SPIRE & PACS Sorption Coolers AIV PLAN

SBT internal ref : SBT/CT/2001-25

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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
1	1	20/11/2001	64	§ 1, 4.2. Tasks MA010, CO010, CO080, CO090, CO110, CO250, CO280, CO290, CO310, CO330, CO350, CO360, ST010, HS050. Task MA030 suppressed : transfered into two new tasks CO095 and HS 065. Verification matrix updated.
2	0	17/09/2003		AIV updated after CQM qualification and delivery. Tasks rearranged in accordance with as run plan
2	1	25/11/2003		Updated after FM Fab phase review Board comment (see H-P-ASP-RP-3846 v 1.1)
2	2	20/01/2004		Task ST030 added, C0060, 070 and 080 rearranged. Flow chart updated.
2	3	26/01/2004		"After" manufacturing tasks rearranged (cleaning task added after laser marking). Minor corrections

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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 SubmillimetreTelescope		
FS	Flight spare		
HSE	Heat Switch (on evaporator)		
HSP	Heat Switch (on sorption pump)		
LLB	Laboratory Log Book		
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		

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, STM, PFM and FS cooler.

2 Documents

2.1 Applicable documents

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

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).

		Verification method			
§ Spec	**Heading**	**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 µW net heat lift @ 290 mK		X	X	
4.1.1 b)	12 µW maximum parasitic load		X	X	
4.1.1 c)	Hold time ≥ 22 h – 46 h favoured		X	X	
4.1.1 d)	Recycling time ≤ 2 h		X	X	
4.1.1 e)	Energy per cycle ≤ 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 responsability 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		
4.8.8.9	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

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).

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 in the following way :

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

Only the tasks marked with an "*" applies to the STM.

The task numbered CO 260 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.

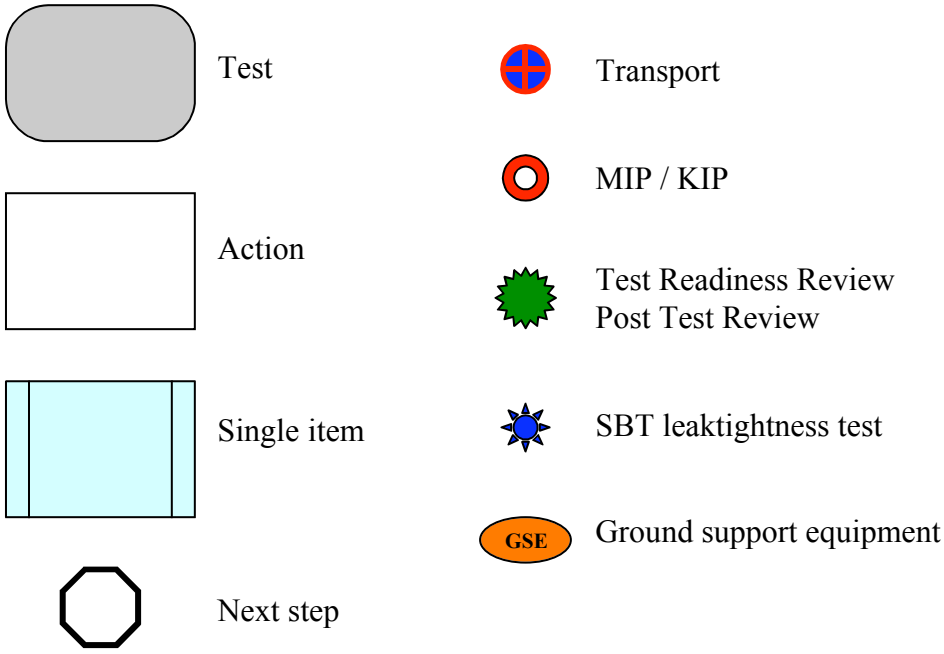
task	Manufacturing	Cooler heart	Structure	Heat Switch
010	Critical Parts Verification + fit check*	Pump and Evaporator Pre Assembly	Assembly of Main Structure *	Pre Assembly – Switch base
020	Laser marking of specific parts*	Welding inspection and Leaktightness tests	Final Machining of Main Structure *	Assembly – Switch
030	Cleaning of parts	Soldering of Thermal Shunt and Fill Tube	Cleaning of structure	Leak TightnessTest
040	Assembly of Pump and Evaporator Half Sphere		Charcoal Mounting	
050	Baking and Mounting of Procelit		Closing of Minipump	
060	Charcoal Gluing onto Copper Casing (pump)		Leak Tightness Test	
070	Gluing of Grid and Cover		Gold plating	
080	Assembly of Evaporator Copper Half Sphere		Baking and cleaning of switch	
090	Closing of Cooler Heart		Filling / Crimping of Heat Switch	
100	Assembling and heat treatment of straps		Gluing of Thermometers and Heaters / Pre wiring	
110	Gold plating		Thermal characterization of Heat Switch	
120	Leaktightness and Proof Pressure Test at 20 MPa			
130	Cleaning and baking of Cooler Heart / Structure			
140	Gluing of Thermal Parts / Pre wiring			
150	Performance Test (Cooler Empty)			
160	^{3}He Filling of Cooler Heart / Pre-test (Cold Phase)			
170	Crimping of Cooler			
180	Mounting of Mechanical Items*			
190	Mounting of Cooler into Main Structure*			
200	Processing of Kevlar strings*			
210	Integration of Heat Switches			
220	Cabling,Soldering of Connectors & Thermal Parts			
230	Mounting and Adjustment of Snubbers			
240	Integration of Thermal Straps			
250	Final assembly			

task	Cooler fully assembled
260	Thermal Test #1 (reference – Health Check (HCR))
270	Thermal vacuum
280	Thermal Test #2 (HCR)
290	Vibration Test*
300	Thermal Test #3 (HCR)
310	Performance Test
320	Packing
330	Delivery

