Procedure Summary

Objectives

This procedure describes the steps to analyze the possible contingencies considered for the cryostat and take actions if required.

The three major contingencies with possibilities to intervene are:

- A leak in the Helium subsystem into the CVV vacuum (most probably occurring during launch only)
- Higher HTT temperature than predicted
- Lower HTT temperature than predicted
- Higher FPU I/F temperatures than predicted

This procedure is based in HP-2-ASED-PR-0110 "Mission contingency procedure input from cryostat".

Summary of Constraints

The cryostat helium subsystem is required to be a passive system. The possibilities to influence the system are very limited.

Any critical decision must be agreed by ESA/TAS/ASED engineering.

If a leak of Helium in the CVV, the only action that can be taken is to open the cryo cover in order to decrease the exceeded temperature in the HTT wall. However, it could have an impact in the telescope decontamination activities.

The cryo cover shall only be opened after agreement with ESA/TAS/ASED engineering, as a last resort.

If HTT temperature is too high or too low, or FPU I/F temperatures are too high, an action shall be taken after agreement or request of scientific intruments.

The recovery action to reduce the L2 temperature by using DLCM heating periodically (as per HP-2-ASED-PR-0141) will have an impact in the mission life time.

Cryostat thermal predictions can be found in HP-2-ASED-RP-0011 "HEPLM Thermal Model and Analysis".

The thermal requirements for instrument FPU interfaces are annexed in sheet

Spacecraft Configuration

Start of Procedure

CDMU in default configuration
CCU monitoring function active

End of Procedure

CDMU in default configuration
CCU monitoring function active

Reference File(s)

