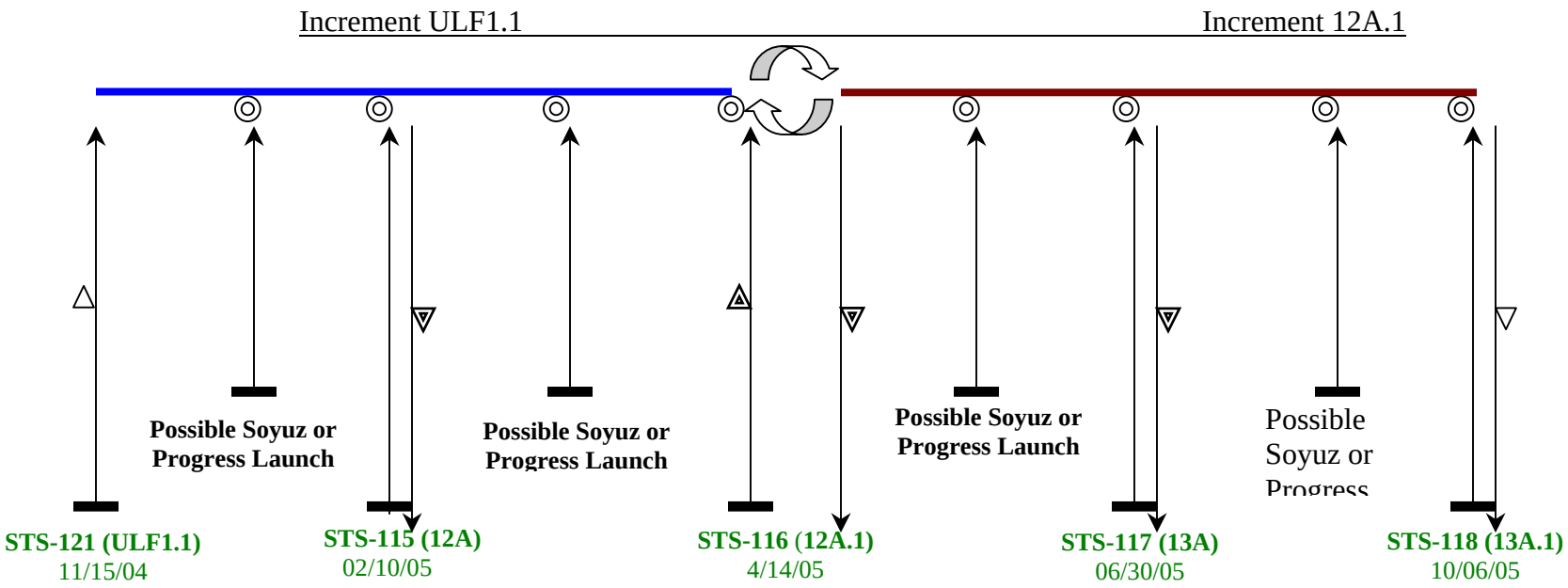
A new SWAB kit containing two additional SWAB Return Kits will be resupplied at the start of the next Increment.

POSTFLIGHT

There are no postflight BDC samples to acquire. All SWAB Kit(s) containing inflight samples must be retrieved from the orbiter within R+6 hours.

Reference the following chart for further definition of the flow of the experiment and the various BDC sessions.

E049/SWAB EXPERIMENT FLOW DIAGRAM



Ground BDC

Vehicle Launch and Landing

SWAB Experiment Kit launch and return

ISS SAMPLING SESSION
(Air Water and Surface)