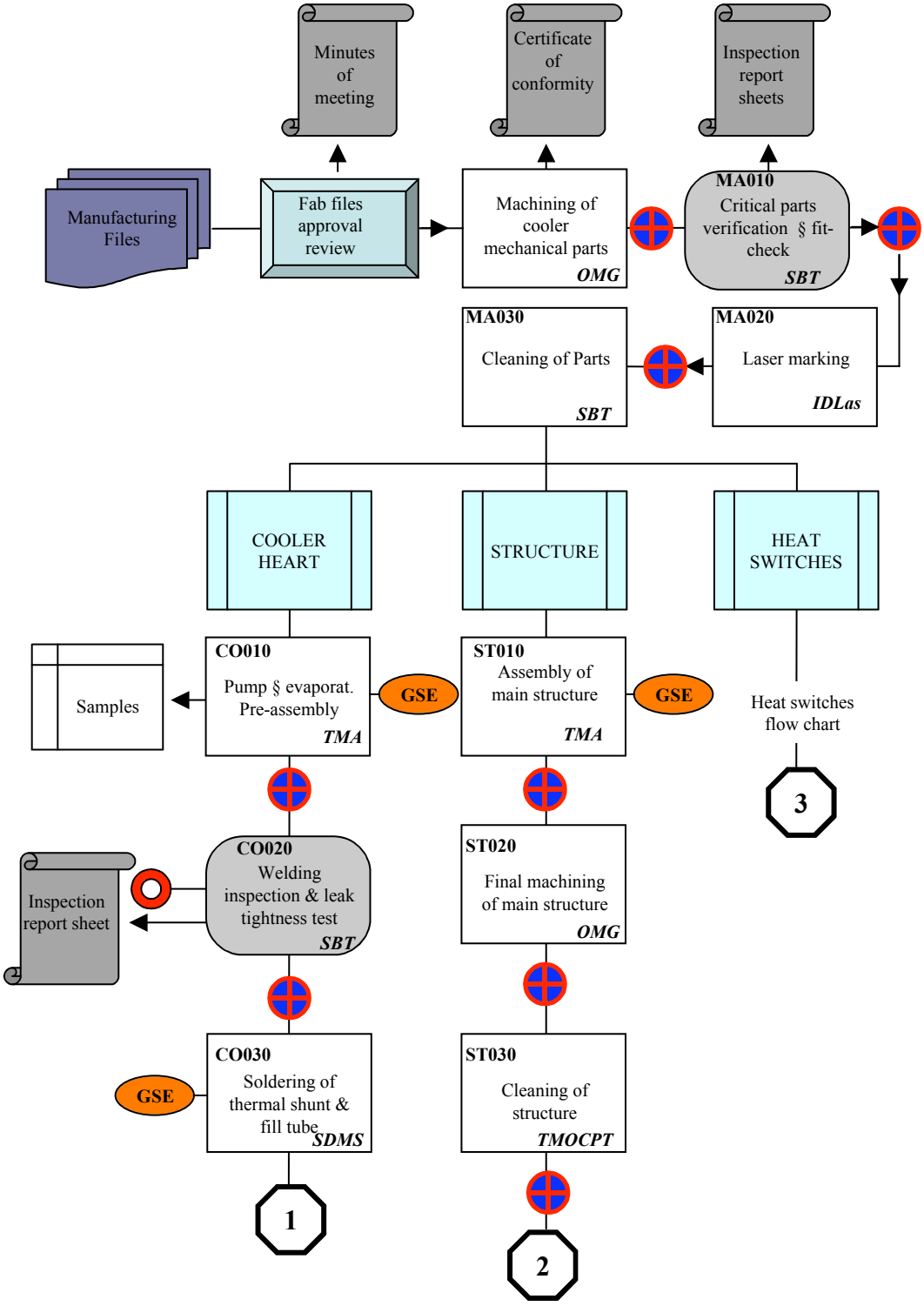
4.2.1 MAIV Flow chart

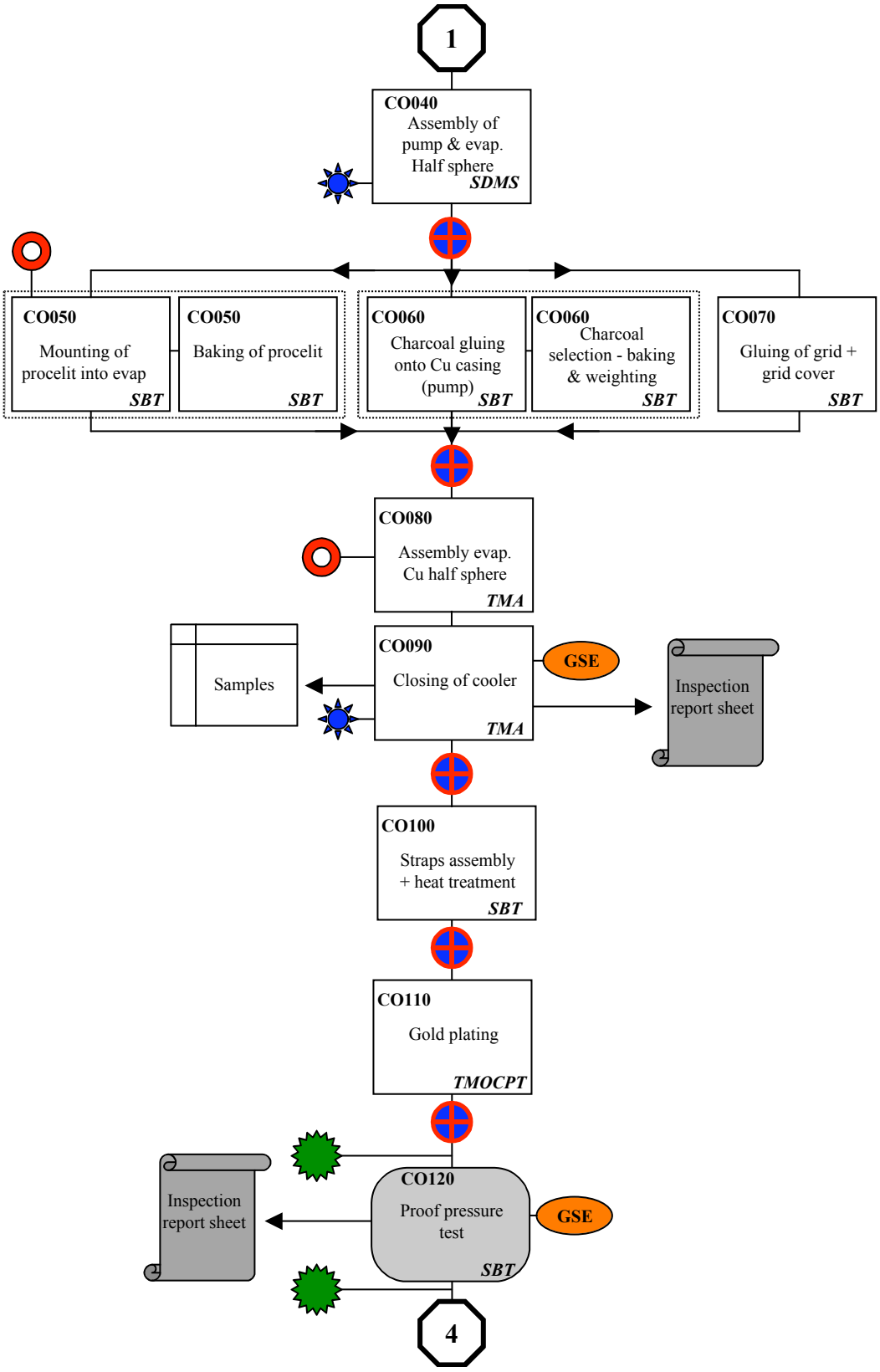
The MAIV flow chart summarizes the AIV plan in a graphical form. Each task is then detailed in the following paragraph (§ 4.2.2 and further).

