



SPIRE & PACS
Sorption Coolers
AIV Plan

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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

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Document Status

Issue	Revision	Date	Nb of pages	Modifications
0	0	26/04/2001	-	First draft
0	1	13/09/2001		Baking and V test tasks switched. Verification matrix improved
0	2	17/09/2001		HS070 and HS080 switched. CO220 modified
0	3	18/10/2001		Laser marking task added (MA020) Assembling tasks reviewed
1	0	29/10/2001		Gold plating task performed on parts before assembly : new task MA030 added. Gold plating tasks for cooler heart and switch suppressed. Tasks re-numbered



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List of Acronyms

AD	Applicable Document		
CEA	Commissariat à l' Energie Atomique		
CDR	Critical Design Review	Revue de conception détaillée	RCD
CQM	Cryogenic Qualification Model		
EV	Evaporator		
FI	Inspection Sheet	Fiche d'Inspection	
FIRST	Far Infrared and Submillimetre Telescope		
FS	Flight spare		
HSE	Heat Switch (on evaporator)		
HSP	Heat Switch (on sorption pump)		
N/A	Not Applicable		
PACS	Photoconductor. Array Camera and Spectrometer		
PFM	ProtoFlight Model		
RD	Reference Document		
SAP	Service d'Astrophysique		
SBT	Service des Basses Températures		
SCO	Sorption Cooler (full unit)		
SP	Sorption pump		
SPIRE	Spectral & Photometric Imaging Receiver		
SST	Support Structure		
TS	Thermal Shunt		
TSES	Thermal Strap to Evaporator Switch		
TSPS	Thermal Strap to Pump Switch		



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1 Scope of the document

This document defines the sequence of tasks and tests which shall lead to the qualification of the sorption cooler. It comprises the Assembly, Integration and Verification phases. this document should be read in accordance with the MAIV Flow Chart (ref. HSO-SBT-FC-003). Unless otherwise specified it applies to the CQM, PFM and FS cooler.



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2 Documents

2.1 Applicable documents

All Applicable Documents are listed in the AD chapter of the CIDL (HSO-SBT-LI-010).



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3 Verification matrix

The STM, CQM, PFM and FS coolers are designed based on our mechanical and low temperature know how and manufactured and assembled by qualified and skilled subcontractors and CEA-SBT.

All precautions are taken to guarantee successful devices and the coolers are controlled at various step during their fabrication. The manufacturing, assembling, integration and verification flow chart is described in the document “MAIV Flow Chart” ref. HSO-SBT-FC-003.

The table hereafter is a verification matrix in which for each relevant specification or requirement is indicated whether it is verified by analysis, design, test and/or inspection. The column “§ Spec.” refers to the related paragraph in the document “SPIRE & PACS Sorption Cooler Specifications”, ref. HSO-SBT-SP-001.

These verifications apply to all models (to the exception of the STM).



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§ Spec	Heading	Verification method			
		Analysis	Design	Test	Inspection
4.1	Functional requirements				
4.1 a)	Thermal architecture (4K / 1.8 K)		X		
4.1 b)	Performance versus orientation		X	X	
4.1 c)	Design "plug in" type		X		
4.1.1 a)	10 μ W net heat lift @ 290 mK		X	X	
4.1.1 b)	12 μ W maximum parasitic load		X	X	
4.1.1 c)	Hold time \geq 22 h – 46 h favoured		X	X	
4.1.1 d)	Recycling time \leq 2 h		X	X	
4.1.1 e)	Energy per cycle \leq 860 J		X	X	
4.2	Operational requirements				
4.2.1	Safety : Leak Before Burst	X	X		
4.2.2	Lifetime	X	X		
4.2.3	Operating modes		X	X	
4.2.4	Commands : thermometers & heaters		X		
4.2.5	Monitoring : thermometers accuracy		X		
4.3	Environmental requirements				
4.3.1 a)	Ground & launch thermal environment		X	X	
4.3.1 b)	Storage & handling		X		
4.3.1 c)	Humidity		X		
4.3.1 d)	Test or orbit (idem 4.1 a)		X		
4.3.2.1	Limit loads and launch levels	X	X	X	X
4.3.2.2	Orbit		X	X	
4.3.2.3	Ground		X	X	
4.3.3	Electrical environment		X		
4.3.4	Radiation environment		X		
4.4	Design & construction requirements				
4.4.1	Interchangeability		X		
4.4.2	Control electronics	Under responsibility of SAp			
4.4.3.1	Maximum operating pressure		X		
4.4.3.2	Proof pressure and Burst pressure	X	X	X	
4.4.4	Mass		X		
4.4.5	Size		X		
4.4.6	Mechanical stiffness requirement	X	X	X	
4.4.7.1	Design margin – Structural	X	X	X	
4.4.8.1	Parts, Material and processes	X	X		X
4.4.8.2	Magnetic materials		X		
4.4.8.3	Fungus Nutrient Materials		X		
4.4.8.4	Flammable, toxic & unstable materials		X		
4.4.8.5	Cleanliness			X	X
4.4.8.6	Finish		X		
4.4.8.7	Outgassing			X	
4.4.8.8	Susceptibility to stress corrosion		X		
4.4.8.9	Limited lifetime materials		X		
4.5	Interface requirements				
4.5.1	Thermal interface to detector		X		
4.5.2	Mechanical interface to the heat sink		X		
4.5.3	Thermal interface to the heat sink		X		
4.5.4	Electrical interface		X	X	
4.6	Logistic requirements		X		X



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4 Tests sequence

This section describes the tests sequence to be performed on the sorption cooler which contributes, together with analysis and other verification methods, to qualification. This test program covers the functional, performance and environmental tests required to provide confidence in the ability of the cooler to meet the specified requirements. Tasks related to the manufacturing and cooler assembly are also included in this program. Performance measurements will be made before and after the environmental tests, designed to detect changes in performance parameters which may indicate a potential failure.

4.1 Organization and Methods

The test team will schedule and prepare all test procedures, will identify all necessary tests equipment and tools, and finally will performed the tests program. The test team includes engineers and technicians with the necessary experience. They will be supported by specialists when appropriate. The test team also includes members of the quality department who will carry out the PA tasks as described in the PA plan. The project manager is responsible for the implementation of the complete qualification program.

Most tests are conducted in accordance with procedures approved by the project manager, under the Product Assurance control. The tests will be performed following the tasks description identified hereafter. Prior to the start of any major test activities and after the completion of a test a formal technical review will be held. This review will determine if the tests requirements have been met.

The outcome of each test performed will be documented in a test report for all major test, and in an inspection sheet (FI : fiche d'inspection) for other test. In addition a test referenced as the "Health Check Report" has been set up. This test allows to verify nominal operation of the cooler from a mechanical, leaktightness and thermal point of view. A specific data sheet referenced as "Health Check Report" has been established, in which the experimental results will be reported (see appendix & 5.1). This health check will be performed whenever necessary to check for the integrity of the cooler.

In the event a decision is made to reject the test, the re-test and trouble-shooting requirements will be defined.

During transportation phases, dedicated container (one per model) are used following :

- before assembly : each set of cooler parts are carried in a transportation suitcase
- after assembly : each cooler (excluding STM) are handled in a transport container which includes a clean inner container maintained under a dry nitrogen environment

During all test activities a daily laboratory log book (LLB) will be kept in the working area. This will be a "live" document containing an outline of the day's activities carried out, with cross reference to any problems arising during those activities.

Finally the history of the cooler after assembly will be recorded in a Log Book which will be part of the Acceptance Data Package (ADP).