SWAB Experiment Kit Launch

SWAB Return Kit Return

TABLE 1.1 - DETAILED EXPERIMENT FLOW DESCRIPTION

ACTIVITY	DESCRIPTION
ULF1.1 BDC #1	BDC Session includes: **L-15 days prior to launch vehicle launch** 1. Surface sampling of the STS-121 at 10 locations determined by PI at time of sampling 2. Air Sampling of the STS-121 at 2 (two) locations Aft and Forward portions (Middeck and Flight deck) 3. Water collection from Launch vehicle **15-20 days prior to hatch closure of ISS module** 1. Surface Sampling of any available ISS module (or MPLM) 10 locations determined by PI at time of sampling with 3 being the Air Inlet Surface, Air Outlet Surface and the hatch handle. 2. Air Sampling of all ISS module(s) at 2 (two) locations, Aft and Forward portions
ULF1.1 Launch	SWAB Experiment Kit launches with hardware to supply entire increment. Experiment Kit will contain two SWAB Return Kits that will return collected samples on shuttle flights only.
Soyuz or Progress Launch #1	BDC Session includes: **L-15 Days prior to launch vehicle launch** 1. Surface sampling of the Soyuz/Progress vehicle at 10 locations determined by PI at time of sampling 2. Air Sampling of the Soyuz/Progress vehicle at 2 (two) locations Aft and Forward portions 3. Water collection from Launch vehicle **(if available)** **15-20 days prior to hatch closure of ISS module (if available)** 1. Surface Sampling of any available ISS module (or MPLM) 10 locations determined by PI at time of sampling with 3 being the Air Inlet Surface, Air Outlet Surface and the hatch handle. 1. Air Sampling of the ISS module at 2 (two) locations, Aft and Forward portions
Inflight Sampling Session #1	At **48 hours within docking of launch vehicle,** acquire ISS samples for the first Inflight SWAB Sampling. These include: 1. Collect 4 water samples, 800ml of SRV-K Hot Water into the 1 liter collection bag, 800ml of SRV-K "Cold" water, 800ml of SVO-ZV potable water and any free floating condensate using the contingency syringe 2. Collect 2 surface samples using swab tube from each available ISS module in orbit 3. Sample 1 m^3 of air using the HRF ASD for each available ISS module in orbit 4. Return all samples to the SWAB Return Kit#1
12A BDC #3	BDC Session includes: **L-15 Days prior to launch** 1. Surface sampling of the STS-115 at 10 locations determined by PI at time of sampling 2. Air Sampling of the STS-115 at 2 (two) locations Aft and Forward portions (Middeck and Flight deck) 3. Water collection from Launch vehicle **15-20 days prior to hatch closure of ISS module** 1. Surface Sampling of any available ISS module (or MPLM) 10 locations determined by PI at time of sampling with 3 being the Air Inlet Surface, Air Outlet Surface and the hatch handle. 2. Air Sampling of the ISS module at 2 (two) locations, Aft and Forward portions
Inflight Sampling Session #2	At **48 hours within docking of STS-115 (15A)** acquire ISS samples for the second Inflight SWAB Sampling. These include: 1. Collect 4 water samples, 800ml of SRV-K Hot Water into the 800mlcollection bag, 800ml of SRV-K "Cold" water, 800ml of SVO-ZV potable water and any free floating condensate using the contingency syringe 2. Collect 2 surface samples using swab tube from each available ISS module in orbit 3. Sample 1 m^3 of air using the HRF ASD for each available ISS module in orbit 4. Return all samples to the SWAB Return Kit#1

ACTIVITY	DESCRIPTION
12A Descent	Transfer SWAB Return Kit#1 with first two sampling session samples to the vehicle and return to ground
Soyuz/Progress BDC #4	BDC Session includes: **L-15 Days** 4. Surface sampling of the Soyuz/Progress vehicle at 10 locations determined by PI at time of sampling 5. Air Sampling of the Soyuz/Progress vehicle at 2 (two) locations Aft and Forward portions 6. Water collection from Launch vehicle **(if available)** **15-20 days prior to hatch closure of ISS module (if available)** 2. Surface Sampling of any available ISS module (or MPLM) 10 locations determined by PI at time of sampling with 3 being the Air Inlet Surface, Air Outlet Surface and the hatch handle. 3. Air Sampling of the ISS module at 2 (two) locations, Aft and Forward portions
Inflight Sampling Session #3	At **48 hours within docking of possible Soyuz or Progress** acquire ISS samples for the third Inflight SWAB Sampling. These include: 1. Collect 4 water samples, 800ml of SRV-K Hot Water into the 1 liter collection bag, 800ml of SRV-K "Cold" water, 800ml of SVO-ZV potable water and any free floating condensate using the contingency syringe 2. Collect 2 surface samples using swab tube from each available ISS module in orbit 3. Sample 1 m^3 of air using the HRF ASD for each available ISS module in orbit 4. Return all samples to the SWAB Return Kit#2
12A.1 BDC #5	BDC Session includes: **L-15 Days** 1. Surface sampling of the STS-116 at 10 locations determined by PI at time of sampling 2. Air Sampling of the STS-116 at 2 (two) locations Aft and Forward portions (Middeck and Flight deck) 3. Water collection from Launch vehicle **15-20 days prior to hatch closure of ISS module** 1. Surface Sampling of any available ISS module (or MPLM) 10 locations determined by PI at time of sampling with 3 being the Air Inlet Surface, Air Outlet Surface and the hatch handle. 2. Air Sampling of the ISS module at 2 (two) locations, Aft and Forward portions
Inflight Sampling Session #4	At **48 hours within docking of possible STS-116 (12A.1)** acquire ISS samples for the fourth Inflight SWAB Sampling. These include: 1. Collect 4 water samples, 1 liter of SRV-K Hot Water into the 1 liter collection bag, 1 liter of SRV-K "Cold" water, 1 liter of SVO-ZV potable water and any free floating condensate using the contingency syringe 2. Collect 2 surface samples using swab tube from each available ISS module in orbit 3. Sample 1 m^3 of air using the HRF ASD for each available ISS module in orbit 4. Return all samples to the SWAB Return Kit#2 5. Return the SWAB Experiment Kit
12A.1 Descent	Transfer SWAB Return Kit with second two sampling session samples (Inflight Samples #3 and #4) to the vehicle and return to ground
12A.1Ascent	Send Another SWAB Experiment Kit with two Return Kits to resupply the SWAB Equipment for all of Inc 12 collections
Soyuz/Progress BDC #6	BDC Session includes: **L-15 Days** 1. Surface sampling of the Soyuz/Progress vehicle at 10 locations determined by PI at time of sampling 2. Air Sampling of the Soyuz/Progress vehicle at 2 (two) locations Aft and Forward portions 3. Water collection from Launch vehicle **(if available)** **15-20 days prior to hatch closure of ISS module (if available)** 1. Surface Sampling of any available ISS module (or MPLM) 10 locations determined by PI at time of sampling with 3 being the Air Inlet Surface, Air Outlet Surface and the hatch handle.