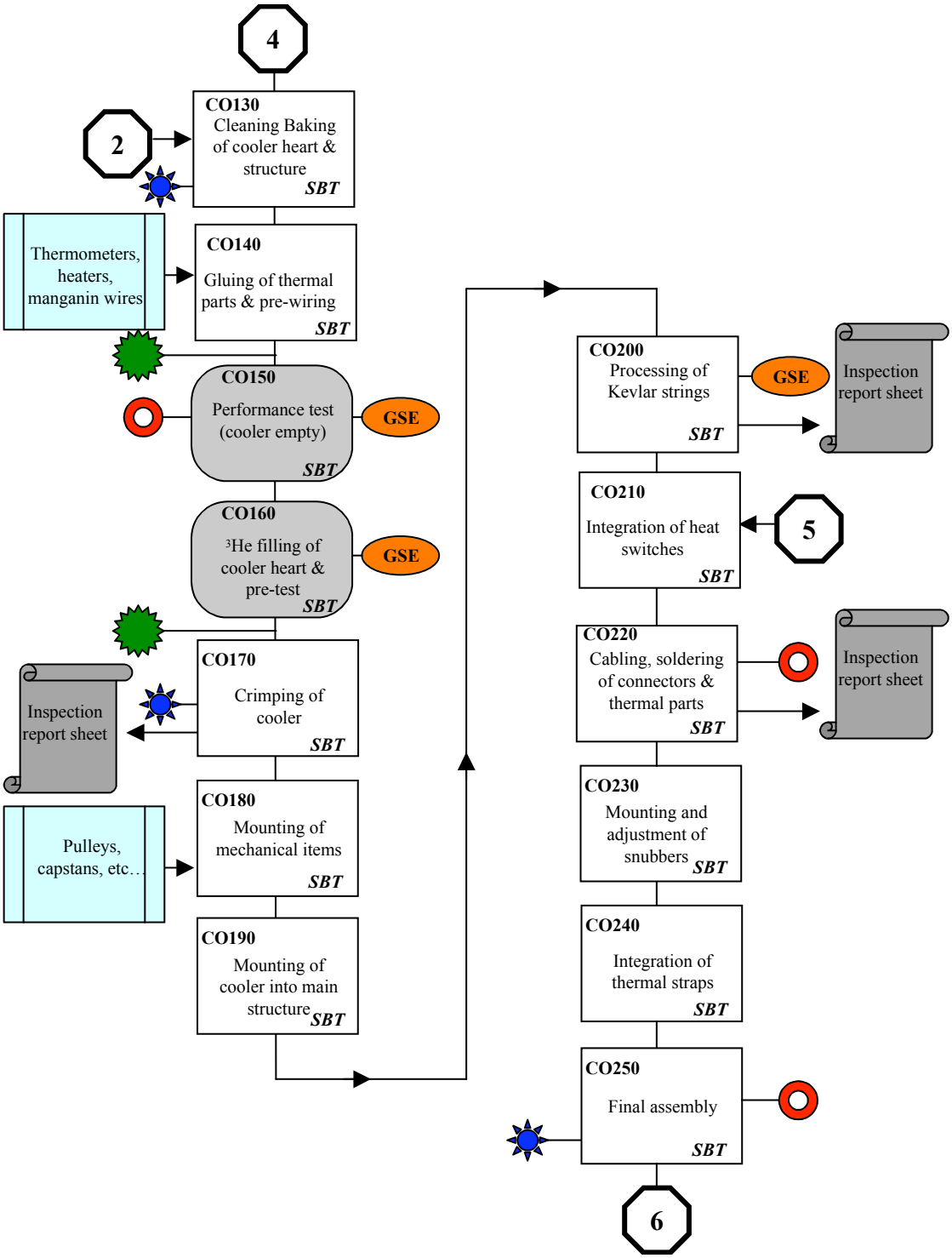
4.2.1.1 Symbols explanation

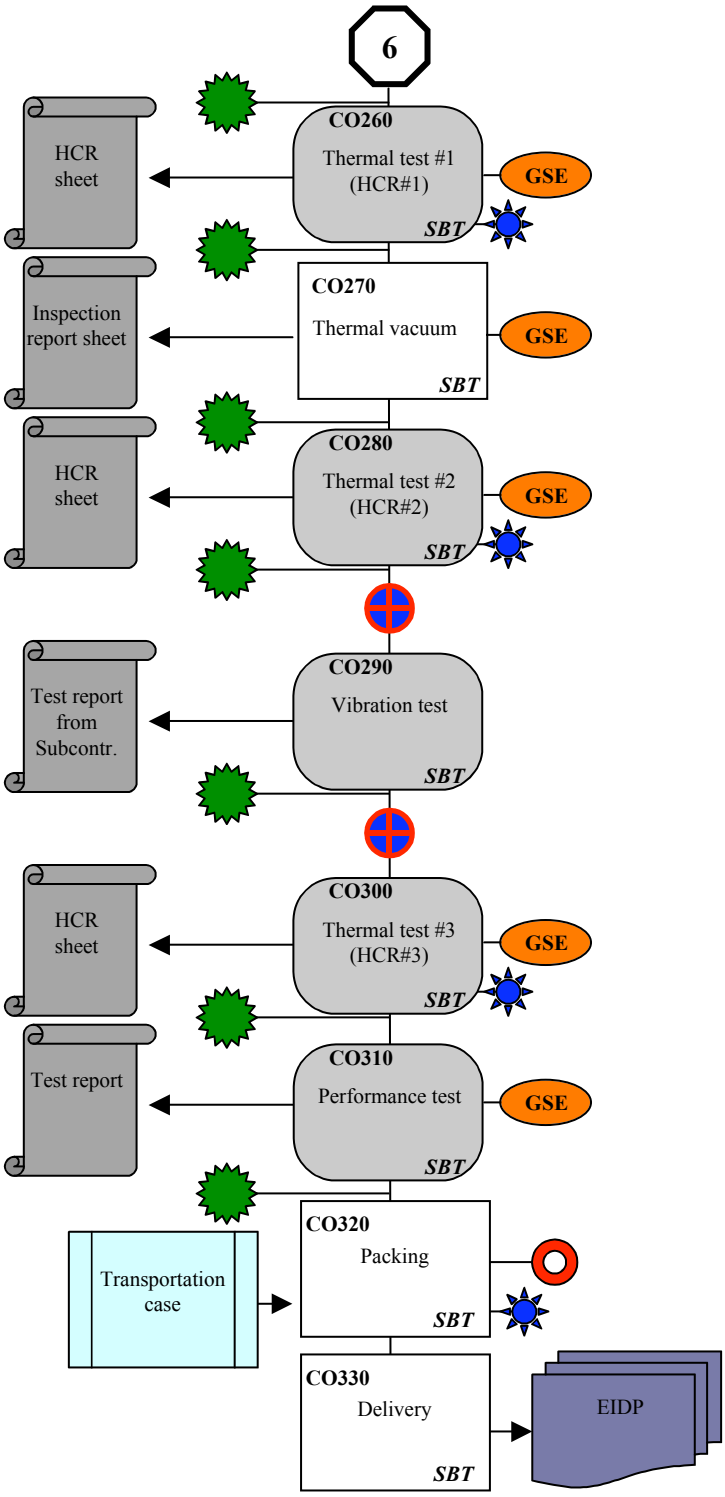


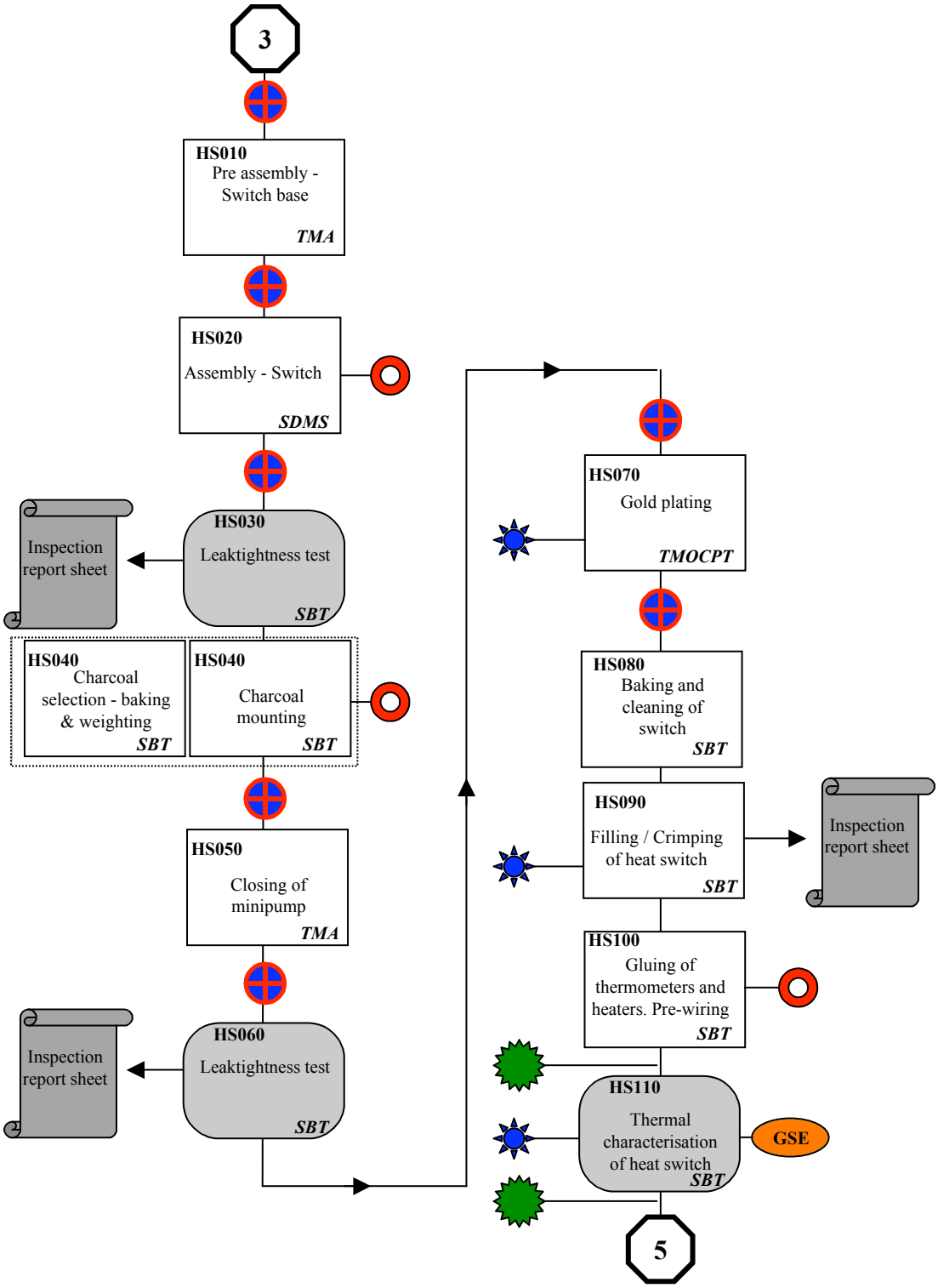
4.2.1.2 Flow chart











4.2.2 Manufacturing

TASK NUMBER : MA 010
TASK NAME
Critical Parts Verification and fit check
OBJECTIVES
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
REQUIRED DOCUMENTATION
All detailed drawings related to reference 2000-14 B 000, 100, 200, 300, 400, 530, 540 Certificate of conformity from subcontractor
COOLER AND TEST CONFIGURATION
N/A
FACILITY AND GROUND SUPPORT EQUIPMENT
Clean room, ambient conditions Metrology devices – weighing machine
TASK DESCRIPTION
- 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 and perform a fit check - Take photographic record of one full set
ACCEPTANCE CRITERIA AND COMMENTS
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
OUTPUT DOCUMENTS
Report in LLB – For all thin wall tubes, report in Inspection Sheet (FI) Photographic records Fill in the “as run procedure”

TASK NUMBER : MA 020

TASK NAME

Laser marking of specific parts

OBJECTIVES

Laser mark all major components for identification purpose

REQUIRED DOCUMENTATION

HSO-SBT-SP-039 (Identification des pièces et sous ensembles)

COOLER AND TEST CONFIGURATION

N/A

FACILITY AND GROUND SUPPORT EQUIPMENT

Operation subcontracted - Under subcontractor responsability

TASK DESCRIPTION

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.

ACCEPTANCE CRITERIA AND COMMENTS

Work performed in accordance with subcontractor quality program

OUTPUT DOCUMENTS

N/A

TASK NUMBER : MA 030

TASK NAME

Cleaning of Parts

OBJECTIVES

Clean all parts

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-0026 (Nettoyage)

COOLER AND TEST CONFIGURATION

N/A

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room, ambient conditions
Cleaning facility

TASK DESCRIPTION

- Clean all parts following cleaning procedure

ACCEPTANCE CRITERIA AND COMMENTS

OUTPUT DOCUMENTS

Report in LLB
Fill in the “as run procedure”

4.2.3 Cooler "heart" / Cooler fully assembled

TASK NUMBER : CO 010
TASK NAME
Pump and Evaporator Pre-assembly
OBJECTIVES
Electron beam welding of thin wall titanium tubes with evaporator and pump half titanium sphere
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
N/A
FACILITY AND GROUND SUPPORT EQUIPMENT
Dedicated tool provided by SBT Operation subcontracted - Under subcontractor responsability
TASK DESCRIPTION
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
ACCEPTANCE CRITERIA AND COMMENTS
Work performed in accordance with subcontractor quality program Outcome of task CO 020
OUTPUT DOCUMENTS
Certificate of conformity

TASK NUMBER : CO 020

TASK NAME

Welding Inspection and Leaktightness Tests

OBJECTIVES

Verify the quality and leaktightness of the welds

REQUIRED DOCUMENTATION

N/A

COOLER AND TEST CONFIGURATION

N/A