Input Command Sequences

Output Command Sequences

Referenced Displays

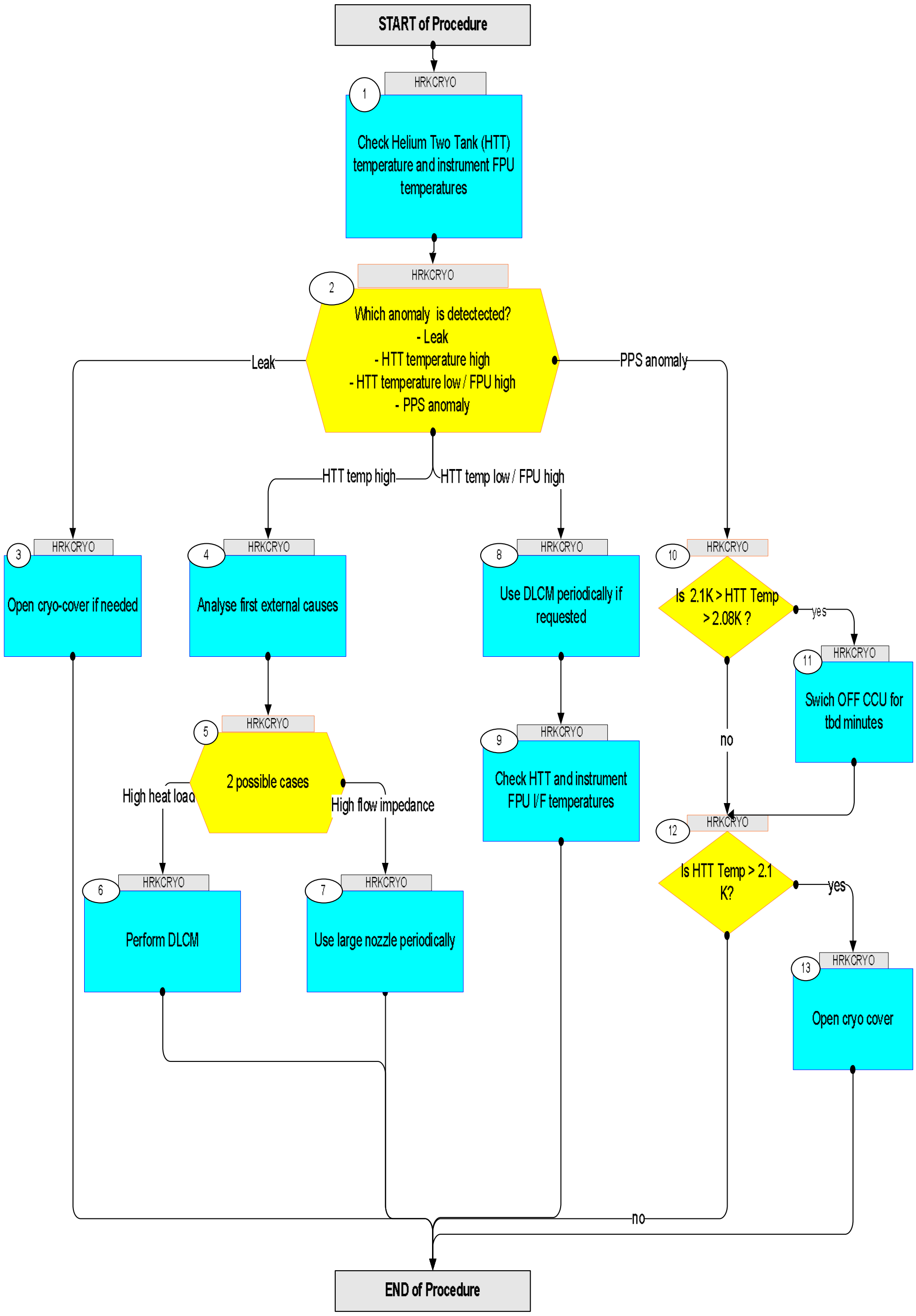
ANDs	GRDs	SLDs
ZAZ9N999		
KA004303		

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
31/07/08	1	1	Created	E. Picallo	
21/02/09	2.1	2	Completed procedure will all info in HP-2-ASED-PR-0110 Added temperature requirements from instruments	E. Picallo	
06/04/09	2.3	3	Summary and Step 3.2 : The Cryo Cover Opening COULD have an impact on the Decontamination Activities In Step 3.1: increase of temperatures average by more than 2mK per min should be observed for more than 10 min	E. Picallo	

Cryostat Anomaly
File: H_CRP_CCU_CRYO.xls
Author: E. Picallo

Procedure Flowchart Overview



Step No.	Time	Activity/Remarks	TC/TLM	Display/ Branch
Beginning of Procedure				
		TC Seq. Name :HRKCRYO (Cryostat Anomaly) *TimeTag Type: N* *Sub Schedule ID:*		
1		*Check Helium Two Tank (HTT) temperature and instrument FPU temperatures*		Next Step: 2
		The HTT temperatures must never exceed 2.1K. **T101, T102, T104, T105, T106, T107 should be in the range [1.55K - 2.1K], nominally 1.65K.** **The instrument FPU temperatures should satisfy the thermal requirements at interface level (L0, L1, L2, L3) reflected in the annexed tables (refer to sheet "FPU Temp").**		
		Execute Procedure: **H_SVT_CCU_MONS** **CCU Temperature and Pressure sensors monitoring**		
1.1		*Verify HTT temperatures on CCU A*		
		Verify DLCM-1, tank lower bulkhead; -x-y; integrated into DLCM housing Telemetry **C100_0_T105** **KD201302**	**>= 1.55 K** **<= 2.1 K**	AND=ZAZ9N999
		Verify DLCM-2, tank lower bulkhead;-x+y; integrated into DLCM housing Telemetry **C100_0_T102** **KD200302**	**>= 1.55 K** **<= 2.1 K**	AND=ZAZ9N999
		Verify Temperature tank lower bulkhead; -x-z+y **C100_2_T106** **KD204302**	**>= 1.55 K** **<= 2.1 K**	AND=ZAZ9N999
1.2		*Verify HTT temperatures on CCU B*		
		Verify DLCM-1, tank lower bulkhead;-x-y; integrated into DLCM housing Telemetry **C100_0_T101** **KD200303**	**>= 1.55 K** **<= 2.1 K**	AND=ZAZ9N999
		Verify DLCM-2, tank lower bulkhead; -x+y; integrated into DLCM housing Telemetry **C100_0_T104** **KD201303**	**>= 1.55 K** **<= 2.1 K**	AND=KA004303
		Verify Temperature tank upper bulkhead; +x-z+y **C100_2_T107** **KD204303**	**>= 1.55 K** **<= 2.1 K**	AND=KA004303