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4.2 Test program

This plan defines the methods and sequence by which all verification by test activities are intended to be performed. The test activities required to complete the test program are compiled into major test phases in a logical sequence. The following list of test includes for each test the following :

- Task name and number
- Objectives
- Required documentation
- Cooler and test configuration
- Facility and Ground support equipment
- Task description
- Acceptance criteria and comments
- Output document

Tasks are numbered 010, 020, 030 ... to enable future revisions to incorporate additional supporting tasks in sequence. The tasks have been arranged and named as described in the MAIV flow chart (ref. HSO-SBT-FC-003), in the following way :

<i>Task reference</i>	<i>Related to</i>
MA nnn	Manufacturing phase
CO nnn	Cooler heart and later cooler fully assembled
ST nnn	Structure
HS nnn	Heat Switch

The task numbered CO 230 corresponds to a test referenced as the “Health Check”. This test allows to verify nominal operation of the cooler from a mechanical, leaktightness and thermal point of view. A specific data sheet referenced as “Health Check Report” has been established, in which the experimental results will be reported (see appendix § 5.1). This health check will be performed whenever necessary to check for the integrity of the cooler.

A set of procedures has been produced and can be reviewed at CEA-SBT premises. Most of these procedures are intended to be used by the test team and by French companies, and thus are written in French.

Unless otherwise stated the tests are carried out at CEA-SBT.

The table hereafter summarizes the sequence of tasks.



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	Manufacturing	Cooler heart	Structure	Heat Switch
010	Critical Parts Verification + fit check	Pump and Evaporator Pre Assembly	Assembly of Main Structure	Pre Assembly – Switch base
020	Laser marking of specific parts	Welding inspection and Leaktightness tests	Final Machining of Main Structure	Assembly – Switch
030	Gold plating	Soldering of Thermal Shunt and Fill Tube		Leak Tightness Test
040		Assembly of Pump and Evaporator Half Sphere	Charcoal Mounting	
050	Baking and Mounting of Procelit		Closing of Minipump	
060	Assembly of Evaporator Copper Half Sphere		Leak Tightness Test	
070	Charcoal Gluing onto Copper Casing (pump)		Baking and cleaning of switch	
080	Gluing of Grid and Cover		He3 Filling	
090	Closing of Cooler		Crimping of Heat Switch	
100	Leaktightness and Proof Pressure Test at 20 MPa		Leak Tightness Test	
110	Baking and cleaning of Cooler		Gluing of Cover onto Crimped tube	
120	Gluing of Thermal Parts		Leak Tightness Test	
130	Mounting of Mechanical Items		Gluing of Thermometers and Heaters	
140	Mounting of Cooler into Main Structure		Cabling of Thermal Parts	
150	Verification of Kevlar Cables Tension		Characterization of Heat Switch	
160	Integration of Heat Switches			
170	Cabling, Soldering of Connectors & Thermal Parts			
180	Mounting and Adjustment of Snubbers			
190	Welding of Braided Copper onto Copper Ends			
200	Integration of Thermal Straps			
210	Performance Test (Cooler Empty)			
220	He3 Filling of Cooler (Cold Phase)			
230	Thermal Test #1 (reference – Health Check (HCR))			
240	Crimping of Cooler			
250	Leak Tightness Test			
260	Gluing of Cover onto Crimped Tube			
270	Mounting of Lateral Plates, Tubing and Covers			
280	Leak Tightness Test			
290	Vibration Test			
300	Thermal Test #2 (HCR)			
310	Baking			
320	Thermal Test #3 (HCR)			
330	Performance Test			
340	Cleaning			
350	Packing			
360	Delivery			



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4.2.1 Manufacturing

TASK NUMBER : MA 010
<i>TASK NAME</i>
Critical Parts Verification and fit check
<i>OBJECTIVES</i>
Verify the critical parts (in particular the thin wall titanium tubes) – Establish the mass budget for each part. Perform a fit check. Take photographic record of one full set
<i>REQUIRED DOCUMENTATION</i>
All detailed drawings related to reference 2000-14 B 000, 100, 200, 300, 400, 530, 540 Certificate of conformity from subcontractor
<i>COOLER AND TEST CONFIGURATION</i>
N/A
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room, ambient conditions Metrology devices – weighing machine
<i>TASK DESCRIPTION</i>
<ul style="list-style-type: none"> - Particularly check all parts subjected to pressure. In particular check for any geometrical and visual defects parts reference 2000-14 B203, B205 and B211 - Check the surface quality on all pulleys and capstan (ref. B109, B114, B129) - Weight each piece - Perform a fit check - Take photographic record of one full set
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
All dimensions shall be within tolerances – No defects can be accepted on critical parts, i.e. submitted to internal pressure. No defects on surface quality can be accepted for pulleys and capstans
<i>OUTPUT DOCUMENTS</i>
Report in LLB – For all thin wall tubes, report in Inspection Sheet (FI) Photographic records



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TASK NUMBER : MA 020
<i>TASK NAME</i>
Laser marking of specific parts
<i>OBJECTIVES</i>
Laser mark all major components for identification purpose
<i>REQUIRED DOCUMENTATION</i>
HSO-SBT-SP-039 (Identification des pièces et sous ensembles)
<i>COOLER AND TEST CONFIGURATION</i>
N/A
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Operation subcontracted - Under subcontractor responsibility
<i>TASK DESCRIPTION</i>
All demountable cooler components and toolings are marked using a Nd-Yag laser – Cooler components include : cooler heart, heat switches, structure, lateral covers, evaporator cover, pump cover, pump strap, evaporator strap. Applies to STM cooler too.
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Work performed in accordance with subcontractor quality program
<i>OUTPUT DOCUMENTS</i>
N/A



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TASK NUMBER : MA 030
<i>TASK NAME</i>
Gold Plating
<i>OBJECTIVES</i>
Gold plating of all external copper surfaces
<i>REQUIRED DOCUMENTATION</i>
HSO-SBT-SP-044 (Définition des pièces à dorer)
<i>COOLER AND TEST CONFIGURATION</i>
N/A
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Operation subcontracted – Under subcontractor responsibility
<i>TASK DESCRIPTION</i>
Gold plate all external copper surfaces (nota : to the exception of the surfaces indicated in HSO-SBT-SP-044) : <ul style="list-style-type: none">- pump and evaporator cold tip- thermal shunt- thermal straps (evaporator, pump and shunt)- heat switches head and base
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Work performed in accordance with subcontractor quality program
<i>OUTPUT DOCUMENTS</i>
Certificate of conformity



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4.2.2 Cooler “heart” / Cooler fully assembled

TASK NUMBER : CO 010
<i>TASK NAME</i>
Pump and Evaporator Pre-assembly
<i>OBJECTIVES</i>
Electron beam welding of thin wall titanium tubes with evaporator and pump half titanium sphere
<i>REQUIRED DOCUMENTATION</i>
Related drawings HSO-SBT-SP-014 (Spécifications qualité appliquées à la fabrication) HSO-SBT-FC-023 (Organigramme des soudures)
<i>COOLER AND TEST CONFIGURATION</i>
N/A
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Dedicated tool provided by SBT Operation subcontracted - Under subcontractor responsibility
<i>TASK DESCRIPTION</i>
See HSO-SBT-FC-023 – Use tool ref 2000-14 T470, 2000-14 T480, 2000-14 T460 1. Perform a first EB weld on test samples to define parameters and verify the weld quality 2. EB weld part ref B209 with part ref B211, and the resulting piece with part ref B207 3. EB weld part ref B205 with part ref B202
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Work performed in accordance with subcontractor quality program
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TASK NUMBER : CO 020
<i>TASK NAME</i>
Welding Inspection and Leaktightness Tests
<i>OBJECTIVES</i>
Verify the quality and leaktightness of the welds
<i>REQUIRED DOCUMENTATION</i>
N/A
<i>COOLER AND TEST CONFIGURATION</i>
N/A
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room - Ambient conditions Helium leak detector (mass spectrometer)
<i>TASK DESCRIPTION</i>
Use appropriate rubber plugs and connection to leak detector to check for the leaktightness of the welded joint under vacuum.
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Leakrates level must not exceed 10^{-9} mB.Ls ⁻¹
<i>OUTPUT DOCUMENTS</i>
Report in LLB – report outcome in Inspection Sheet (FI)