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room - Ambient conditions
Helium leak detector (mass spectrometer)

TASK DESCRIPTION

Use appropriate rubber plugs and connection to leak detector to check for the leaktightness of the welded joint under vacuum.

ACCEPTANCE CRITERIA AND COMMENTS

Leakrates level must not exceed 10^{-9} mB.Ls^{-1}

OUTPUT DOCUMENTS

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

TASK NUMBER : CO 030

TASK NAME

Soldering of Thermal Shunt and Fill Tube

OBJECTIVES

Assemble (brazing) the thermal shunt and fill tube with the pumping line

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

N/A

FACILITY AND GROUND SUPPORT EQUIPMENT

Dedicated tool provided by SBT
Operation subcontracted – Under subcontractor responsability

TASK DESCRIPTION

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

ACCEPTANCE CRITERIA AND COMMENTS

Work performed in accordance with subcontractor quality program

OUTPUT DOCUMENTS

Certificate of conformity

TASK NUMBER : CO 040

TASK NAME

Assembly of Pump and Evaporator Half Sphere

OBJECTIVES

Brazing of copper end parts to pump and evaporator half titanium sphere + internal copper structures to copper end parts (pump and evap).

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

N/A

FACILITY AND GROUND SUPPORT EQUIPMENT

Operation subcontracted – Under subcontractor responsability

TASK DESCRIPTION

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)

ACCEPTANCE CRITERIA AND COMMENTS

Work performed in accordance with subcontractor quality program
Once parts are back at SBT : perform a leaktightness test : Leakrates level must not exceed 10^{-9} mB.Ls^{-1}

OUTPUT DOCUMENTS

Certificate of conformity

TASK NUMBER : CO 050

TASK NAME

Baking and Mounting of Procelit

OBJECTIVES

Insert the porous material (Procelit) use for liquid confinement into evaporator

REQUIRED DOCUMENTATION

N/A

COOLER AND TEST CONFIGURATION

Cooler partly assembled

FACILITY AND GROUND SUPPORT EQUIPMENT

Baking chamber equipped with primary vacuum pump

TASK DESCRIPTION

1. Weights Part ref. B206 (Procelit) prior to baking
2. Baked out Part B206 at 100°C under vacuum (primary) for 12 hours minimum (overnight)
3. Weights Part B206 after baking
4. Insert Part B206 into evaporator cup (Part ref. B203)

ACCEPTANCE CRITERIA AND COMMENTS

No damages acceptable to Part B206

OUTPUT DOCUMENTS

Report in the LLB

TASK NUMBER : CO 060

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
Fill in the “as run procedure”

TASK NUMBER : CO 070

TASK NAME

Gluing of Grid and Cover

OBJECTIVES

Install the filter mesh at the input of the pumping line on the sorption pump side

REQUIRED DOCUMENTATION

Related drawings

COOLER AND TEST CONFIGURATION

Cooler partly assembled

FACILITY AND GROUND SUPPORT EQUIPMENT

N/A

TASK DESCRIPTION

- 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.