Step No.	Time	Activity/Remarks	TC/TLM	Display/ Branch
2		*Which anomaly is detected?* *- Leak* *- HTT temperature high* *- HTT temperature low / FPU high* *- PPS anomaly*		Next Step: Leak 3 HTT temp high 4 HTT temp low / FPU high 8 PPS anomaly 10
2.1		*Leak*		□
		A significant amount of helium in the isolation vacuum increases the HTT wall temperature, as detected by T106 and T107, above the bath temperature measured by T101, T102, T104 and T105. **A leak can be detected if T106 and/or T107 minus average of {T101,T102,T104,T105} is > 10 mK (difference of temperature between the interior and exterior of the HTT)** **Database Note: Derived parameters should be defined and provided by ASED via HPSDB for leak detection.** **NOTE: this anomaly is only considered before opening the cryo cover. After that, it should not be detectable.**		
2.2		*PPS anomaly*		□
		The operating range of the PPS has been qualified up to 2.1 K. If this temperature is exceeded in the LEOP phase on the sensors T101, T102, T104 and T105, the superfluid helium may brake through and the HTT will be empty very fast. **A high heat load e.g. due to a leak may be the cause.** **WARNING: an anomaly in the CCU might also be the cause for a high heat load. Then, before taking any action, make sure that there is no an anomaly on CCU (refer to procedure H_FCP_CCU_CHECK . If it was the case, refer to procedure H_CRP_CCU_CCUR).** **NOTE: this anomaly is only considered before opening the cryo cover.**		
2.3		*HTT temp high*		□
		If sensors T101, T102, T104, T105 show higher values compared to the prediction (> 2.1 K) **NOTE: it should be confirmed by a request from the scientific instruments.**		

Step No.	Time	Activity/Remarks	TC/TLM	Display/ Branch
2.4		*HTT temperature low / FPU high*		□
		If sensors T101, T102, T104, T105 show lower values compared to the prediction (< 1.55K) **OR** **FPU I/F temperatures show higher values compared to the estimated max operating temperature (refer to tables in sheet "FPU Temp")** **NOTE: it should be confirmed by a request from the scientific instruments.** **In case of higher FPU and lower HTT temperatures than expected, the instruments experts shall determine if it could affect the instrument performances and they shall decide to take or not the necessary action to reduce the instrument temperature.**		
3		*Open cryo-cover if needed*		Next Step: END
		Check the difference between T106/T107 and the average of {T101,T102,T104,T105} (a derived parameter should be defined and provided by ASED via HPSDB) **Verify that noise on the data is not corrupting the results.**		
3.1		*If a serious leak problem*		□
		If the difference between T106/T107 and the average of {T101,T102,T104,T105} increases by more than 2mK per minute observed for more than 10 min (as the measured temperatures may show significant noise), then open cryo cover. **NOTE: The cryo cover shall only be opened after agreement with ESA/TAS/ASED engineering.**		
3.2		*Open cryo cover*		□
		Execute Procedure: **H_LEO_EPS_NCA** **NCA activation**		
		WARNING: the opening of the cryo cover could have an impact in the decontamination activities. **A discussion shall be required to decide if continue or stop the decontamination (in case it is already running) or to start it (in case it is not yet activated).**		

Step No.	Time	Activity/Remarks	TC/TLM	Display/ Branch
3.3		*Verify Helium Two Tank (HTT) temperature*		
		Chech difference between T106/T107 and the average of {T101,T102,T104,T105}		
3.3.1		*Verify HTT temperatures on CCU A*		
		Verify Temperature tank lower bulkhead; -x-z+y **C100_2_T106** **KD204302**		AND=ZAZ9N999
		Verify DLCM-1, tank lower bulkhead; -x-y; integrated into DLCM housing Telemetry **C100_0_T105** **KD201302**		AND=ZAZ9N999
		Verify DLCM-2, tank lower bulkhead;-x+y; integrated into DLCM housing Telemetry **C100_0_T102** **KD200302**		AND=ZAZ9N999
3.3.2		*Verify HTT temperatures on CCU B*		
		Verify Temperature tank upper bulkhead; +x-z+y **C100_2_T107** **KD204303**		AND=ZAZ9N999
		Verify DLCM-1, tank lower bulkhead;-x-y; integrated into DLCM housing Telemetry **C100_0_T101** **KD200303**		AND=ZAZ9N999
		Verify DLCM-2, tank lower bulkhead; -x+y; integrated into DLCM housing Telemetry **C100_0_T104** **KD201303**		AND=ZAZ9N999
4		*Analyse first external causes*		Next Step: 5
		Decisions are not urgent. **To determine the possible causes, different analysis shall be performed by cryo and instruments experts, and after discussion, a decision shall be taken to cope with the problem.** **e.g:** **- First external causes should be analysed (as sun aspect angle, CVV temperature...)** **- Estimate current mass flow by running H-EPLM - TMM** **This might have two causes:** **- The heat load on the HTT is higher leading to a higher mass flow** **- The flow impedance in the vent line is higher**		
5		*2 possible cases*		Next Step: High heat load 6 High flow impedance 7