ACTIVITY	DESCRIPTION
	2. Air Sampling of the ISS module at 2 (two) locations, Aft and Forward portions
Inflight Sampling Session #1	At **48 hours within docking of possible Soyuz or Progress** acquire ISS samples for the fifth **(First for Inc 12A.1)** Inflight SWAB Sampling. These include: 1. Collect 4 water samples, 1 liter of SRV-K Hot Water into the 1 liter collection bag, 1 liter of SRV-K "Cold" water, 1 liter of SVO-ZV potable water and any free floating condensate using the contingency syringe 2. Collect 2 surface samples using swab tube from each available ISS module in orbit 3. Sample 1 m^3 of air using the HRF ASD for each available ISS module in orbit 4. Return all samples to the SWAB Return Kit#1
13A BDC #7	BDC Session includes: **L-15 Days** 4. Surface sampling of the STS-117 at 10 locations determined by PI at time of sampling 5. Air Sampling of the STS-117 at 2 (two) locations Aft and Forward portions (Middeck and Flight deck) 6. Water collection from Launch vehicle **15-20 days prior to hatch closure of ISS module** 3. Surface Sampling of any available ISS module (or MPLM) 10 locations determined by PI at time of sampling with 3 being the Air Inlet Surface, Air Outlet Surface and the hatch handle. 4. Air Sampling of the ISS module at 2 (two) locations, Aft and Forward portions
Inflight Sampling Session #2	At **48 hours within docking of possible STS-115 (13A)** acquire ISS samples for the sixth **(second for Inc 12A.1)** Inflight SWAB Sampling. These include: 1. Collect 4 water samples, 1 liter of SRV-K Hot Water into the 1 liter collection bag, 1 liter of SRV-K "Cold" water, 1 liter of SVO-ZV potable water and any free floating condensate using the contingency syringe 2. Collect 2 surface samples using swab tube from each available ISS module in orbit 3. Sample 1 m^3 of air using the HRF ASD for each available ISS module in orbit 4. Return all samples to the SWAB Return Kit#1
13A Descent	Transfer SWAB Return Kit#1 with first two sampling session samples to the vehicle and return to ground
Soyuz/Progress BDC#8	BDC Session includes: **L-15 Days** 1. Surface sampling of the Soyuz/Progress vehicle at 10 locations determined by PI at time of sampling 2. Air Sampling of the Soyuz/Progress vehicle at 2 (two) locations Aft and Forward portions 3. Water collection from Launch vehicle **(if available)** **15-20 days prior to hatch closure of ISS module (if available)** 1. Surface Sampling of any available ISS module (or MPLM) 10 locations determined by PI at time of sampling with 3 being the Air Inlet Surface, Air Outlet Surface and the hatch handle. 2. Air Sampling of the ISS module at 2 (two) locations, Aft and Forward portions
Inflight Sampling Session #3	At **48 hours within docking of possible Soyuz or Progress** acquire ISS samples for the seventh **(third for Inc 12A.1)** Inflight SWAB Sampling. These include: 1. Collect 4 water samples, 800ml of SRV-K Hot Water into the 1 liter collection bag, 800ml of SRV-K "Cold" water, 800ml of SVO-ZV potable water and any free floating condensate using the contingency syringe 2. Collect 2 surface samples using swab tube from each available ISS module in orbit 3. Sample 1 m^3 of air using the HRF ASD for each available ISS module in orbit 4. Return all samples to the SWAB Return Kit#2
13A.1 BDC #9	BDC Session includes: **L-15 Days** 1. Surface sampling of the STS-118 at 10 locations determined by PI at time of sampling 2. Air Sampling of the STS-118 at 2 (two) locations Aft and Forward portions (Middeck and Flight deck)