ACCEPTANCE CRITERIA AND COMMENTS

No Stycast acceptable on the mesh.

OUTPUT DOCUMENTS

Report in the LLB

TASK NUMBER : CO 080
TASK NAME
Assembly of Evaporator Copper Half Sphere
OBJECTIVES
Close the internal evaporator copper sphere containing the Procelit piece
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
Operation subcontracted – Under subcontractor responsability
TASK DESCRIPTION
See HSO-SBT-FC-023 EB weld Part ref B203 with Part ref B204 (closing of Procelit copper casing)
ACCEPTANCE CRITERIA AND COMMENTS
Work performed in accordance with subcontractor quality program
OUTPUT DOCUMENTS
Certificate of conformity

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 responsability

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
- 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
Once parts are back at SBT : perform a leaktightness test : Leakrates level must not exceed 10^{-9} mB.Ls^{-1}
Final acceptance established at output of task CO120 (leaktightness and proof pressure test)

OUTPUT DOCUMENTS

Certificate of conformity
Report outcome in Inspection Sheet (FI)

TASK NUMBER : CO 100

TASK NAME

Assembling and heat treatment of straps

OBJECTIVES

Production of thermal straps (evaporator and sorption pump side + shunt)

REQUIRED DOCUMENTATION

Related drawings
HSO-SBT-SP-014 (Spécifications qualité appliquées à la fabrication)
HSO-SBT-FC-023 (Organigramme des soudures)
2000-14 B530, 2000-14 B540, 2000-14 B550

COOLER AND TEST CONFIGURATION

N/A

FACILITY AND GROUND SUPPORT EQUIPMENT

Operation either partly subcontracted and performed at SBT– Under subcontractor responsability

TASK DESCRIPTION

1. TIG welding of copper braid with part ref. B531 and part ref. B532
2. TIG welding of copper braid with part ref. B541 and part ref. B542
3. TIG welding of copper braid with part ref. B551 and part ref. B552
4. If necessary heat treatment of straps following procedure HSO-SBT-PR-080

ACCEPTANCE CRITERIA AND COMMENTS

Work performed in accordance with subcontractor and SBT quality program

OUTPUT DOCUMENTS

TASK NUMBER : CO 110

TASK NAME

Gold Plating

OBJECTIVES

Gold plating of all external copper surfaces

REQUIRED DOCUMENTATION

HSO-SBT-SP-044 (Définition des pièces à dorer)

COOLER AND TEST CONFIGURATION

N/A

FACILITY AND GROUND SUPPORT EQUIPMENT

Operation subcontracted – Under subcontractor responsability

TASK DESCRIPTION

Gold plate all external copper surfaces (nota : to the exception of: the surfaces indicated in HSO-SBT-SP-044)

- pump and evaporator cold tip
- thermal shunt
- thermal straps – end piece only (evaporator, pump and shunt)
- switches head and base

ACCEPTANCE CRITERIA AND COMMENTS

Work performed in accordance with subcontractor quality program

OUTPUT DOCUMENTS

Certificate of conformity

TASK NUMBER : CO 120

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 ^{4}He 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)
Fill in the “as run procedure”

TASK NUMBER : CO 130

TASK NAME

Cleaning and baking of Cooler Heart / Structure

OBJECTIVES

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

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-0026 (Nettoyage)
Procedure HSO-SBT-PR-0035 (Etuvage)

COOLER AND TEST CONFIGURATION

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

FACILITY AND GROUND SUPPORT EQUIPMENT

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

TASK DESCRIPTION

Clean out the cooler heart and structure following cleaning procedure
Bake out at 80°C under vacuum (primary) for 12 hours minimum
Once baked and cleaned, parts must be kept in appropriate environment (plastic bag under helium gas is acceptable) and the fill tube must be plugged with a rubber plug

ACCEPTANCE CRITERIA AND COMMENTS

N/A

OUTPUT DOCUMENTS

Report in the LLB
Fill in the “as run procedure”

TASK NUMBER : CO 140

TASK NAME

Gluing of Thermal Parts / Pre wiring

OBJECTIVES

Instrument the cooler heart with heaters and thermometers

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-033 (Collage, thermalisation et soudure des composants)

COOLER AND TEST CONFIGURATION

Cooler heart almost fully assembled

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room – Ambient conditions

TASK DESCRIPTION

Glue all required heaters and thermometers on the evaporator, sorption pump and thermal shunt, using Stycast 2850 FT (see procedure HSO-SBT-PR-033)
Pre wire all components, including thermal anchoring at shunt of wires routed to the evaporator (see procedure). All wires are twisted manganin wires 200 µm diameter.

ACCEPTANCE CRITERIA AND COMMENTS

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

OUTPUT DOCUMENTS

Report in the LLB
Fill in the “as run procedure”

TASK NUMBER : CO 150

TASK NAME

Performance Test (Cooler Empty)

OBJECTIVES

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

REQUIRED DOCUMENTATION

Partly apply : Procedure HSO-SBT-PR-029 (Remplissage du cooler)

COOLER AND TEST CONFIGURATION

Cooler heart mounted in test cryostat following procedure HSO-SBT-PR-029. Cooler fill tube connected to cryostat internal high pressure circuitry (once cooler is connected, circuitry must been 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.

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 ^{3}He gas (or ^{4}He)

OUTPUT DOCUMENTS

Report in LLB – Test report

TASK NUMBER : CO 160

TASK NAME

^{3}He Filling of Cooler / Pre test (Cold Phase)

OBJECTIVES

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

REQUIRED DOCUMENTATION

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

COOLER AND TEST CONFIGURATION

Idem CO 150

FACILITY AND GROUND SUPPORT EQUIPMENT

Idem as CO 150, plus high pressure ^{3}He 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 ^{3}He bottle to cryostat internal high pressure circuitry
2. Turn ON both heat switches
3. Inject the appropriate amount of ^{3}He gas – check for any internal leak (cryostat vacuum)
4. Close high pressure ^{3}He bottle and valves to cryostat

ACCEPTANCE CRITERIA AND COMMENTS

Internal pressure at room temperature consistent with prediction (check at warm up) – see CO170.

OUTPUT DOCUMENTS

Report in the LLB
Fill in the “as run procedure”

TASK NUMBER : CO 170

TASK NAME

Crimping of Cooler

OBJECTIVES

Crimp the cooler fill tube. Cooler heart becomes then self contained.