Step No.	Time	Activity/Remarks	TC/TLM	Display/ Branch
5.1		*High heat load*		☐
5.2		*High flow impedance*		☐
6		*Perform DLCM*		Next Step: END
		Perform DLCM and inform SOM about new predicted lifetime		
		Execute Procedure: **H_FCP_CCU_DLCM** **CCU DLCM**		
7		*Use large nozzle periodically*		Next Step: END
		Use large nozzle by switching V504 or V505 periodically in agreement with scientific instruments to decrease the temperature to the expected values		
7.1		*Open big nozzle valves*		☐
		Execute Procedure: **H_CRP_CCU_VBN0** **Big Nozzle Open**		
7.2		*Wait the requested time (tbd by experts)*		☐
		Verify HTT temperatures reaching expected values		
		Verify DLCM-1, tank lower bulkhead; -x-y; integrated into DLCM housing Telemetry **C100_0_T105** **KD201302**		AND=ZAZ9N999
		Verify DLCM-2, tank lower bulkhead;-x+y; integrated into DLCM housing Telemetry **C100_0_T102** **KD200302**		AND=ZAZ9N999
		Verify DLCM-1, tank lower bulkhead;-x-y; integrated into DLCM housing Telemetry **C100_0_T101** **KD200303**		AND=ZAZ9N999
		Verify DLCM-2, tank lower bulkhead; -x+y; integrated into DLCM housing Telemetry **C100_0_T104** **KD201303**		AND=ZAZ9N999
7.3		*Close big nozzle valves*		☐

Step No.	Time	Activity/Remarks	TC/TLM	Display/ Branch
		Execute Procedure: **H_CRP_CCU_VBN1** **Big Nozzle Close**		
8		*Use DLCM periodically if requested*		Next Step: 9
		If the scientific instruments have a serious request, use DLCM heating periodically to reduce the FPU I/F temperatures to the expected values. **DLCM can be used as a contingency operation to reduce L2 temperature by increasing the Helium mass periodically , according to HP-2-ASED-PR-0141.** **The DLCM strategy shall be decided by instrument and cryo experts (i.e. to use one or both DLCM, which application period). In this case, the post monitoring phase could be set to zero since post processing is not necessary.** **Call procedure H_FCP_CCU_DLCM to perform a DLCM and refer to HP-2-ASED-PR-0141 for more information.** **WARNING: The use of the DLCM heating periodically will have an impact in the mission life time.**		
8.1		*Use DLCM heating periodically to increase the temperature to the expected values*		
		Execute Procedure: **H_FCP_CCU_DLCM** **CCU DLCM**		
9		*Check HTT and instrument FPU I/F temperatures*		Next Step: END
		Execute Procedure: **H_FCP_CCU_MONS** **CCU Sensors monitoring**		
10		*Is 2.1K > HTT Temp > 2.08K ?*		Next Step: yes 11 no 12
		If (T101+T104)/2 or (T102+T105)/2 > 2.080 K		
11		*Swich OFF CCU for tbd minutes*		Next Step: 12

Step No.	Time	Activity/Remarks	TC/TLM	Display/ Branch
		Call the procedure H_CRP_CCU_AB00 to shut down CCU (one or both) for tbd minutes (extrapolated from the temperature evolution before). **To be determined by cryo experts.**		
		Execute Procedure: **H_CRP_CCU_AB00** **CCU Switch OFF**		
11.1		*Wait the requested minutes (tbd by cryo experts) and re-start CCU*		
		Call the procedure H_CRP_CCU_AB01 to switch CCU (one or both)		
		Execute Procedure: **H_CRP_CCU_AB01** **CCU Switch ON**		
11.2		*Perform H-EPLM health checkout*		
		Execute Procedure: **H_FCP_CCU_MONS** **CCU Sensors monitoring**		
12		*Is HTT Temp > 2.1 K?*		Next Step: yes 13 no END
		If (T101+T104)/2 > 2.1 K		
13		*Open cryo cover*		Next Step: END
		Open cryo cover and switch off telescope heating if it is activated. **Tilt the spacecraft to cold conditions.** **NOTE: The cryo cover shall only be opened after agreement with ESA/TAS/ASED engineering.**		
		Execute Procedure: **H_LEO_EPS_NCA** **NCA activation**		

