INTERFACE HAZOP STUDY

JLAB DISTRIBUTION		
☑ Yes ☐ No		
☐ FOR INFORMATION		
☑ FOR APPROVAL		
APPROVED Name and signature Date:	APPROVED with comments Reference of comment: Name and signature Date:	REJECTED Reference of comment for rejection: Name and signature Date:

Approved by
Design Authority: **Veronique GRABIE**
veronique.grabie@airliquide.com

Written by
Technical Manager: **Gilles FLAVIEN**
gilles.flavin@airliquide.com

Distribution:

JLAB
AL project team

AIR LIQUIDE ADVANCED BUSINESS & TECHNOLOGIES	**Technical Note** **LCLS-II 4.5K COLD BOX SYSTEM**	Doc n° : C1303 NT 701 (0)

Interface HAZOP study

Change Record :

Version	Date	Change description	Author	Verified by	Approved by
0	June 17th, 2016	first edition	G.FLAVIEN		V.GRABIE

AIR LIQUIDE ADVANCED BUSINESS & TECHNOLOGIES	9807 Katy Freeway, Suit 100 Houston, Texas 77024 (US)	**Technical Note** **LCLS-II 4.5K COLD BOX SYSTEM**	Doc n° : C1303 NT 701 (0)

Interface HAZOP study

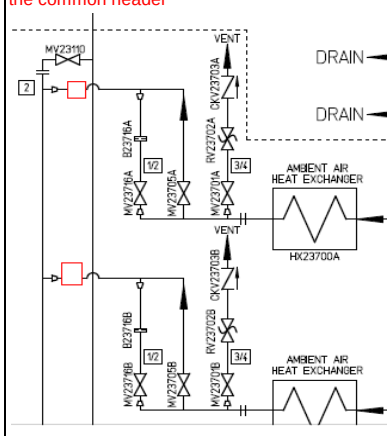
Actions

n°	ref	action	responsible
1	R1	Confirm the way the pressure is regulated this way (cf node #21 general description), with in addition the use of interface valve PV-22391 to throttle the flow and maintain T4 outlet pressure in case of very High demand on Subatmospheric supply line	AL
2	R2	Check if necessary to interlock closed the T4 by-pass valve PV-22485 when pressure rises before load safety valve pops	AL
3	R19	Add interlock: Ramp down PV-22115 when the Temperature difference on Warm end of HX-1B reaches more than 20K. Force PV-22110 whenever one valve of the Cool Down line is interlocked closed	AL
4	R25	Add interlock on PV-22441	AL
5	R26, R27, R28	Alarm on PT-22245	AL
6	R30	JLAB has to check with SLAC that the PSV protecting the Dewar are designed for the flow	JLAB/SLAC
7	R32	Add Interlock on PV-22393	AL
8	R43	Add action on cold box side (minimize T1 T2 flow then trip) in case of Low Temperature TP22201)	AL
9	R50	Flow scenario protecting LPR and LPL lines covered by flow safety valves on compressor station side	AL
10	R50, R51, R55	JLAB to consider adding ambient temperature CKV on the portion of circuit which links each adsober to the common header	JLAB/SLAC
11	R53, R54	JLAB to protect the vacuum pump (B2) with a relief plate.	JLAB/SLAC
12	R57	Add Check valve (downstream of MV23207)	AL