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-030 (Quesottage)

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. Leak detector with the ^{3}He mass option. Test box (vacuum jacket)

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 / cut it / Soft solder plug it / Release crimp tool
3. Leak test / glue Part ref. B221 on crimped tube
4. Perform final leak test

ACCEPTANCE CRITERIA AND COMMENTS

Before crimping internal cooler pressure must be 8 MPa at 20°C to within 5%
Leakrates level must not exceed 10^{-9} l.mB.s^{-1} or vacuum box ^{3}He background measured prior to insertion of cooler

OUTPUT DOCUMENTS

Report in the LLB – Report outcome in Inspection sheet (FI)
Fill in the “as run procedure”

TASK NUMBER : CO 180

TASK NAME

Mounting of Mechanical Items

OBJECTIVES

Install all pulleys and axis on the evaporator and sorption pump

REQUIRED DOCUMENTATION

Detailed drawings 2000-14 B 000 and associated drawings

COOLER AND TEST CONFIGURATION

Cooler heart almost fully assembled

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room – Ambient conditions

TASK DESCRIPTION

Task name and objectives are self descriptive. All torques must be verified.

ACCEPTANCE CRITERIA AND COMMENTS

No damage on pulleys and capstans surfaces acceptable

OUTPUT DOCUMENTS

Report in the LLB

TASK NUMBER : CO 190

TASK NAME

Mounting of Cooler into Main Structure

OBJECTIVES

To insert cooler heart into the structural box and to install all Kevlar cords

REQUIRED DOCUMENTATION

Partly apply : Procedure HSO-SBT-PR-028 (Installation et réglages des suspentes Kevlar)

COOLER AND TEST CONFIGURATION

Cooler heart fully assembled and structural box

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room – Ambient conditions

TASK DESCRIPTION

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)

ACCEPTANCE CRITERIA AND COMMENTS

See procedure – Visual check, cooler heart centered, etc..

OUTPUT DOCUMENTS

Report in the LLB
Fill in the “as run procedure”

TASK NUMBER : CO 200

TASK NAME

Processing of Kevlar strings

OBJECTIVES

Thermally trained and tune the suspension system (Kevlar strings) to stabilize the tension (Kevlar).

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-028 (Installation et réglages des suspentes Kevlar)

COOLER AND TEST CONFIGURATION

Cooler heart mounted inside structural box

FACILITY AND GROUND SUPPORT EQUIPMENT

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

TASK DESCRIPTION

Follow procedure HSO-SBT-PR-028
After initial tensioning of strings, suspension system is baked three times at 80°C for 4 hours and is retensioned during the process.

ACCEPTANCE CRITERIA AND COMMENTS

OUTPUT DOCUMENTS

Report in the LLB.
Report measured tension in Inspection Sheet (FI)
Fill in the “as run procedure”

TASK NUMBER : CO 210

TASK NAME

Integration of Heat Switches

OBJECTIVES

Integrate the two heat switches inside the cooler

REQUIRED DOCUMENTATION

Related drawings

COOLER AND TEST CONFIGURATION

Cooler heart mounted inside structural box

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room – Ambient conditions

TASK DESCRIPTION

Mechanically mount the two heat switches inside the cooler structural box.
The recommended torque for the three holding screws is 2.1 Nm.

ACCEPTANCE CRITERIA AND COMMENTS

Must be done with great care : thin titanium tube on heat switch is fragile and critical to the performance of the heat switch / cooler
Verify the electrical isolation with respect to the structure

OUTPUT DOCUMENTS

Report in the LLB

TASK NUMBER : CO 220

TASK NAME

Cabling and Soldering of Connectors and Thermal Parts

OBJECTIVES

Connect all thermometers and heaters to the two electrical connectors via manganin wires

REQUIRED DOCUMENTATION

Interface Control Document (HSO-SBT-ICD-012)
Procedure HSO-SBT-PR-033 (Collage, thermalisation et soudure des composants)

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
Refer to wiring table in ICD. All the wires connected to the evaporator are thermally anchored to the thermal shunt (done previously at task CO 140)

ACCEPTANCE CRITERIA AND COMMENTS

Visual check
Electrical resistance check (component resistance and electrical isolation with regards to cooler)
Electrical isolation of cooler heart and heat switch with the structure (Nota : make sure the centering screws (transit screws) are removed)

OUTPUT DOCUMENTS

Report in LLB – Report outcome in Inspection Sheet (FI)
Fill in the “as run procedure”

TASK NUMBER : CO 230

TASK NAME

Mounting and Adjustment of Snubbers

OBJECTIVES

Mechanically mount and adjust the snubbers on the heat switches to prevent any excessive lateral motion

REQUIRED DOCUMENTATION

Related drawings

COOLER AND TEST CONFIGURATION

Cooler heart + heat switches mounted inside structural box

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room – Ambient conditions

TASK DESCRIPTION

Mount and adjust the snubbers (Part ref. B119, B120, B311). The snubbers must be centered with regards to the “inside” part.

ACCEPTANCE CRITERIA AND COMMENTS

No contact is acceptable between snubber and “inside” part

OUTPUT DOCUMENTS

Report in the LLB

TASK NUMBER : CO 240

TASK NAME

Integration of Thermal Straps

OBJECTIVES

Connect the thermal straps : switch end to evaporator, switch end to pump and shunt to evaporator switch base

REQUIRED DOCUMENTATION

Related drawings

COOLER AND TEST CONFIGURATION

Cooler heart + heat switches mounted inside structural box

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room – Ambient conditions

TASK DESCRIPTION

1. Secure the cooler heart with the centering screws (B134, B135)
2. Connect thermal strap B530 between the pump heat switch and sorption pump cold tip
3. Connect thermal strap B540 between the evaporator heat switch and evaporator cold tip
4. Connect thermal strap B550 between the shunt and the evaporator switch base
5. Remove the centering screws

ACCEPTANCE CRITERIA AND COMMENTS

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

OUTPUT DOCUMENTS

Report in the LLB

TASK NUMBER : CO 250

TASK NAME

Final assembly

OBJECTIVES

Complete the final assembly of the cooler

REQUIRED DOCUMENTATION

Related drawings

COOLER AND TEST CONFIGURATION

Cooler fully operational.

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room – Ambient conditions

TASK DESCRIPTION

1. Set in place Part ref. B136 (guiding tube)
2. Mount the two lateral plates ref. B404 and B405
3. Mount Part ref. B137 (evaporator cover)
4. Mount Part ref. B124 (pump cover)

ACCEPTANCE CRITERIA AND COMMENTS

Visual check

OUTPUT DOCUMENTS

Report in the LLB

TASK NUMBER : CO 260

TASK NAME

Thermal Test #1 (reference – Health Check (HCR))

OBJECTIVES

Perform a thermal check of the cooler performance. This test sequence defines the test referenced as 'Health Check"

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-031 (Health Check)

COOLER AND TEST CONFIGURATION

Operational 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 procedure HSO-SBT-PR-031. Summary of data recorded :

1. Leak rate (before and after thermal tests)
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 30 and 200 µW load

ACCEPTANCE CRITERIA AND COMMENTS

Results shall be consistent with predictions
See procedure HSO-SBT-PR-031 and health check data sheet. This test will then serve as a reference for all subsequent thermal tests.

