ProtoDUNEs Interface documents (NP-02, NP-04)

David Montanari

(on behalf of Redouan A, Mark A, Johan B, Michel C, Joaquim C, Aurelien D, Kevin H)

Apr 14, 2016

Outline

- Intro
- Process Flow Diagram (PFD)
- Interfaces
- Dielectric breaks
- Example of interface
- Example of interface sheets
- Summary

Intro

- The scope of the tender is the design, procurement, fabrication and installation of the following items:
  - SBN-FD (NP-01) **Proximity Cryogenics.**
  - ProtoDUNE Dual Phase (NP-02) **Proximity and External Cryogenics** (minus the LAr/LN2 tanks and the LAr circulation pumps).
  - SBND (NP-03) **Proximity Cryogenics.**
  - ProtoDUNE Single Phase (NP-04) **Proximity and External Cryogenics** (minus the LAr/LN2 tanks and the LAr circulation pumps).
- The tender is issued with a **Design Specifications** (we do not supply pipe/valve sizes, etc.).
- The Internal Cryogenics is NOT part of this tender for any project. We have defined the interfaces between the Proximity and Internal (and/or External where applicable) such that we can procure the Proximity and properly interface it with the rest of the equipment.
- The warm piping is NOT part of this tender for any project.
- This contribution presents the **interfaces** for **NP-02** and **NP-04**.

Information supplied to the bidders

- Main document: Design Specifications.
- P&IDs.
- 3D Models of buildings (EHN1, SBND, SBD-FD) and installation with valve boxes and pipes envelopes (not to exceed) based on space constraints.
- Interface sheets.
- 2D drawings.

Cryogenic systems

- **Internal Cryogenics:**
  - Inside the cryostat.
  - GAr/LAr distribution for cryostat purge, cool down, fill.

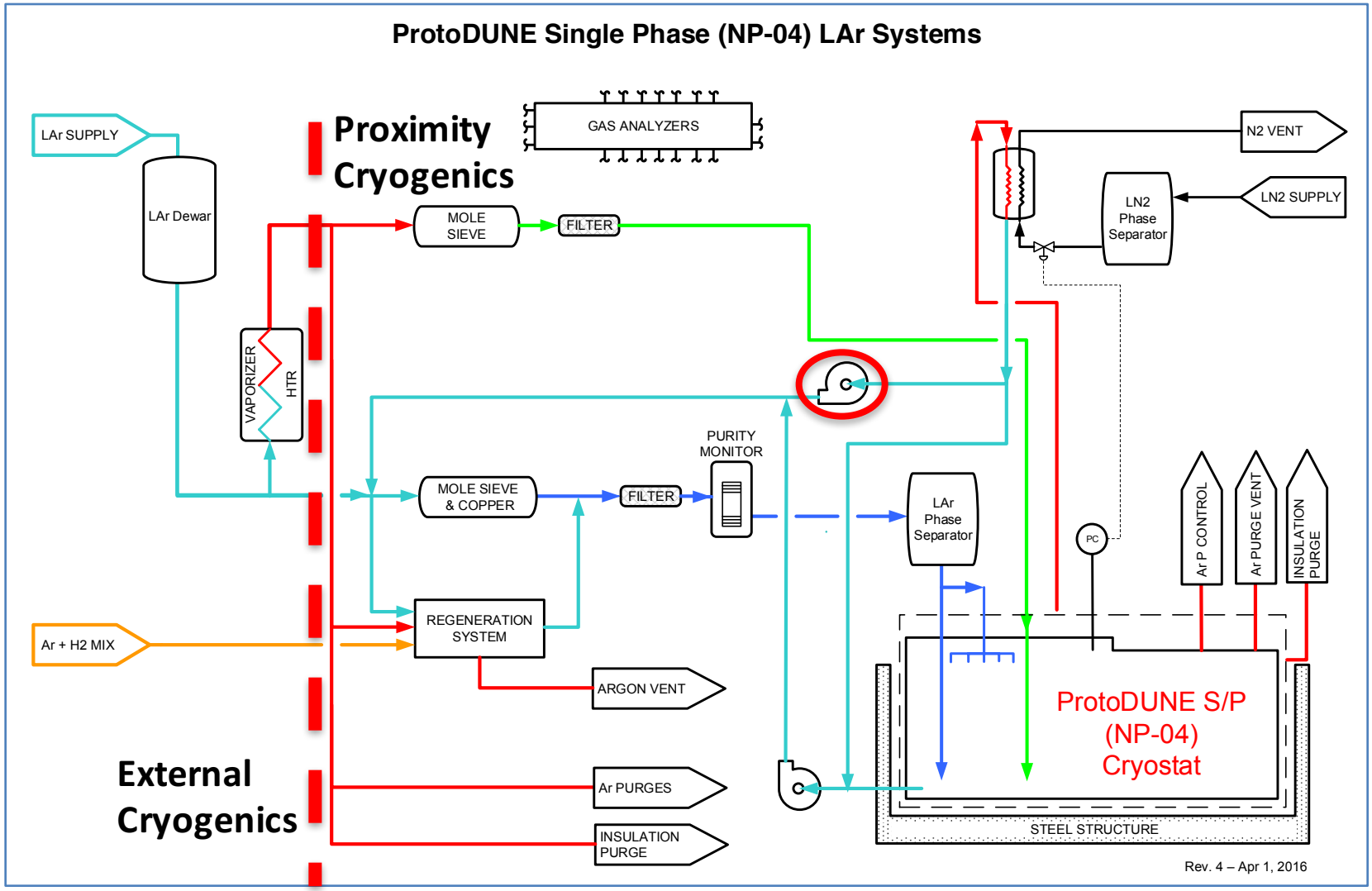
Not part of this tender.