ACTIVITY	DESCRIPTION
	3. Water collection from Launch vehicle **15-20 days prior to hatch closure of ISS module** 1. Surface Sampling of any available ISS module (or MPLM) 10 locations determined by PI at time of sampling with 3 being the Air Inlet Surface, Air Outlet Surface and the hatch handle. 2. Air Sampling of the ISS module at 2 (two) locations, Aft and Forward portions
Inflight Sampling Session #4	At **48 hours within docking of possible STS-118 (13A.1)** acquire ISS samples for the eighth **(fourth for Inc 12A.1)** Inflight SWAB Sampling. These include: 1. Collect 4 water samples, 1 liter of SRV-K Hot Water into the 800ml collection bag, 800ml of SRV-K "Cold" water, 800ml of SVO-ZV potable water and any free floating condensate using the contingency syringe 2. Collect 2 surface samples using swab tube from each available ISS module in orbit 3. Sample 1 m^3 of air using the HRF ASD for each available ISS module in orbit 4. Return all samples to the SWAB Return Kit #2
13A.1 Descent	Transfer SWAB Return Kit with second two sampling session samples (Inflight Samples #3 and #4) to the vehicle and return to ground. Transfer the Experiment Kit back to ground as well.

INCREMENT ULF1.1

INCREMENT 12A.1

Training and BDC Development
The SWAB experiment will require formal crew training. The crew must be trained following the CheCS Operational Environmental sampling training session. The requested training is at L-4 months for a single session of 1.5 hours per crewmember which will include introduction to the SWAB Experiment Kit, sub-kits, water, surface and air collection, return kit and malfunction or contingency operations will be trained during this session.

Baseline Data Collection sessions are dependent on launch vehicle and ISS module delivery/development scheduling. If opportunities exist, the experiment team will share collection opportunities with the Environmental Operations team(s) in acquiring samples. Refer to the following table for an overview of the operational/training times.

Activity Description	Crewtime
Training[1]	3hrs
Pre/Postflight[2]	None
Inflight Operations	4hr/4modules/docking

1 Assumes two crewmembers trained: one prime and one backup.
2 All BDC performed by trained ground personnel.
3 Each sampling protocol can be scheduled separately. Total time required is not continuous

V. Experiment schedule

Major Milestones E049 SWAB – BASELINED

MILESTONE	PROJECTED COMPLETION DATE
SWAB EUE CDR	January 29th 2004
ASD and ASD Battery Pack Fabrication Completed	March 2004
SWAB Experiment Kit Training/Prototype Unit Completed	April 2004
SWAB Experiment CDR	April 2004
EB Internal TRR for all Testing	April 2004
Acceptance Testing **Begins** for ASD and ASD Battery	April 2004
Acceptance Testing **Completed** for ASD and ASD Battery	June 2004
SWAB Tube Assembly Completed	June 2004
SWAB Water Bag Assembly Completed	July 2004
Acceptance Testing Completed for Water and Surface Equipment	July 2004
Phase III Safety	August 2004

SVT	August 2004
H/W Certified For Flight	August 2004
H/W Delivery	September 2004

APPENDIX A

DETAILED SWAB DEVELOPMENT SCHEDULE

BASELINED (12/18/03)

APPENDIX B

ENGINEERING DRAWINGS
&
ASD SYSTEM MENU LAYOUT

APPENDIX C

SWAB EXPERIMENT KIT LAYOUT DIAGRAM

APPENDIX D

SWAB SAFETY DATA PACKAGE INFORMATION

APPENDIX E

SWAB SUPPORTING ANALYSIS REPORTS

APPENDIX F

SWAB EUE DESIGN and DEVELOPMENTAL TESTING

APPENDIX G

SWAB SRD
SWAB SRD Updates (From / To)
SWAB Verification Plan