OUTPUT DOCUMENTS

Report in LLB – Health Check Report (HCR) data sheet

TASK NUMBER : CO 270

TASK NAME

Thermal Vacuum

OBJECTIVES

Bake out the cooler at 80°C under vacuum for 5 days to check for any effect on the performance

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-035 (Etuvage)

COOLER AND TEST CONFIGURATION

Cooler fully assembled – Self standing unit

FACILITY AND GROUND SUPPORT EQUIPMENT

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

TASK DESCRIPTION

Follow procedure HSO-SBT-PR-035
Bake out the cooler at 80°C under vacuum (primary) for 5 days
Note : no thermal cycling foreseen

ACCEPTANCE CRITERIA AND COMMENTS

No visual damage – this test is followed by a heath check to check for the cooler integrity

OUTPUT DOCUMENTS

Report in LLB + Log Book
Fill in the “as run procedure”

TASK NUMBER : CO 280

TASK NAME

Thermal Test #2 (HCR)

OBJECTIVES

Verify the cooler performance are not affected after the thermal vacuum (bake out)

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-031 (Health Check)

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 procedure HSO-SBT-PR-031. Summary of data recorded :

1 Leak rate (before and after thermal tests)
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 30 and 200 µW load

ACCEPTANCE CRITERIA AND COMMENTS

Results shall be consistent with the first set of data established during Task CO 260 (first health check)
See procedure HSO-SBT-PR-031 and health check data sheet.

OUTPUT DOCUMENTS

Report in LLB + Log Book – Health Check Report (HCR) data sheet

TASK NUMBER : CO 290

TASK NAME

Vibration Test

OBJECTIVES

Determine the resonant frequencies and demonstrate the ability of the cooler to withstand the V test

REQUIRED DOCUMENTATION

Vibration levels (HSO-SBT-SP-001)
Procedure HSO-SBT-PR-045 (Tests Vibratoires)

COOLER AND TEST CONFIGURATION

Cooler fully assembled – Self standing unit. Clean room – Ambient conditions

FACILITY AND GROUND SUPPORT EQUIPMENT

Operation subcontracted – Under CEA-SBT and subcontractor responsability.

TASK DESCRIPTION

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.

ACCEPTANCE CRITERIA AND COMMENTS

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 and SBT PA Plan

OUTPUT DOCUMENTS

Report in LLB + Log Book – Test report (from subcontractor)

TASK NUMBER : CO 300

TASK NAME

Thermal Test #3 (HCR)

OBJECTIVES

Verify the cooler performance are not affected after the vibration tests

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-031 (Health Check)

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 procedure HSO-SBT-PR-031. Summary of data recorded :

1. Leak rate (before and after thermal tests)
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 30 and 200 µW load

ACCEPTANCE CRITERIA AND COMMENTS

Results shall be consistent with the first set of data established during Task CO 260 (first health check)
See procedure HSO-SBT-PR-031 and health check data sheet.

OUTPUT DOCUMENTS

Report in LLB + Log Book – Health Check Report (HCR) data sheet

TASK NUMBER : CO 310

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 µW 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 predictions

OUTPUT DOCUMENTS

Report in LLB + Log Book – Test Report

TASK NUMBER : CO 320

TASK NAME

Packing

OBJECTIVES

Pack the cooler before delivery

REQUIRED DOCUMENTATION

CQM : Procedure HSO-SBT-PR-077 (Handling, packing, transportation and storage manual) (applies also to FM for now).

COOLER AND TEST CONFIGURATION

Cooler fully assembled – Self standing unit, cleaned.

FACILITY AND GROUND SUPPORT EQUIPMENT

Dedicated transportation container

TASK DESCRIPTION

Before packing : perform a last leaktightness test
Follow procedure HSO-SBT-PR-077. Summary :

- mounting of cooler inside inner container
- purging with dry nitrogen
- mounting of inner container inside transportation container

ACCEPTANCE CRITERIA AND COMMENTS

Leakrates level must not exceed 10^{-9} mB.Ls^{-1}
Internal pressure of inner container must remains at least 100 mB above atmospheric pressure

OUTPUT DOCUMENTS

Report in LLB + Log Book

TASK NUMBER : CO 330

TASK NAME

Delivery

OBJECTIVES

Deliver the cooler to RAL (SPIRE) or SAp (PACS)

REQUIRED DOCUMENTATION

Acceptance Data Package

COOLER AND TEST CONFIGURATION

Cooler fully assembled – Self standing unit, cleaned and packed in transportation container

FACILITY AND GROUND SUPPORT EQUIPMENT

Transportation box. The cooler is carried by car or train and is accompanied

TASK DESCRIPTION

Review of documentation
Delivery of cooler

ACCEPTANCE CRITERIA AND COMMENTS

- No damage during transportation
- Shock level indicator not triggered

OUTPUT DOCUMENTS

Report in LLB + Log Book. Acceptance Data Package (including Log Book)

4.2.4 Structure

TASK NUMBER : ST 010
TASK NAME
Assembly of Main Structure
OBJECTIVES
EB Welding of parts composing the main structural box
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
N/A
FACILITY AND GROUND SUPPORT EQUIPMENT
Dedicated tool provided by SBT Operation subcontracted - Under subcontractor responsability
TASK DESCRIPTION
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)
ACCEPTANCE CRITERIA AND COMMENTS
Work performed in accordance with subcontractor quality program Assembled structure in accordance with drawings specifications
OUTPUT DOCUMENTS
Certificate of conformity

TASK NUMBER : ST 020

TASK NAME

Final Machining of Main Structure

OBJECTIVES

Remove by machining the extra material (TA6V) initially left for EB welding purpose

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

N/A

FACILITY AND GROUND SUPPORT EQUIPMENT

Operation subcontracted – Under subcontractor responsability

TASK DESCRIPTION

Remove by machining the extra material (TA6V) initially left for EB welding purpose on the support structure

ACCEPTANCE CRITERIA AND COMMENTS

Work performed in accordance with subcontractor quality program

OUTPUT DOCUMENTS

Certificate of conformity

TASK NUMBER : ST 030
TASK NAME
Cleaning of Structure
OBJECTIVES
Clean the structure (after final assembly and laser marking)
REQUIRED DOCUMENTATION
N/A
COOLER AND TEST CONFIGURATION
N/A
FACILITY AND GROUND SUPPORT EQUIPMENT
Operation subcontracted – Under subcontractor responsability
TASK DESCRIPTION
Clean the structure to remove all trace of contamination (grease, machining, etc…)
ACCEPTANCE CRITERIA AND COMMENTS
Work performed in accordance with subcontractor quality program
OUTPUT DOCUMENTS
Certificate of conformity

4.2.5 Heat Switches

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

TASK NUMBER : HS 020

TASK NAME

Assembly - Switch

OBJECTIVES

Assemble the heat switch

REQUIRED DOCUMENTATION

Related drawings : 2000-14 B300
HSO-SBT-SP-014 (Spécifications qualité appliquées à la fabrication)
HSO-SBT-FC-023 (Organigramme des soudures)

COOLER AND TEST CONFIGURATION

N/A

FACILITY AND GROUND SUPPORT EQUIPMENT

Operation subcontracted – Under subcontractor responsability

TASK DESCRIPTION

See HSO-SBT-FC-023
Brazing of part ref. B301, B302, 103, B309/B310, B305, B306

ACCEPTANCE CRITERIA AND COMMENTS

Work performed in accordance with subcontractor quality program
Acceptance established at output of task HS 030 (leaktightness test)

OUTPUT DOCUMENTS

Certificate of conformity

TASK NUMBER : HS 030

TASK NAME

Leak Tightness Test

OBJECTIVES

Verify the quality and leaktightness of all joints

REQUIRED DOCUMENTATION

N/A

COOLER AND TEST CONFIGURATION

Heat switch partly assembled

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room - Ambient conditions
Helium leak detector (mass spectrometer)

TASK DESCRIPTION

Use appropriate rubber plugs and connection to leak detector to check for the leaktightness of all joints under vacuum.