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TASK NUMBER : CO 030
<i>TASK NAME</i>
Soldering of Thermal Shunt and Fill Tube
<i>OBJECTIVES</i>
Assemble (brazing) the thermal shunt and fill tube with the pumping line
<i>REQUIRED DOCUMENTATION</i>
Related drawings HSO-SBT-SP-014 (Spécifications qualité appliquées à la fabrication) HSO-SBT-FC-023 (Organigramme des soudures)
<i>COOLER AND TEST CONFIGURATION</i>
N/A
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Dedicated tool provided by SBT Operation subcontracted – Under subcontractor responsibility
<i>TASK DESCRIPTION</i>
See HSO-SBT-FC-023– Use tool ref 2000-14 T350, 2000-14 T300 Brazing of thermal shunt (part ref. B210), copper fill tube and copper tubes with partly assembled pumping line (tube - evaporator half sphere and tube - pump half sphere). Note : the copper fill tube must be at least 150 mm long
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Work performed in accordance with subcontractor quality program
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TASK NUMBER : CO 040
<i>TASK NAME</i>
Assembly of Pump and Evaporator Half Sphere
<i>OBJECTIVES</i>
Brazing of copper end parts to pump and evaporator half titanium sphere + internal copper structures to copper end parts (pump and evap).
<i>REQUIRED DOCUMENTATION</i>
Related drawings HSO-SBT-SP-014 (Spécifications qualité appliquées à la fabrication) HSO-SBT-FC-023 (Organigramme des soudures)
<i>COOLER AND TEST CONFIGURATION</i>
N/A
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Operation subcontracted – Under subcontractor responsibility
<i>TASK DESCRIPTION</i>
See HSO-SBT-FC-023 1. Brazing of evaporator 1/2 sphere (ref. B201) with evaporator cold tip (ref. B219) 2. Brazing of evaporator cup (ref. B203) with evaporator cold tip (ref. B219) 3. Brazing of pump 1/2 sphere (ref. B208) with pump cold tip (ref. B220) 4. Brazing of charcoal casing (ref. B212) with pump cold tip (ref. B220)
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
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TASK NUMBER : CO 050
<i>TASK NAME</i>
Baking and Mounting of Procelit
<i>OBJECTIVES</i>
Insert the porous material (Procelit) use for liquid confinement into evaporator
<i>REQUIRED DOCUMENTATION</i>
N/A
<i>COOLER AND TEST CONFIGURATION</i>
Cooler partly assembled
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Baking chamber equipped with primary vacuum pump
<i>TASK DESCRIPTION</i>
<ol style="list-style-type: none">1. Weights Part ref. B206 (Procelit) prior to baking2. Baked out Part B206 at 100°C under vacuum (primary) for 12 hours minimum (overnight)3. Weights Part B206 after baking4. Insert Part B206 into evaporator cup (Part ref. B203)
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
No damages acceptable to Part B206
<i>OUTPUT DOCUMENTS</i>
Report in the LLB



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TASK NUMBER : CO 060
<i>TASK NAME</i>
Assembly of Evaporator Copper Half Sphere
<i>OBJECTIVES</i>
Close the internal evaporator copper sphere containing the Procelit piece
<i>REQUIRED DOCUMENTATION</i>
Related drawings HSO-SBT-SP-014 (Spécifications qualité appliquées à la fabrication) HSO-SBT-FC-023 (Organigramme des soudures)
<i>COOLER AND TEST CONFIGURATION</i>
Cooler partly assembled
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Operation subcontracted – Under subcontractor responsibility
<i>TASK DESCRIPTION</i>
See HSO-SBT-FC-023 TIG Part ref B203 with Part ref B204 (closing of Procelit copper casing)
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
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TASK NUMBER : CO 070

TASK NAME

Charcoal Gluing onto Copper Casing (pump)

OBJECTIVES

Assembling of sorption pump

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-024 (Mise en place du charbon actif)

COOLER AND TEST CONFIGURATION

Cooler partly assembled

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room. Ambient conditions. Weighing machine. Baking chamber equipped with primary pump

TASK DESCRIPTION

Follow procedure HSO-SBT-PR-024. Summary :

1. Perform a visual selection of charcoal pellets
2. Bake out at 140°C under vacuum (primary) the charcoal pellets for 24 hours
3. Weights and prepare the appropriate amount
4. Glue the pellets onto the charcoal casing (B212) using Stycast 2850 FT

ACCEPTANCE CRITERIA AND COMMENTS

Total amount of charcoal must be glued (few pellets left is acceptable). Charcoal pellets must not fall when slightly shaking the sorption pump.

OUTPUT DOCUMENTS

Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : CO 080
<i>TASK NAME</i>
Gluing of Grid and Cover
<i>OBJECTIVES</i>
Install the filter mesh at the input of the pumping line on the sorption pump side
<i>REQUIRED DOCUMENTATION</i>
N/A
<i>COOLER AND TEST CONFIGURATION</i>
Cooler partly assembled
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
N/A
<i>TASK DESCRIPTION</i>
<ul style="list-style-type: none">- Install mesh ref. B218 against part ref B209- Insert the cover (ref. B217) and glue the cover on part B209/B211 using Stycast 2850 FT.
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
No Stycast acceptable on the mesh.
<i>OUTPUT DOCUMENTS</i>
Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : CO 090

TASK NAME

Closing of Cooler

OBJECTIVES

EB weld the titanium half spheres together (evaporator and pump). Cooler heart is fully assembled.

REQUIRED DOCUMENTATION

Related drawings
HSO-SBT-SP-014 (Spécifications qualité appliquées à la fabrication)
HSO-SBT-FC-023 (Organigramme des soudures)

COOLER AND TEST CONFIGURATION

Cooler partly assembled

FACILITY AND GROUND SUPPORT EQUIPMENT

Dedicated tool provided by SBT
Operation subcontracted – Under subcontractor responsibility

TASK DESCRIPTION

See HSO-SBT-FC-023 - Use tool ref 2000-14 T450
Perform a first EB weld on test samples to define parameters and verify the weld quality
1. EB weld part ref B201 with part ref B202, and part ref B207 with part ref B208

ACCEPTANCE CRITERIA AND COMMENTS

Work performed in accordance with subcontractor quality program

OUTPUT DOCUMENTS

Certificate of conformity



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : CO 100

TASK NAME

Leaktightness and Proof Pressure Test at 20 MPa.

OBJECTIVES

Internal pressure test of the cooler to 20 MPa to address the proof and burst pressure requirements. Test is carried out with ⁴He gas.

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-025 (Test en pression)

COOLER AND TEST CONFIGURATION

Cooler heart almost fully assembled - Cooler inserted into test box (vacuum jacket) and connected via its fill tube to a high pressure helium bottle

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room, ambient conditions

High pressure helium bottle with pressure regulator, pressure transducer, test box (vacuum jacket), leak detector and possibly primary vacuum pump.

TASK DESCRIPTION

Follow procedure HSO-SBT-PR-025 - Summary

1. Insert cooler heart inside test box, with pressure line connected to the fill tube (soft solder)
2. Connect the test box to the leak detector
3. increase the internal pressure inside the cooler to 20 MPa over the course of typically one minute, and once the pressure reaches 20 MPa, remains at this value for 2 minutes. Then release the pressure.

ACCEPTANCE CRITERIA AND COMMENTS

Leakrates level must not exceed 10^{-9} l.mB.s⁻¹.

After the test, the cooler must be pumped down in secondary vacuum for 2 hours minimum, and then left in appropriate environment (see task CO 110 : plastic bag under helium gas, fill tube plugged with rubber plug).