- **Proximity Cryogenics:**
  - Circulate and purify LAr.
  - Achieve and maintain LAr purity.
  - Recondense and purify boil off GAr.

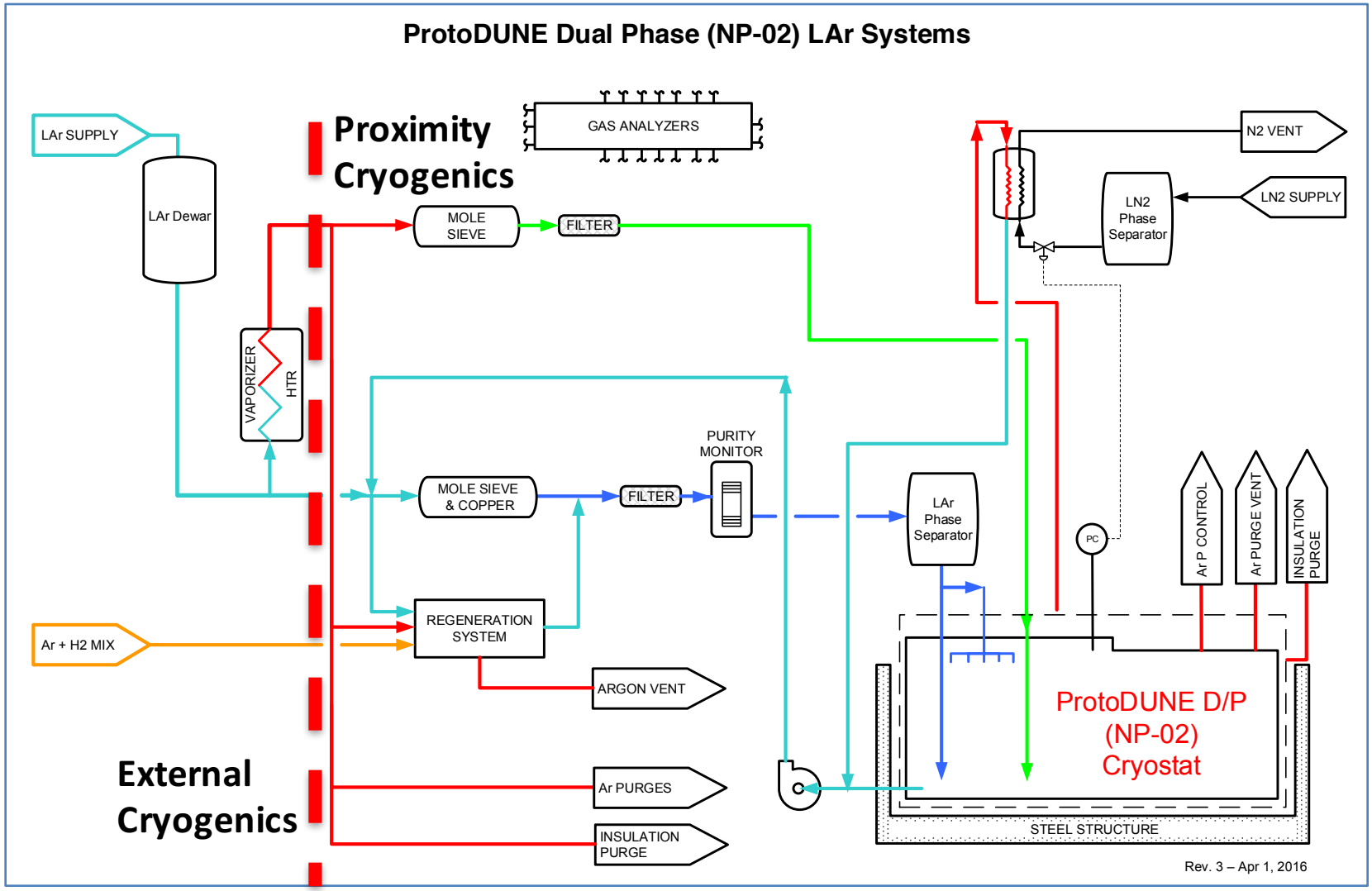
- **Infrastructure/External Cryogenics**:
  - Receive Ar/N2.
  - Transport GAr/LAr, GN2/LN2 to Proximity.
  - Vents.