Interface HAZOP study

Analysis

Node	Intention	PRIMARY KEYWORDS	SECONDARY KEYWORDS	DEVIATION	CAUSE	CONSEQUENCE	SAFEGUARDS	ACTION FOLLOWING HAZOP	REF.
#21	Subatmospheric Supply node	General Process description: 4.5K supply at 3.2 Atm Pressure control either by PV-22390 (if Liquefaction to the Subcooler) or PV-22393 (if liquefaction to the dewar) Load is protected at 45 psig, with a larger equipment that covers any flow scenario from the Cold Boxes Transfer line to the interface box is around 20m long (for the thermal expansion scenario of PSV-22391) Note: The Cool down line is connected either to the LP Compressors or to a Recovery System (Manual switching). The valve PV22110 can be opened whenever required for the 4.5K Cold box. A check valve is installed on the line between the Cold Box toward the Atmospheric Exchangers.						Confirm the way the pressure is regulated this way, with in addition the use of interface valve PV-22391 to throttle the flow and maintain T4 outlet pressure in case of very High demand on Subatmospheric supply line	R1
#21	Subatmospheric Supply node	Pressure	More	More Pressure	Pressure regulation issue by PV-22390 or PV-22393 depending on the control in operation	Exceed downstream line design pressure which is rated for 145 psig or higher.	PSV-22391 set at 145 Psig	AL: Check if necessary to interlock closed the T4 by-pass valve PV-22485 when pressure rises before load safety valve pops	R2
#21	Subatmospheric Supply node	Pressure	More	More Pressure	Blocked flow in the line to the cavities	Exceed downstream line design pressure which is rated for 145 psig or higher.	PSV-22391 set at 145 Psig		R3
#21	Subatmospheric Supply node	Pressure	Less	Less Pressure	Pressure regulation issue by PV-22390 or PV-22393 depending on the control in operation Or Lack of performance from the 4.5 Cold Box	Liquid in the supply line if the pressure is below 2.3 Atm in the supply line	No safegard except Turbine 4 discharge pressure protection		R4
#21	Subatmospheric Supply node	Pressure	Less	Less Pressure	Higher drawn in the line to the cavities	Liquid in the supply line if the pressure is below 2.3 Atm in the supply line	No safegard except Turbine 4 discharge pressure protection		R5
#21	Subatmospheric Supply node	Flow	No	No Flow	Any reason	No issue			R6
#21	Subatmospheric Supply node	Flow	Less	Less Flow	Any reason	No issue			R7
#21	Subatmospheric Supply node	Flow	Less	Less Flow	Any reason	No issue			R8
#21	Subatmospheric Supply node	Flow	Other	Other Flow	Any reason	No issue			R9
#21	Subatmospheric Supply node	Flow	back	back Flow	Any reason	No issue			R10
#21	Subatmospheric Supply node	Temperature	More	More Temperature	No Lhe in the Subcooler Less efficiency of HXSc	Can't maintain Lhe level in the cavities	Control on Cavities side (RF stops on low level)		R11
#21	Subatmospheric Supply node	Composition	Other	Other Composition	Any reason	No issue			R12
#21	Subatmospheric Supply node	Containment	Loss	Loss Containment	Any reason	No issue			R13
#22	Subatmospheric return node	General Process description: Subatmospheric return line from Cold Compressors at 1.2 Atm and <30K in operation						Important note: Consider setting PSV-22104 at 70 Psig instead of 145 Psig to limit the sizing of PSV-22190 due to a Flow scenario in subatmospheric return valves (PV-22140 , PV-22150, etc…)	R14
#22	Subatmospheric return node	Pressure	More	More Pressure	Abnormal closing of cryogenic valves	Exceed cool down line design pressure which is rated for 145 psig. (Bayonet rated at 75 psig)	PSV-22190 set at 75 Psig		R15
#22	Subatmospheric return node	Pressure (Subcooler)	More	More Pressure (Subcooler)	Any reason	No issue			R16