OUTPUT DOCUMENTS

Report in LLB – Report outcome in Inspection Sheet (FI)



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : CO 110

TASK NAME

Baking and cleaning of Cooler

OBJECTIVES

Remove any trace of pollution from activated charcoal (baking) - Cleaning of cooler external to be under cleanliness and contamination control

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-0026 (Nettoyage)

COOLER AND TEST CONFIGURATION

Cooler heart almost fully assembled (closed, to the exception of the fill tube)

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room. Ambient conditions. Baking chamber equipped with primary pump

TASK DESCRIPTION

Bake out at 80°C under vacuum (primary) for 12 hours minimum the cooler heart
Clean out the cooler heart following cleaning procedure

ACCEPTANCE CRITERIA AND COMMENTS

Once baked and cleaned, the cooler must be kept in appropriate environment (plastic bag under helium gas is acceptable) and the fill tube must be plugged with a rubber plug.

OUTPUT DOCUMENTS

Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : CO 120
<i>TASK NAME</i>
Gluing of Thermal Parts
<i>OBJECTIVES</i>
Instrument the cooler heart with heaters and thermometers
<i>REQUIRED DOCUMENTATION</i>
Procedure HSO-SBT-PR-033 (Collage et thermalisation des composants)
<i>COOLER AND TEST CONFIGURATION</i>
Cooler heart almost fully assembled
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room – Ambient conditions
<i>TASK DESCRIPTION</i>
Glue all required heaters and thermometers on the evaporator, sorption pump and thermal shunt, using Stycast 2850 FT (see procedure HSO-SBT-PR-033)
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Visual check
<i>OUTPUT DOCUMENTS</i>
Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : CO 130
<i>TASK NAME</i>
Mounting of Mechanical Items
<i>OBJECTIVES</i>
Install all pulleys and axis on the evaporator and sorption pump
<i>REQUIRED DOCUMENTATION</i>
Detailed drawings 2000-14 B 000 and associated drawings
<i>COOLER AND TEST CONFIGURATION</i>
Cooler heart almost fully assembled
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room – Ambient conditions
<i>TASK DESCRIPTION</i>
Task name and objectives are self descriptive. All torques must be verified.
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
No damage on pulleys and capstans surfaces acceptable
<i>OUTPUT DOCUMENTS</i>
Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : CO 140
<i>TASK NAME</i>
Mounting of Cooler into Main Structure
<i>OBJECTIVES</i>
To insert cooler heart into the structural box and to install all Kevlar cords
<i>REQUIRED DOCUMENTATION</i>
Procedure HSO-SBT-PR-028 (Installation et réglages des suspentes Kevlar)
<i>COOLER AND TEST CONFIGURATION</i>
Cooler heart fully assembled and structural box
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room – Ambient conditions
<i>TASK DESCRIPTION</i>
Follow procedure HSO-SBT-PR-028 - Summary 1. Insert cooler heart inside structural box 2. Screw in the centering screws (B134, B135) to secure the cooler heart 3. Install all Kevlar cords 4. Release cooler heart (unscrew B134 and B135)
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
See procedure – Visual check, cooler heart centered, etc..
<i>OUTPUT DOCUMENTS</i>
Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : CO 150
<i>TASK NAME</i>
Verification of Kevlar Cables Tension
<i>OBJECTIVES</i>
Verify the tension at different location in each of the four Kevlar cords is set to nominal
<i>REQUIRED DOCUMENTATION</i>
Procedure HSO-SBT-PR-028 (Installation et réglages des suspentes Kevlar)
<i>COOLER AND TEST CONFIGURATION</i>
Cooler heart mounted inside structural box
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room – Ambient conditions Tensiometer
<i>TASK DESCRIPTION</i>
Follow procedure HSO-SBT-PR-028 – For each side on sorption pump and evaporator, check the tension : 1. in between the tensioning capstan (ratchet) and first pulley 2. in between the last pulley and end capstan 3. in between two pulleys opposite to capstans.
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Tension must be equals in each cord to within 10% and must be within 10 % to the nominal value (TBD)
<i>OUTPUT DOCUMENTS</i>
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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : CO 160
<i>TASK NAME</i>
Integration of Heat Switches
<i>OBJECTIVES</i>
Integrate the two heat switches inside the cooler
<i>REQUIRED DOCUMENTATION</i>
Related drawings
<i>COOLER AND TEST CONFIGURATION</i>
Cooler heart mounted inside structural box
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room – Ambient conditions
<i>TASK DESCRIPTION</i>
Mechanically mount the two heat switches inside the cooler structural box. The recommended torque for the three holding screws is TBD Nm. Use stainless steel screws ref. nnn
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Must be done with great care : thin titanium tube on heat switch is fragile and critical to the performance of the heat switch / cooler
<i>OUTPUT DOCUMENTS</i>
Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : CO 170

TASK NAME

Cabling and Soldering of Connectors and Thermal Parts

OBJECTIVES

Connect all thermometers and heaters, glued at various locations, to the two electrical connectors via manganin wires

REQUIRED DOCUMENTATION

Interface Control Document (HSO-SBT-ICD-012)
Procedure HSO-SBT-PR-033 (Collage et thermalisation des composants)
Procedure HSO-SBT-PR-034 (Réalisation des soudures des fils de mesure)

COOLER AND TEST CONFIGURATION

Cooler heart + heat switches mounted inside structural box

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room – Ambient conditions. Soldering tool

TASK DESCRIPTION

Follow procedure HSO-SBT-PR-033 and 034
Refer to wiring table in ICD. For each components (heater, thermometer) wires are twisted (4), inserted in a Teflon “gaine” (TBD). All the wires connected to the evaporator are thermally anchored to the thermal shunt.

ACCEPTANCE CRITERIA AND COMMENTS

Visual check
Electrical resistance check (component resistance and electrical isolation with regards to cooler)

OUTPUT DOCUMENTS

Report in LLB – Report outcome in Inspection Sheet (FI)



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : CO 180
<i>TASK NAME</i>
Mounting and Adjustment of Snubbers
<i>OBJECTIVES</i>
Mechanically mount and adjust the snubbers on the heat switches to prevent any excessive lateral motion
<i>REQUIRED DOCUMENTATION</i>
Related drawings
<i>COOLER AND TEST CONFIGURATION</i>
Cooler heart + heat switches mounted inside structural box
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room – Ambient conditions
<i>TASK DESCRIPTION</i>
Mount and adjust the snubbers (Part ref. B119, B120, B311). The snubbers must be centered with regards to the “inside” part. Use stainless steel screws ref. nnn
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
No contact is acceptable between snubber and “inside” part
<i>OUTPUT DOCUMENTS</i>
Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : CO 190
<i>TASK NAME</i>
Welding of Braided Copper onto Copper Ends
<i>OBJECTIVES</i>
Assembling of thermal straps (evaporator and sorption pump side)
<i>REQUIRED DOCUMENTATION</i>
Related drawings HSO-SBT-SP-014 (Spécifications qualité appliquées à la fabrication) HSO-SBT-FC-023 (Organigramme des soudures)
<i>COOLER AND TEST CONFIGURATION</i>
N/A
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Operation subcontracted – Under subcontractor responsibility
<i>TASK DESCRIPTION</i>
1. TIG welding of copper braid with part ref. B531 at one end, and part ref. B532 at the other end TIG welding of copper braid with part ref. B541 at one end, and part ref. B542 at the other end
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Work performed in accordance with subcontractor quality program
<i>OUTPUT DOCUMENTS</i>
Certificate of conformity



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : CO 200
<i>TASK NAME</i>
Integration of Thermal Straps
<i>OBJECTIVES</i>
Connect the two thermal straps with the switch ends and the evaporator and pump copper end.
<i>REQUIRED DOCUMENTATION</i>
Related drawings
<i>COOLER AND TEST CONFIGURATION</i>
Cooler heart + heat switches mounted inside structural box
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room – Ambient conditions
<i>TASK DESCRIPTION</i>
<ol style="list-style-type: none">1. Connect the first thermal strap to the pump heat switch end and sorption pump copper cold tip2. Connect the second thermal strap to the evaporator heat switch and evaporator copper cold tip Use stainless steel screws ref. nnn. The recommended torque is TBD Nm.
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Do not apply any torque on the heat switches to avoid any damage to the thin wall titanium tube. Always use two wrenches (one on each side) when tightening screws. If necessary the centering screws (B134, B135) can be used to hold the cooler heart (must be unscrewed afterwards)
<i>OUTPUT DOCUMENTS</i>
Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : CO 210

TASK NAME

Performance Test (Cooler Empty)

OBJECTIVES

Thermally characterize the thermal conductance between the cooler and cold heat sink (cryostat).