Step No.	Time	Activity/Remarks	TC/TLM	Display/ Branch
13.1		*If telescope decontamination is activated, stop it.*		
		Execute Procedure: **H_LEO_SYS_DEC0** **Stop Decontamination heating**		
13.2		*Perform H-EPLM health checkout*		
		Execute Procedure: **H_FCP_CCU_MONS** **CCU Sensors monitoring**		

End of Procedure

Cryostat Anomaly
File: H_CRP_CCU_CRYO.xls
Author: E. Picallo

SPIRE FPU thermal I/F		Temp @ Heat Load			Start-up	Switch-off	Non-operating		Bakeout (72h max)	Stability	Estimated max operating T	
level	thermal interface	Requirement	Goal	Cooler State	Min °C	Max °C	Min. K	Max. °C	°C	K/s	K	uncertainty (+/-K)
L0	Detector Box	2 K @ 4 mW	1.71 K @ 1 mW	Operating				60	80		1.74	0.06
	Cooler Pump	2 K @ 2 mW	2 K @ 2 mW	Operating				60	80		1.69	0.06
		10 K @ 500 mW peak	10 K @ 500 mW peak	Recycling				60	80		9.77	0.06
	Cooler Evaporator	1.85 K @ 15 mW	1.75 K @ 15 mW	Recycling				60	80		1.7	0.06
L1		5.5 K @ 15 mW	3.7 K @ 13 mW	Operating				60	80		4.22	0.18
L2	Optical bench / FPU legs	12 K @ no load	8 K @ no load	Operating					80		10.6	0.5
L3	HSJFP (JFET Photometer)	15 K @ 50 mW	15 K @ 50 mW	-					80		15.1	0.5
	? HSJFS (JFET Spectrometer)	15 K @ 25 mW	15 K @ 25 mW	-					80		13.7	0.5

PACS thermal I/F		Temp @ Heat Load										
level	thermal interface	Requirement in Operating conditions		Comments	Start-up	Switch-off	Non-operating		Bakeout (72h max)	Stability	Estimated max operating T	
		Max	Min		Min °C	Max °C	Min. K	Max. °C	°C	K/S	K	uncertainty (+/-K)
L0	FPFPU Red Detector	1.75 K @ 0.8 mW	1.6 K (i)	(i) Min				60	85		1.68	0.06
	FPFPU Blue Detector	2 K @ 2 mW		temperature for				60	85		1.73	0.06
	Cooler Pump	10 K @ 500 mW peak		Peak during				60	85		12	0.06
		5 K @ 2 mW		pump cooling				60	85		1.73	0.06
	Cooler Evaporator	1.85 K @ 15 mW (*)		(*) During 200s at end of condensation				60	85		1.796	0.06
L1	FPFPU Photometer	5 K @ 10 mW (**)	2 K	(**) : Assuming				60	85		3.55	0.18
	FPFPU Spectrometer	5 K @ 10 mW (**)		12 K at L2 (the				60	85		4.24	0.18
	FPFPU Collimator (1)	5 K @ 10 mW (**)		sum of 30 mW				60	85		4.43	0.18
L2	HOB	12 K @ no load	NA					60	85		10.9	0.5

HIFI thermal I/F		Temp @ Heat Load										
level	thermal interface	Requirement in Operating conditions		Comments	Start-up	Switch-off	Non-operating		Bakeout (72h max)	Stability	Estimated max operating T	
		Max	Min (K)		Min °C	Max °C	Min. K	Max. °C	°C	Max K / 100s	K	uncertainty (+/-K)
L0	Mixers of FHFPU (Level 0)	2.0K@6.8mW	0		NA	40	0	60	80	0.006	1.96	0.06
L1	Parts of FHFPU ** (Level 1)	6K@15.5mW	0		NA	40	0	60	80	0.006	5.37	0.18
L2	FHFPU (Level 2)	20K@22mW	0		NA	40	0	60	80	0.015	12.4	0.5

Table 5.7.1-2: Herschel Instrument FPU thermal requirements at the thermal interfaces, together with predicted hot case interface temperatures from RD81