#22	Subatmospheric return node	Pressure (Subcooler)	More	More Pressure (Subcooler)	Any reason	No issue			R17
#22	Subatmospheric return node	Temperature	More	More Temperature	Any reason	No issue			R18
#22	Subatmospheric return node	Temperature	Less	Less Temperature	Abnormal opening of the return valve PV-22115 to LPL line	High Temperature difference on HX-1B and potential cold temperature to Compression station	(Internal Hazop safeguards)	Add interlock: Ramp down PV-22115 when the Temperature difference on Warm end of HX-1B reaches more than 20K. Force PV-22110 whenever one valve of the Cool Down line is interlocked closed	R19
#23	Cold Intercepts Node	General Process description: Supply and return at around 3.2 Atm (Cold Shields are made of a 2" line) Supply at 5K and return regulated at 8K							R20
#23	Cold Intercepts Node	Pressure	More	More Pressure	Pressure regulation issue by PV-22392	None (the cold intercept could bear 320 psig)	Safety valve PSV22391 at 145 psig sized for flow		R21
#23	Cold Intercepts Node	Pressure	More	More Pressure	Blocked flow in the line to the Cold Intercepts	None (the cold intercept could bear 320 psig)	Safety valve PSV22391 at 145 psig sized for flow		R22
#23	Cold Intercepts Node	Pressure	More	More Pressure	Thermal expansion	None (the cold intercept could bear 320 psig)	Safety valve PSV22391 at 145 psig		R23
#24	Warm Shields	General Process description: Supply at around 3.4 Atm and return at around 2.4 Atm							R24
#24	Warm Shields	Pressure	More	More Pressure	Abnormal opening PV-22441	Exceed warm shields line design pressure which is rated for 145 psig.	Interlock PV-22441 closed if pressure in Warm Shields supply line (PT-222245) is higher than 6 Atm Ultimate protection by PSV-22245 set at 145 psig (flow scenario on PV-22441 which covers any thermal relief scenario)	Add interlock on PV-22441	R25
#24	Warm Shields	Pressure	Less	Less Pressure	Any reason	No issue	Alarm on PT-22245	Alarm on PT-22245	R26
#24	Warm Shields	Temperature	More	More Temperature	Any reason	No issue	Alarm on TD-22245	Alarm on PT-22245	R27
#24	Warm Shields	Temperature	Less	Less Temperature	Any reason	No issue	Alarm on TD-22245	Alarm on PT-22245	R28
#25	Dewar	General Process description: 3 Interfaces, all rated at 145 Psig Supply at 3.2 Atm and 5K Liq and Vap return in Subcooler at around 1.25 Atm							R29
#25	Dewar	Pressure	More	More Pressure	Abnormal opening PV-22393	Exceed Dewar design pressure which is rated for 30 psig.	PSV on the Dewar	JLAB has to check with SLAC that the PSV protecting the Dewar are designed for the flow	R30
#25	Dewar	Pressure	Less	Less Pressure	Any reason	No issue			R31
#25	Dewar	Temperature	More	More Temperature	Any reason	Undesired vaporisation of Lhe	Max Opening Interlock on PV-22393 if: - Dewar Pressure becomes higher than 1.6 Atm - Supply Temperature TD-22393 more than 25K	Add Interlock on PV-22393	R32
#26	LPL interface with Compression station	General Process description: LPL Interface to the Compression station at 1.1Atm & 300K							R33
#26	LPL interface with Compression station	Pressure	More	More Pressure	Compression station scenario	Exceed design pressure of the network	LPL PSV on Compression station at 65 Psig designed for the full flow of the compressor in the by pass		R34
#26	LPL interface with Compression station	Pressure	More	More Pressure	Bad regulation of LPL or stop of the Compressor	Back pressure in the Subcooler	Subcooler designed for 145 psig		R35
#26	LPL interface with Compression station	Pressure	Less	Less Pressure	Bad regulation of LPL by the Compression station	No consequences (line designed for Vacuum inside)	Compressors trip if suction pressure is too low (with a time delay)		R36