REQUIRED DOCUMENTATION

N/A

COOLER AND TEST CONFIGURATION

Cooler fully assembled, mounted in test cryostat, with fill tube connected to cryostat internal high pressure circuitry (once cooler is connected, circuitry must be leak tested under 6 MPa – IMPORTANT : following this pressure test cooler must be pumped down in secondary vacuum for 2 hours minimum).

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean Room – Ambient conditions. Test cryostat with all relevant associated equipment : secondary vacuum pump, liquid helium level indicator, temperature bridges, power supplies, voltmeters, large capacity vacuum pump (bath pumping), manometers, etc...

TASK DESCRIPTION

For a heat sink temperature of 1.8 K (pumped bath) and cooler structure of 4.2 K, characterize the following conductance :

1. sorption pump to cold heat sink
2. thermal shunt to cold heat sink
3. evaporator to cold heat sink

The thermal conductance will be characterized with the switches in the ON and OFF position.

ACCEPTANCE CRITERIA AND COMMENTS

Results shall be consistent with predictions (see HSO-SBT-SP-037)

This task will allow once the cooler will be filled with helium gas to check for any unexpected problems (thermoacoustic oscillations, etc...) which signatures are in most cases unexpected thermal conductance.

Following this test, if no problems arises, the cooler is filled with ^3He gas (or ^4He)

OUTPUT DOCUMENTS

Report in LLB – Test report



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : CO 220

TASK NAME

He3 Filling of Cooler (Cold Phase)

OBJECTIVES

Fill the cooler with ^3He gas. Cooler becomes thermally operational.

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-029 (Remplissage du cooler)

COOLER AND TEST CONFIGURATION

Idem CO 210

FACILITY AND GROUND SUPPORT EQUIPMENT

Idem as CO 210, plus high pressure ^3He bottle and appropriate manometers and valves. In addition a leak detector with the mass 3 option is connected to cryostat internal vacuum.

TASK DESCRIPTION

The cryostat bath can be either at 4.2 K or 1.8 K. Follow procedure HSO-SBT-PR-029. Summary :

1. Connect high pressure ^3He bottle to cryostat internal high pressure circuitry
2. Turn ON both heat switches
3. Inject the appropriate amount of ^3He gas – check for any internal leak (cryostat vacuum)
4. Close high pressure ^3He bottle and valves to cryostat

ACCEPTANCE CRITERIA AND COMMENTS

Internal pressure at room temperature consistent with prediction (check at warm up) – see CO250.

OUTPUT DOCUMENTS

Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : CO 230
<i>TASK NAME</i>
Thermal Test #1 (reference – Health Check (HCR))
<i>OBJECTIVES</i>
Perform a thermal check of the cooler performance. This test sequence defines the test referenced as ‘Health Check’
<i>REQUIRED DOCUMENTATION</i>
Procedure HSO-SBT-PR-031 (Health Check)
<i>COOLER AND TEST CONFIGURATION</i>
Operational cooler mounted in test cryostat
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean Room – Ambient conditions. Test cryostat with all relevant associated equipment : secondary vacuum pump, liquid helium level indicator, temperature bridges, power supplies, voltmeters, large capacity vacuum pump (bath pumping), manometers, etc...
<i>TASK DESCRIPTION</i>
Follow procedure HSO-SBT-PR-031, to the exception of the tests performed at room temperature if the cooler is already cold (if done after task CO 230). Input powers to cooler must be consistent with data from CO220 - Summary of data recorded : <ol style="list-style-type: none">1. ultimate temperature (right side up and upside down)2. cooling power curve (right side up and upside down)3. hold time under 200 μW load
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Results shall be consistent with predictions (see HSO-SBT-SP-037) See procedure HSO-SBT-PR-031 and health check data sheet. This test will then serve as a reference for all subsequent thermal tests.
<i>OUTPUT DOCUMENTS</i>
Report in LLB – Health Check Report (HCR) data sheet



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : CO 240

TASK NAME

Crimping of Cooler

OBJECTIVES

Crimp the cooler fill tube. Cooler becomes then self contained. Fully operational

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-030 (Quesotage)

COOLER AND TEST CONFIGURATION

Cooler mounted in test cryostat. Test cryostat at room temperature, open.

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room – Ambient conditions. Crimping tool. Soldering tool

TASK DESCRIPTION

Follow procedure HSO-SBT-PR-030. Summary :

1. Once cooler and cryostat are at room temperature, check the cooler internal pressure
2. Crimp the fill tube and cut it
3. Plug the cut tube with soft solder
4. Release crimp tool

ACCEPTANCE CRITERIA AND COMMENTS

Before crimping internal cooler pressure must be TBD MPa at 20°C to within 5%

OUTPUT DOCUMENTS

Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : CO 250

TASK NAME

Leak Tightness Test

OBJECTIVES

Verify the crimped cooler does not leak

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-030 (Quesotage)

COOLER AND TEST CONFIGURATION

Cooler partly crimped (cover not glued yet)

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room – Ambient conditions. Leak detector with 3He mass option

TASK DESCRIPTION

Follow procedure HSO-SBT-PR-030

1. Insert cooler inside vacuum box
2. Check for any leak

ACCEPTANCE CRITERIA AND COMMENTS

Leakrates level must not exceed 10^{-9} l.mB.s⁻¹ or vacuum box background measured prior to insertion of cooler

OUTPUT DOCUMENTS

Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : CO 260
<i>TASK NAME</i>
Gluing of Cover onto Crimped Tube
<i>OBJECTIVES</i>
Protect the crimped tube with a cover
<i>REQUIRED DOCUMENTATION</i>
Procedure HSO-SBT-PR-030 (Quesotage)
<i>COOLER AND TEST CONFIGURATION</i>
Cooler partly crimped (cover not glued yet)
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room – Ambient conditions.
<i>TASK DESCRIPTION</i>
Follow procedure HSO-SBT-PR-030 1. Glue Part ref. B221 on crimped tube, using Stycast 2850 FT (Fill Part B221 with Stycast, insert crimped tube inside, remove all overflowing Stycast) 2. Leave the cooler oriented so the crimped tube and cover are vertical with crimped tube directed toward the ground 3. Leave cooler untouched for about 12 hours
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Visual check
<i>OUTPUT DOCUMENTS</i>
Report in LLB – Report outcome of CO250, CO260 and CO270 in Inspection Sheet (FI)



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : CO 270
<i>TASK NAME</i>
Mounting of Lateral Plates, Tubing and Covers
<i>OBJECTIVES</i>
Complete the final assembly of the cooler
<i>REQUIRED DOCUMENTATION</i>
Related drawings
<i>COOLER AND TEST CONFIGURATION</i>
Cooler fully operational.
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room – Ambient conditions
<i>TASK DESCRIPTION</i>
<ol style="list-style-type: none">1. Set in place Part ref. B136 (guiding tube)2. Mount the two lateral plates ref. B404 and B405 using screws ref. nmmn3. Mount Part ref. B137 (evaporator cover)4. Mount Part ref. B124 (pump cover)
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Visual check
<i>OUTPUT DOCUMENTS</i>
Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : CO 280