ACCEPTANCE CRITERIA AND COMMENTS

Leakrates level must not exceed 10^{-9} mB.Ls^{-1}

OUTPUT DOCUMENTS

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

TASK NUMBER : HS 040

TASK NAME

Charcoal mounting

OBJECTIVES

Pre assembly of miniature sorption pump

REQUIRED DOCUMENTATION

N/A

COOLER AND TEST CONFIGURATION

Heat switch partly assembled

FACILITY AND GROUND SUPPORT EQUIPMENT

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

TASK DESCRIPTION

1. Perform a visual selection of charcoal pellets
2. Bake out at 140°C under vacuum (primary) the charcoal pellets for 12 hours minimum
3. Weights and prepare the appropriate amount, ie 20 milligrams
4. Insert the fine mesh inside the minipump (B306) and then the pellet into the minipump

ACCEPTANCE CRITERIA AND COMMENTS

N/A

OUTPUT DOCUMENTS

Report in the LLB

TASK NUMBER : HS 050

TASK NAME

Closing of Minipump

OBJECTIVES

EB weld the minipump cap

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

Heat switch partly assembled

FACILITY AND GROUND SUPPORT EQUIPMENT

Operation subcontracted – Under subcontractor responsability

TASK DESCRIPTION

See HSO-SBT-FC-023
EB weld Part ref. B306 with Part ref. B307

ACCEPTANCE CRITERIA AND COMMENTS

Work performed in accordance with subcontractor quality program
Acceptance established at output of task HS 060 (leaktightness test)
After this operation the heat switch must be kept in a clean environment – Put a rubber plug on fill tube

OUTPUT DOCUMENTS

Certificate of conformity

TASK NUMBER : HS 060

TASK NAME

Leak Tightness Test

OBJECTIVES

Verify the leaktightness of the heat switch

REQUIRED DOCUMENTATION

N/A

COOLER AND TEST CONFIGURATION

Heat switch partly assembled

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room - Ambient conditions
Helium leak detector (mass spectrometer)

TASK DESCRIPTION

Use appropriate connection to leak detector to check for the leaktightness of the heat switches under vacuum

ACCEPTANCE CRITERIA AND COMMENTS

Leakrates level must not exceed 10^{-9} mB.Ls^{-1}

OUTPUT DOCUMENTS

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

TASK NUMBER : HS 070

TASK NAME

Gold Plating

OBJECTIVES

Gold plating of all external copper surfaces

REQUIRED DOCUMENTATION

HSO-SBT-SP-044 (Définition des pièces à dorer)

COOLER AND TEST CONFIGURATION

N/A

FACILITY AND GROUND SUPPORT EQUIPMENT

Operation subcontracted – Under subcontractor responsability

TASK DESCRIPTION

Gold plate all external copper surfaces (nota : to the exception of the surfaces indicated in HSO-SBT-SP-044) :

- heat switches head and base

Once switch is back at SBT : perform a leaktightness test : Leakrates level must not exceed 10^{-9} mB.Ls^{-1}

ACCEPTANCE CRITERIA AND COMMENTS

Work performed in accordance with subcontractor quality program

OUTPUT DOCUMENTS

Certificate of conformity

TASK NUMBER : HS 080

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
Fill in the “as run procedure”

TASK NUMBER : HS 90

TASK NAME

Filling / Crimping of Heat Switch

OBJECTIVES

Fill the heat switch with ^{3}He gas and crimp it

REQUIRED DOCUMENTATION

Procedure HSO-SBT-PR-036 (Remplissage de l'interrupteur)
Procedure HSO-SBT-PR-030 (Quesottage)

COOLER AND TEST CONFIGURATION

Heat switch partly assembled

FACILITY AND GROUND SUPPORT EQUIPMENT

Clean room – Ambient conditions. 3He gas bottle with appropriate manometers and valves. Crimping tool. Soldering tool. Leak detector with the ^{3}He mass option. Test box (vacuum jacket)

TASK DESCRIPTION

Follow procedure HSO-SBT-PR-036 and HSO-SBT-PR-030. Summary :

- Leakcheck and then fill the switch
- Crimp the fill tube / cut it / Soft solder plug it / Release crimp tool
- Leak test / glue Part ref. B308 on crimped tube
- Perform final leak test

ACCEPTANCE CRITERIA AND COMMENTS

Visual check
Leakrates level must not exceed 10^{-9} mB.Ls^{-1} or vacuum box background measured prior to insertion of switch

OUTPUT DOCUMENTS

Report in the LLB – Report outcome in Inspection sheet (FI)
Fill in the "as run procedure"

TASK NUMBER : HS 100
TASK NAME
Gluing of Thermometers and heaters / Pre wiring
OBJECTIVES
Instrument the heat switch with heaters and thermometers
REQUIRED DOCUMENTATION
Procedure HSO-SBT-PR-033 (Collage, thermalisation et soudure des composants)
COOLER AND TEST CONFIGURATION
Heat switch almost fully assembled
FACILITY AND GROUND SUPPORT EQUIPMENT
Clean room – Ambient conditions
TASK DESCRIPTION
Glue all required heaters and thermometers on the minature sorption pump using Stycast 2850 FT (see procedure HSO-SBT-PR-033) Pre wire all components using twisted manganin wires 200 µm diameter.
ACCEPTANCE CRITERIA AND COMMENTS
Visual check Electrical resistance check (component resistance and electrical isolation with regards to switch).
OUTPUT DOCUMENTS
Report in LLB Fill in the “as run procedure”

TASK NUMBER : HS 110

TASK NAME

Thermal characterization of heat switch

OBJECTIVES

Thermally characterize the gas gap heat switch

REQUIRED DOCUMENTATION

N/A

COOLER AND TEST CONFIGURATION

Heat switch fully assembled and operational, 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, etc…

TASK DESCRIPTION

Summary of data recorded (two set of tests :bath cryostat (T0) at 4.2 K and 1.6 K):

1. Switch OFF : power transmitted between T0 and T up to 40 K. More data at T close to T0
2. Switch ON : power transmitted between T0 and T up to 10-12 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).

ACCEPTANCE CRITERIA AND COMMENTS

Results shall be consistent with predictions

OUTPUT DOCUMENTS

Report in LLB – Test report

5 Appendix

5.1 Health Check Report data sheet

Grenoble	***SPIRE & PACS Sorption Coolers*** ***HEALTH CHECK REPORT (HCR)*** (Version 2.1)	**Référence :** **HCR#**
Référence cryoréfrigérateur : ***Raison du contrôle :***		Date : Nom : Signature :

Contrôle mécanique / électrique Visuel :

Tension des brins Kevlar (mesurée coté pompe)

Avant test Fil 1/8 : Fil 2/8 : Après test Fil 1/8 : Fil 2/8 :

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 (P/R)	C pompe	T inter P	C inter. P	T évaporat.	T inter évap.	C inter évap.	T shunt
/	/	/	/	/	/	/	/

Vérification isolation électrique :

Remarques :

Contrôle de fuite Référence détecteur :

Valeur de fuite mesurée / Avant : Après : 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 : vertical évaporateur en bas (***+90***) et vertical évaporateur en haut (***-90***)

Charge (µW)	0 (Tmini)	10	20	30	40	50	100
T (mK) / ***+90***							
T (mK) / ***-90***							

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 :
Autonomie et temperature sous 30 µW de charge appliquée :

Conformité ***OUI*** ***NON***

RAPPORT :

Visa Projet - Nom, date et signature :