#26	LPL interface with Compression station	Temperature	Less	Less Temperature	Bad regulation of LPL or stop of the Compressor	Back pressure in the Subcooler	All the line toward the Compressors in in Stainless Steel (Only the compressor is made of Carbon Steel Trip of the compressors if Suction temperature falls below 240K		R37
#26	LPL interface with Compression station	Temperature	More	More Temperature	Any reason	No issue			R38
#27	LPR interface with Compression station	General Process description: LPR interface to the compression station (protected at 90 Psig) Normal operation pressure is around 2.5 Atm							R39
#27	LPR interface with Compression station	Pressure	More	More Pressure	Compression station scenario	Exceed design pressure of the interface (protected at 75 Psig, but designed for 145 Psig)	LPR PSV on Compression station at 90 Psig designed for the full flow of the compressor in the by pass		R40
#27	LPR interface with Compression station	Pressure	More	More Pressure	Bad regulation of LPR or stop of the Compressor	Higher pressure at Turbines discharge	Turbines protected (refer to internal HAZOP)		R41
#27	LPR interface with Compression station	Pressure	Less	Less Pressure	Bad regulation of LPR by the Compression station	No consequences (line designed for Vacuum inside)	Compressors trip if suction pressure is too low		R42
#27	LPR interface with Compression station	Temperature	Less	Less Temperature	Bad regulation of LPR or stop of the Compressor	Cold embrittlement	All the line toward the Compressors in in Stainless Steel (Only the compressor is made of Carbon Steel Trip of the compressors if Suction temperature fall below 240K	Add action on cold box side (minimize T1 T2 flow then trip) in case of Low Temperature TP22201)	R43
#27	LPR interface with Compression station	Temperature	More	More Temperature	Any reason	No issue			R44
#28	HP interface with Compression station	General Process description: HP interface from the compression station (protected at 300 Psig) Normal operation pressure is around 19.5 Atm (270 Psig)							R45
#28	HP interface with Compression station	Pressure	More	More Pressure	Bad regulation or sudden flow blocked on Cold box inlet	Exceeding Interface design pressure	PSV on HP set at 300Psig for full flow of the compressors		R46
#28	HP interface with Compression station	Pressure	Less	Less Pressure	Any reason	Low performance on CB Low pressure for Turbines bearings	Turbines protected against Bearing pressure low		R47
#28	HP interface with Compression station	Temperature	More	More Temperature	Problem on compressor cooling system	Potential mechanical damage on BAHX	Temperature trip at compressors discharge and after He cooler at 320K		R48
#29	80K, 20K adsorbers and Purging/pumping collector node	General Process description: 80K, 20K adsorbers and Purging/pumping collector Design at 320 psig							R49
#29	80K, 20K adsorbers and Purging/pumping collector node	Pressure	More	More Pressure	Opening of HP valve (MV22406) with no relief open	Exceed design pressure of the network	PSV-23100 set at 320 Psig	Flow scenario protecting LPR and LPL lines covered by flow safety valves on compressor station side	R50
#29	80K, 20K adsorbers and Purging/pumping collector node	Pressure	More	More Pressure	Opening of HP valve (MV22406) during adsorber cool down	Risk of back flow to adsorbers => risk of mechnical damage		JLAB to consider adding ambient temperature CKV on the portion of circuit which links each adsober to the common header 	R51
#29	80K, 20K adsorbers and Purging/pumping collector node	Pressure	More	More Pressure	Opening of HP valve (MV22406) during adsorber pumping	Risk of back flow to adsorbers => risk of mechnical damage		See #29 pressure more	R52
#29	80K, 20K adsorbers and Purging/pumping collector node	Pressure	More	More Pressure	Opening of HP valve (MV22406) during adsorber pumping	Risk to blow the vacuum pump (B2)	Pressure gage (dial) and trained operators	JLAB to protect the vacuum pump (B2) with a relief plate.	R53
#29	80K, 20K adsorbers and Purging/pumping collector node	Pressure	More	More Pressure	From cool down clean up system	Clean up cool down system protected at 7psig (lower pressure)	Pressure gage (dial) and trained operators	JLAB to protect the vacuum pump (B2) with a relief plate.	R54
#29	80K, 20K adsorbers and Purging/pumping collector node	Flow	Back	Back Flow	From collector (opening of MV23705A/B or MV23766 while another adsorber is under cool down, pumping, heating)	Risk of back flow to adsorbers => risk of mechnical damage		See #29 pressure more	R55
#30	80K, 20K adsorbers and filling collector	General Process description: To fill adsorbers under regeneration with HP Helium from WCS (300K, 18.5 atm) To fill pipes under conditionning with He from Gas distrib. Sys. (300K, 5 atm)							R56
#30	80K, 20K adsorbers and filling collector	Flow	Back	Back Flow	Opening of MV23207	Risk of back flow to adsorbers => risk of mechnical damage		Add Check valve (downstream of MV23207)	R57
#31	LN2 supply and return interfaces node	General Process description: To fill with liquid nitrogen (77K) To evacuate liquid or gazeous nitrogen							R58
#31	LN2 supply and return interfaces node	Pressure	More	More Pressure	Any reason from LN2 Tanks	Exceed design pressure of the equipments	Same design pressure and relief pressure on the whole LN2 circuit: 145 Psig		R59
#31	LN2 supply and return interfaces node	Pressure	Less	Less Pressure					R60
#31	LN2 supply and return interfaces node	Temperature	Less	Less Temperature	Unbalance on HX1A and HX1B resulting in less GN2 vapor exchange in HX1A	Freezing GN2 outlet	Interlocks implemented (refer Internal Hazop)		R61

AIR LIQUIDE ADVANCED BUSINESS & TECHNOLOGIES	9807 Katy Freeway, Suit 100 Houston, Texas 77024 (US)	**Technical Note** **LCLS-II 4.5K COLD BOX SYSTEM**	Doc n° : C1303 NT 701 (0)

Interface HAZOP study

PFD with nodes