TASK NAME

Leak Tightness Test

OBJECTIVES

Verify the cooler does not leak after final assembly

REQUIRED DOCUMENTATION

N/A

COOLER AND TEST CONFIGURATION

Cooler fully assembled

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room – Ambient conditions. Leak detector with 3He mass option

TASK DESCRIPTION

1. Insert cooler inside vacuum box
2. Check for any leak

ACCEPTANCE CRITERIA AND COMMENTS

Leakrates level must not exceed 10^{-9} l.mB.s⁻¹

OUTPUT DOCUMENTS

Report in LLB + Log Book



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : CO 290
<i>TASK NAME</i>
Vibration Test
<i>OBJECTIVES</i>
Determine the resonant frequencies and demonstrate the ability of the cooler to withstand the V test
<i>REQUIRED DOCUMENTATION</i>
Vibration levels (HSO-SBT-SP-001)
<i>COOLER AND TEST CONFIGURATION</i>
Cooler fully assembled – Self standing unit. Clean room – Ambient conditions
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Operation subcontracted – Under subcontractor responsibility.
<i>TASK DESCRIPTION</i>
Perform required vibration sequence for each axis - before each run and at the end of each axis, perform a low level sine sweep to control the dynamic behavior.
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Cooler shall survive the specified vibration levels Performance in accordance with predictions (see HSO-SBT-SP-037) During and at completion of the tests inspect visually for any external damages Work performed in accordance with subcontractor quality program
<i>OUTPUT DOCUMENTS</i>
Report in LLB + Log Book – Test report



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : CO 300
<i>TASK NAME</i>
Thermal Test #2 (HCR)
<i>OBJECTIVES</i>
Verify the cooler performance are not affected after the vibration tests
<i>REQUIRED DOCUMENTATION</i>
Procedure HSO-SBT-PR-031 (Health Check)
<i>COOLER AND TEST CONFIGURATION</i>
Cooler mounted in test cryostat
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean Room – Ambient conditions. Test cryostat with all relevant associated equipment : secondary vacuum pump, liquid helium level indicator, temperature bridges, power supplies, voltmeters, large capacity vacuum pump (bath pumping), manometers, etc...
<i>TASK DESCRIPTION</i>
Follow procedure HSO-SBT-PR-031. Summary of data recorded : <ol style="list-style-type: none">1. Leak rate2. Kevlar cords tension3. ultimate temperature (right side up and upside down)4. cooling power curve (right side up and upside down)5. hold time under 200 μW load
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Results shall be consistent with the first set of data established during Task CO 230 (first health check) (see also HSO-SBT-SP-037) See procedure HSO-SBT-PR-031 and health check data sheet.
<i>OUTPUT DOCUMENTS</i>
Report in LLB + Log Book – Health Check Report (HCR) data sheet



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : CO 310
<i>TASK NAME</i>
Baking
<i>OBJECTIVES</i>
Bake out the cooler at 80°C for 5 days to check for any effect on the performance
<i>REQUIRED DOCUMENTATION</i>
Procedure HSO-SBT-PR-035 (Etuvage)
<i>COOLER AND TEST CONFIGURATION</i>
Cooler fully assembled – Self standing unit
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room. Ambient conditions. Baking chamber equipped with primary pump
<i>TASK DESCRIPTION</i>
Follow procedure HSO-SBT-PR-035 Bake out the cooler at 80°C under vacuum (primary) for 5 days
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
No visual damage – this test is followed by a heath check to check for the cooler integrity
<i>OUTPUT DOCUMENTS</i>
Report in LLB + Log Book



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : CO 320
<i>TASK NAME</i>
Thermal Test #3 (HCR)
<i>OBJECTIVES</i>
Verify the cooler performance are not affected after the bake out
<i>REQUIRED DOCUMENTATION</i>
Procedure HSO-SBT-PR-031 (Health Check)
<i>COOLER AND TEST CONFIGURATION</i>
Cooler mounted in test cryostat
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean Room – Ambient conditions. Test cryostat with all relevant associated equipment : secondary vacuum pump, liquid helium level indicator, temperature bridges, power supplies, voltmeters, large capacity vacuum pump (bath pumping), manometers, etc...
<i>TASK DESCRIPTION</i>
Follow procedure HSO-SBT-PR-031. Summary of data recorded : 1. Leak rate 2. Kevlar cords tension 3. ultimate temperature (right side up and upside down) 4. cooling power curve (right side up and upside down) 5. hold time under 200 μ W load
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Results shall be consistent with the first set of data established during Task CO 230 (first health check) (see also HSO-SBT-SP-037) See procedure HSO-SBT-PR-031 and health check data sheet.
<i>OUTPUT DOCUMENTS</i>
Report in LLB + Log Book – Health Check Report (HCR) data sheet



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : CO 330

TASK NAME

Performance Test

OBJECTIVES

Verify the cooler performance against specifications (hold time and operating temperature)

REQUIRED DOCUMENTATION

“Specifications” ref. HSO-SBT-SP-001

COOLER AND TEST CONFIGURATION

Cooler mounted in test cryostat

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean Room – Ambient conditions. Test cryostat with all relevant associated equipment : secondary vacuum pump, liquid helium level indicator, temperature bridges, power supplies, voltmeters, large capacity vacuum pump (bath pumping), manometers, etc...

TASK DESCRIPTION

Follow standard recycling procedure (see procedure HSO-SBT-PR-031). After recycling set the cooler orientation to horizontal. Then record the following data :

1. all timings
2. hold time and ultimate temperature of cooler under 10 μ W heat load
3. all input power, so as to determine the energy dissipated during the cycle

ACCEPTANCE CRITERIA AND COMMENTS

Results shall at a minimum meet the specifications (see HSO-SBT-SP-037)

OUTPUT DOCUMENTS

Report in LLB + Log Book – Test Report



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : CO 340
<i>TASK NAME</i>
Cleaning
<i>OBJECTIVES</i>
Clean the cooler to specified level before packing and delivery
<i>REQUIRED DOCUMENTATION</i>
Procedure HSO-SBT-PR-026 (Nettoyage)
<i>COOLER AND TEST CONFIGURATION</i>
Cooler fully assembled – Self standing unit. Clean room – Ambient conditions
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room – dedicated cleaning material
<i>TASK DESCRIPTION</i>
Follow procedure HSO-SBT-PR-026
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Visibly clean (TBD)
<i>OUTPUT DOCUMENTS</i>
Report in LLB + Log Book



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : CO 350
<i>TASK NAME</i>
Packing
<i>OBJECTIVES</i>
Pack the cooler before delivery
<i>REQUIRED DOCUMENTATION</i>
Procedure HSO-SBT-PR-027 (Packing and Handling)
<i>COOLER AND TEST CONFIGURATION</i>
Cooler fully assembled – Self standing unit, cleaned.
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Dedicated transportation container
<i>TASK DESCRIPTION</i>
Follow procedure HSO-SBT-PR-027. Summary : <ul style="list-style-type: none">- mounting of cooler inside inner container- purging with dry nitrogen- mounting of inner container inside transportation container
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
N/A
<i>OUTPUT DOCUMENTS</i>
Report in LLB + Log Book



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : CO 360
<i>TASK NAME</i>
Delivery
<i>OBJECTIVES</i>
Deliver the cooler to RAL (SPIRE) or SAp (PACS)
<i>REQUIRED DOCUMENTATION</i>
Acceptance Data Package
<i>COOLER AND TEST CONFIGURATION</i>
Cooler fully assembled – Self standing unit, cleaned and packed in transportation container
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Marcel et son camion
<i>TASK DESCRIPTION</i>
Review of documentation
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
<ul style="list-style-type: none">- No damage during transportation- Shock level indicator not triggered
<i>OUTPUT DOCUMENTS</i>
Report in LLB + Log Book. Acceptance Data Package (including Log Book)



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

4.2.3 Structure

TASK NUMBER : ST 010
<i>TASK NAME</i>
Assembly of Main Structure
<i>OBJECTIVES</i>
EB Welding of parts composing the main structural box
<i>REQUIRED DOCUMENTATION</i>
Related drawings HSO-SBT-SP-014 (Spécifications qualité appliquées à la fabrication) HSO-SBT-FC-023 (Organigramme des soudures)
<i>COOLER AND TEST CONFIGURATION</i>
N/A
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Dedicated tool provided by SBT Operation subcontracted - Under subcontractor responsibility
<i>TASK DESCRIPTION</i>
See HSO-SBT-FC-023 – Use tool ref. 2000-14 T500 Perform a first EB weld on test samples to define parameters and verify the weld quality 1. EB weld part ref B401, B402, B403, B406 and EB407 (according to drawing ref. 2000-14 B 400)
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Work performed in accordance with subcontractor quality program
<i>OUTPUT DOCUMENTS</i>
Certificate of conformity



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : ST 020
<i>TASK NAME</i>
Final Machining of Main Structure
<i>OBJECTIVES</i>
Remove by machining the extra material (TA6V) initially left for EB welding purpose
<i>REQUIRED DOCUMENTATION</i>
Related drawings HSO-SBT-SP-014 (Spécifications qualité appliquées à la fabrication) HSO-SBT-FC-023 (Organigramme des soudures)
<i>COOLER AND TEST CONFIGURATION</i>
N/A
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Operation subcontracted – Under subcontractor responsibility
<i>TASK DESCRIPTION</i>
Remove by machining the extra material (TA6V) initially left for EB welding purpose on the support structure
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Work performed in accordance with subcontractor quality program
<i>OUTPUT DOCUMENTS</i>
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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

4.2.4 Heat Switches

TASK NUMBER : HS 010
<i>TASK NAME</i>
Pre Assembly – Switch base
<i>OBJECTIVES</i>
Assemble heat switch base
<i>REQUIRED DOCUMENTATION</i>
Related drawings : 2000-14 B300 HSO-SBT-SP-014 (Spécifications qualité appliquées à la fabrication) HSO-SBT-FC-023 (Organigramme des soudures)
<i>COOLER AND TEST CONFIGURATION</i>
N/A
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Operation subcontracted – Under subcontractor responsibility
<i>TASK DESCRIPTION</i>
See HSO-SBT-FC-023 EB weld part ref. B310 with part ref. B309
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Work performed in accordance with subcontractor quality program
<i>OUTPUT DOCUMENTS</i>
Certificate of conformity



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : HS 020
<i>TASK NAME</i>
Assembly
<i>OBJECTIVES</i>
Assemble the heat switch
<i>REQUIRED DOCUMENTATION</i>
Related drawings : 2000-14 B300 HSO-SBT-SP-014 (Spécifications qualité appliquées à la fabrication) HSO-SBT-FC-023 (Organigramme des soudures)
<i>COOLER AND TEST CONFIGURATION</i>
N/A
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Operation subcontracted – Under subcontractor responsibility
<i>TASK DESCRIPTION</i>
See HSO-SBT-FC-023 Brazing of part ref. B301, B302, 103, B309/B310, B305, B306
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Work performed in accordance with subcontractor quality program
<i>OUTPUT DOCUMENTS</i>
Certificate of conformity



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : HS 030
<i>TASK NAME</i>
Leak Tightness Test
<i>OBJECTIVES</i>
Verify the quality and leaktightness of all joints
<i>REQUIRED DOCUMENTATION</i>
N/A
<i>COOLER AND TEST CONFIGURATION</i>
Heat switch partly assembled
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room - Ambient conditions Helium leak detector (mass spectrometer)
<i>TASK DESCRIPTION</i>
Use appropriate rubber plugs and connection to leak detector to check for the leaktightness of all joints under vacuum.
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Leakrates level must not exceed 10^{-9} mB.Ls ⁻¹
<i>OUTPUT DOCUMENTS</i>
Report in LLB – Report outcome in Inspection Sheet (FI)



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : HS 040
<i>TASK NAME</i>
Charcoal mounting
<i>OBJECTIVES</i>
Pre assembly of miniature sorption pump
<i>REQUIRED DOCUMENTATION</i>
N/A
<i>COOLER AND TEST CONFIGURATION</i>
Heat switch partly assembled
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room. Ambient conditions. Weighing machine. Baking chamber equipped with primary pump
<i>TASK DESCRIPTION</i>
<ol style="list-style-type: none">1. Perform a visual selection of charcoal pellets2. Bake out at 140°C under vacuum (primary) the charcoal pellets for 12 hours minimum3. Weights and prepare the appropriate amount, ie 20 milligrams4. Insert the pellet into the minipump (B306) in between two pieces of copper mesh
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
N/A
<i>OUTPUT DOCUMENTS</i>
Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : HS 050
<i>TASK NAME</i>
Closing of Minipump
<i>OBJECTIVES</i>
TIG weld the minipump cap
<i>REQUIRED DOCUMENTATION</i>
Related drawings HSO-SBT-SP-014 (Spécifications qualité appliquées à la fabrication) HSO-SBT-FC-023 (Organigramme des soudures)
<i>COOLER AND TEST CONFIGURATION</i>
Heat switch partly assembled
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Operation subcontracted – Under subcontractor responsibility
<i>TASK DESCRIPTION</i>
See HSO-SBT-FC-023 TIG weld Part ref. B306 with Part ref. B307
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Work performed in accordance with subcontractor quality program After this operation the heat switch must be kept in a clean environment – Put a rubber plug on fill tube
<i>OUTPUT DOCUMENTS</i>
Certificate of conformity



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : HS 060
<i>TASK NAME</i>
Leak Tightness Test
<i>OBJECTIVES</i>
Verify the leaktightness of the heat switch
<i>REQUIRED DOCUMENTATION</i>
N/A
<i>COOLER AND TEST CONFIGURATION</i>
Heat switch partly assembled
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room - Ambient conditions Helium leak detector (mass spectrometer)
<i>TASK DESCRIPTION</i>
Use appropriate connection to leak detector to check for the leaktightness of the heat switches under vacuum
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Leakrates level must not exceed 10^{-9} mB.Ls ⁻¹
<i>OUTPUT DOCUMENTS</i>
Report in LLB – Report outcome in Inspection Sheet (FI)



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : HS 070

TASK NAME

Baking and cleaning of switch

OBJECTIVES

Perform a baking to remove any trace of pollution from the charcoal pellet - Cleaning of switch external to be under cleanliness and contamination control

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR -026 (Nettoyage)

COOLER AND TEST CONFIGURATION

Heat switch partly assembled

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room - Ambient conditions – Baking chamber equipped with primary pump

TASK DESCRIPTION

1. Bake out the heat switch at 80°C under primary vacuum for 12 hours minimum
2. Clean the switch (procedure HSO-SBT-PR-026)

ACCEPTANCE CRITERIA AND COMMENTS

Heat switch must then remains under clean environment (plastic bag under helium gas is acceptable) and the fill tube must be plugged with a rubber plug.

OUTPUT DOCUMENTS

Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : HS 080
<i>TASK NAME</i>
He3 Filling
<i>OBJECTIVES</i>
Fill the heat switch with 3He gas
<i>REQUIRED DOCUMENTATION</i>
Procedure HSO-SBT-PR-036 (Remplissage de l'interrupteur)
<i>COOLER AND TEST CONFIGURATION</i>
Heat switch partly assembled
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room – Ambient conditions. 3He gas bottle with appropriate manometers and valves. Leak detector.
<i>TASK DESCRIPTION</i>
Follow procedure HSO-SBT-PR-026
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
N/A
<i>OUTPUT DOCUMENTS</i>
Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : HS 90
<i>TASK NAME</i>
Crimping of Heat Switch
<i>OBJECTIVES</i>
Crimp the heat switch fill tube
<i>REQUIRED DOCUMENTATION</i>
Procedure HSO-SBT-PR-036 (Remplissage de l'interrupteur)
<i>COOLER AND TEST CONFIGURATION</i>
Heat switch filled with 3He gas
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room – Ambient conditions. Crimping tool. Soldering tool
<i>TASK DESCRIPTION</i>
Follow procedure HSO-SBT-PR-036 - Summary : <ol style="list-style-type: none">1. Crimp the fill tube and cut it2. Plug the cut tube with soft solder3. Release crimp tool
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Visual check
<i>OUTPUT DOCUMENTS</i>
Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : HS 100
<i>TASK NAME</i>
Leak Tightness Test
<i>OBJECTIVES</i>
Verify the leaktightness of the heat switch
<i>REQUIRED DOCUMENTATION</i>
N/A
<i>COOLER AND TEST CONFIGURATION</i>
Heat switch partly assembled
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room - Ambient conditions Helium leak detector (mass spectrometer)
<i>TASK DESCRIPTION</i>
Insert heat switch inside vacuum box 1. Check for any leak
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Leakrates level must not exceed 10^{-9} mB.Ls ⁻¹ or vacuum box background measured prior to insertion of switch
<i>OUTPUT DOCUMENTS</i>
Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : HS 110
<i>TASK NAME</i>
Gluing of Cover onto Crimped Tube
<i>OBJECTIVES</i>
Protect the crimped tube with a cover
<i>REQUIRED DOCUMENTATION</i>
N/A
<i>COOLER AND TEST CONFIGURATION</i>
Heat switch partly crimped (cover not glued yet)
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room – Ambient conditions.
<i>TASK DESCRIPTION</i>
<ol style="list-style-type: none">1. Glue Part ref. B308 on crimped tube, using Stycast 2850 FT (Fill Part B308 with Stycast, insert crimped tube inside, remove all overflowing Stycast)2. Leave the heat switches oriented so the crimped tubes and covers are vertical with crimped tube directed toward the ground3. Leave heat switches untouched for about 12 hours
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Visual check
<i>OUTPUT DOCUMENTS</i>
Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : HS 120
<i>TASK NAME</i>
Leak Tightness Test
<i>OBJECTIVES</i>
Verify the leaktightness of the heat switch
<i>REQUIRED DOCUMENTATION</i>
N/A
<i>COOLER AND TEST CONFIGURATION</i>
Heat switch almost fully assembled
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room - Ambient conditions Helium leak detector (mass spectrometer)
<i>TASK DESCRIPTION</i>
Insert heat switch inside vacuum box 1. Check for any leak
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Leakrates level must not exceed 10^{-9} mB.Ls ⁻¹
<i>OUTPUT DOCUMENTS</i>
Report in LLB – Report outcome of HS90 to HS130 in Inspection Sheet (FI)



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : HS 130
<i>TASK NAME</i>
Gluing of Thermometers and heaters
<i>OBJECTIVES</i>
Instrument the heat switch with heaters and thermometers
<i>REQUIRED DOCUMENTATION</i>
Procedure HSO-SBT-PR-033
<i>COOLER AND TEST CONFIGURATION</i>
Heat switch almost fully assembled
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean room – Ambient conditions
<i>TASK DESCRIPTION</i>
Follow procedure HSO-SBT-PR-033 Glue all required heaters and thermometers on the mini sorption pump using Stycast 2850 FT.
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Visual check
<i>OUTPUT DOCUMENTS</i>
Report in LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

TASK NUMBER : HS 140

TASK NAME

Cabling of Thermal Parts

OBJECTIVES

Wires all thermometers and heaters glued on the mini sorption pumps with manganin wires

REQUIRED DOCUMENTATION

Interface Control Document (HSO-SBT-ICD-012)
Procedure HSO-SBT-PR-034 (Réalisation des soudures des fils de mesure)

COOLER AND TEST CONFIGURATION

heat switch almost fully assembled

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room – Ambient conditions. Soldering tool

TASK DESCRIPTION

Refer to wiring table in ICD and follow procedure HSO-SBT-PR-034. For each components (heater, thermometer) wires are twisted (4), inserted in a Teflon “gaine” (TBD)

ACCEPTANCE CRITERIA AND COMMENTS

Visual check
Electrical resistance check (component resistance and electrical isolation with regards to switch)

OUTPUT DOCUMENTS

Report in the LLB



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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/GBT]

TASK NUMBER : HS 150
<i>TASK NAME</i>
Characterization of heat switch
<i>OBJECTIVES</i>
Thermally characterize the gas gap heat switch
<i>REQUIRED DOCUMENTATION</i>
N/A
<i>COOLER AND TEST CONFIGURATION</i>
Heat switch fully assembled and operational, mounted in test cryostat
<i>FACILITY AND GROUND SUPPORT EQUIPMENT</i>
Clean Room – Ambient conditions. Test cryostat with all relevant associated equipment : secondary vacuum pump, liquid helium level indicator, temperature bridges, power supplies, voltmeters, etc...
<i>TASK DESCRIPTION</i>
Summary of data recorded for each switch (bath cryostat at 4.2 K): 1. Switch OFF : power transmitted between 4.2 K and 40 K 2. Switch ON : power transmitted for a ΔT of 1 K for a base temperature of 4.2 K 3. 25 mW applied on switch hot end. Switch miniature pump heated to 20 K : decrease this temperature and record the associated heating power and corresponding switch thermal conductance (determination of switching temperature).
<i>ACCEPTANCE CRITERIA AND COMMENTS</i>
Results shall be consistent with predictions (see HSO-SBT-SP-037)
<i>OUTPUT DOCUMENTS</i>
Report in LLB – Test report




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SERVICE DES BASSES TEMPERATURES [CEA/DSM/DRFMC/SBT]

5 Appendix

5.1 Health Check Report data sheet

		SPIRE & PACS Sorption Coolers HEALTH CHECK REPORT (HCR)	Référence : HCR#				
Référence cryoréfrigérateur : Raison du contrôle :		Date : Nom : Signature :					
Contrôle mécanique / électrique Visuel :							
Tension des brins Kevlar Coté pompe : _____ Coté évaporateur : _____							
Contrôle impédance thermomètres (T) et chauffages (C) (à T ambiante, et comprenant les fils de mesures) (indiquer pour chaque composants les valeurs en Ohm prises au connecteur principal (P) et redondé (R))							
T pompe	C pompe	T inter P	C inter. P	T évaporat.	T inter évap.	C inter évap.	T shunt
/	/	/	/	/	/	/	/
Rapport :							
Contrôle de fuite		Référence détecteur :					
Valeur de fuite mesurée :		Commentaires :					
Contrôle thermique							
Cycle A – Phase de condensation :							
T bain ⁴ He	T structure	T pompe/Puiss.	T évaporateur	T inter P	T inter E/Puiss.	T shunt	
Phase basse température – T bain :							
Orientation	+90° (Endroit)	0° (Horizontal)	- 90° (Envers)	Commentaires :			
T mini (mK)							
Courbe de puissance (Orientation : horizontal)							
Charge (μW)	0 (Tmini)	10	20	30	40	50	100
T (mK)							
Cycle B – Phase de condensation :							
T bain ⁴ He	T structure	T pompe/Puiss.	T évaporateur	T inter P	T inter E/Puiss.	T shunt	
Phase basse température – T bain : Autonomie et température sous 200 μW de charge appliquée :							
Conformité		OUI NON					
RAPPORT :							
Visa Projet - Nom, date et signature :							