For NP-02 and NP-04 this tender covers Proximity and External Cryogenics only.

Process Flow Diagram (NP-04)



Process Flow Diagram (NP-02)

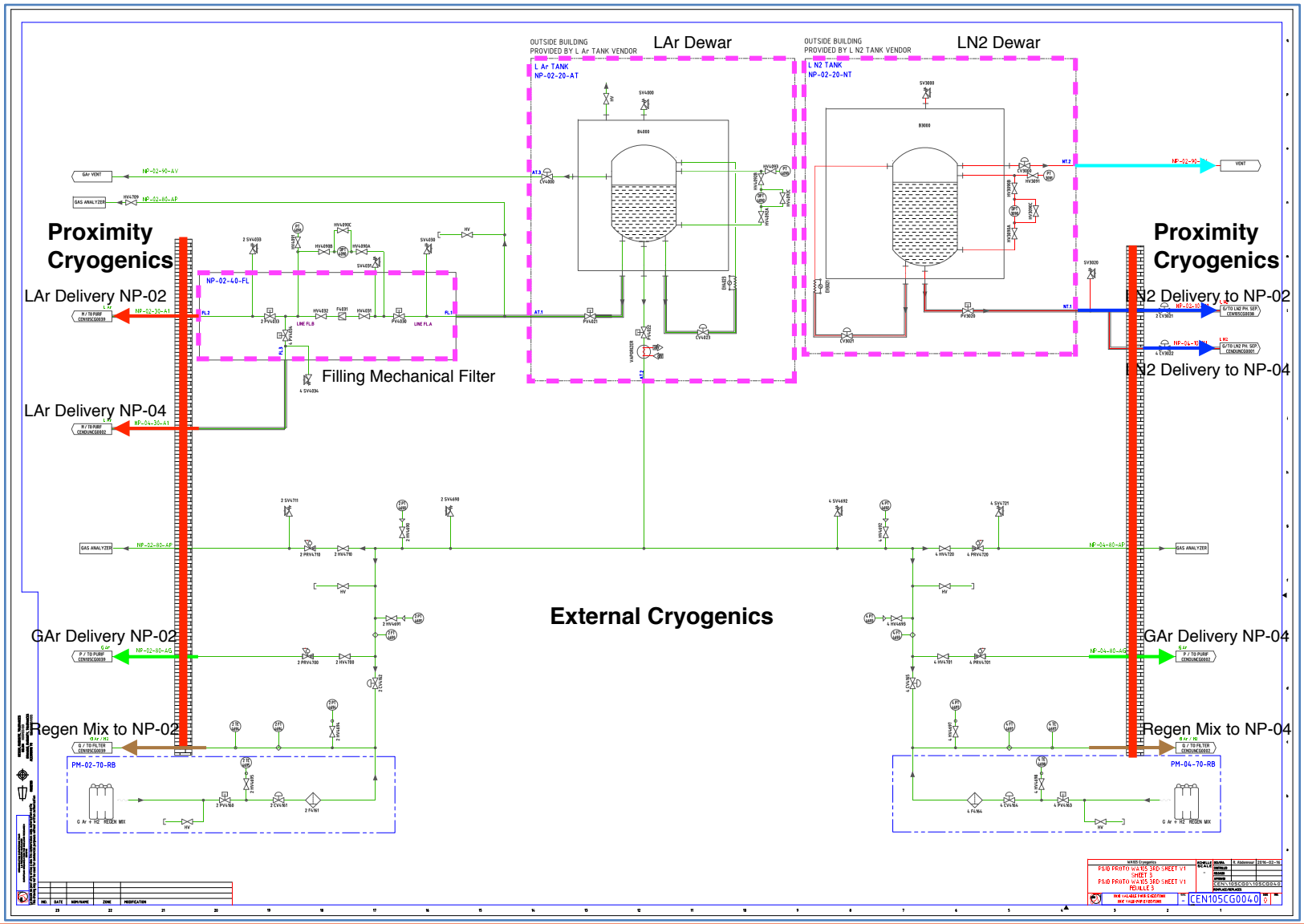


Interfaces

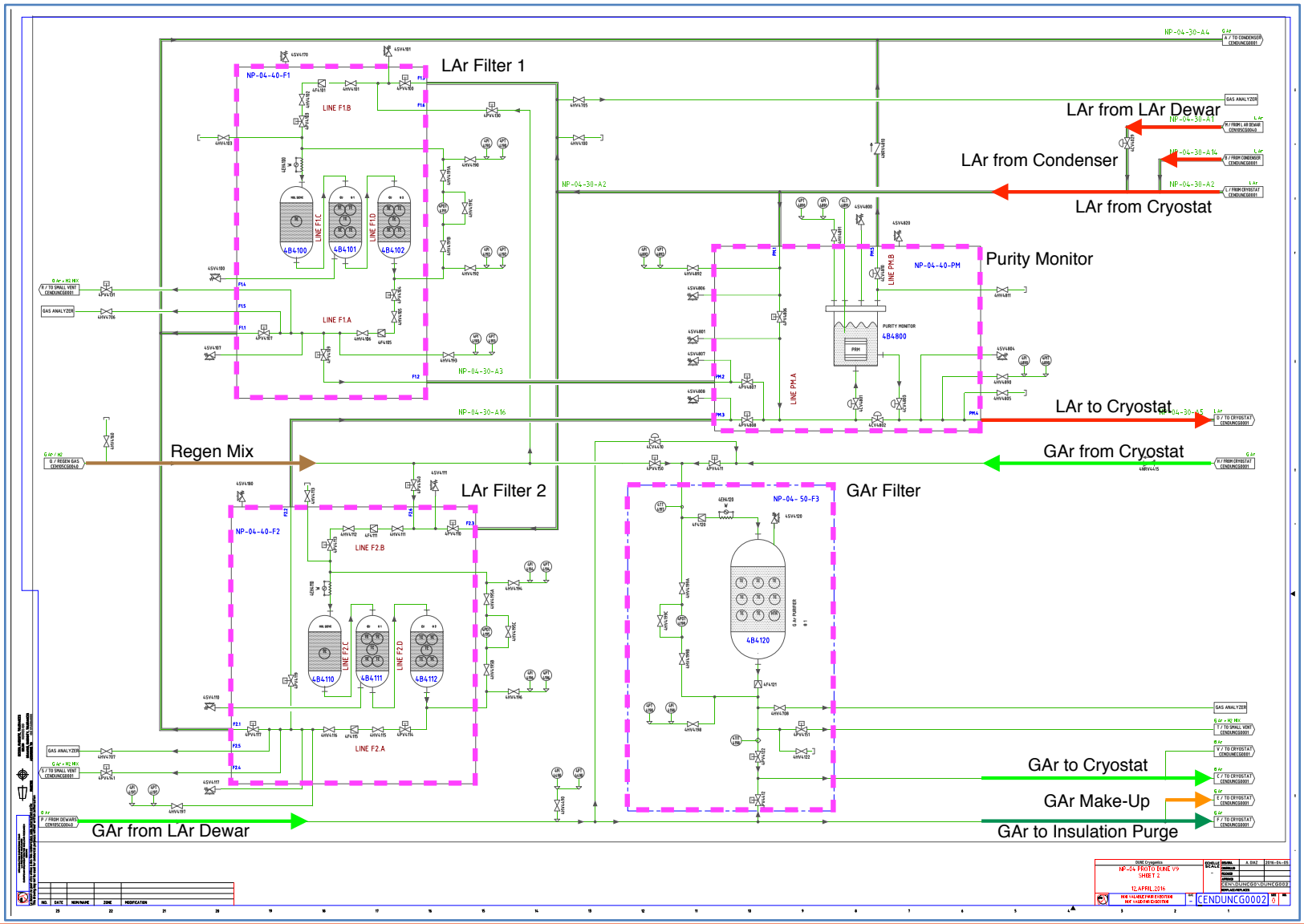
- **External to the tender:**
  - The two sides are supplied by two parties. There is an actual interface.
  - Internal/Proximity Cryogenics (right outside the top of the cryostat).
  - Internal/External (right outside the top of the cryostat).

- **Internal to the tender:**
  - The selected vendor supplies both sides, there is no actual interface, but a continuous item.
  - Proximity/External Cryogenics (not a specific point, in the vicinity of the cryogenic area near the cryostat).
  - Valve Box/Transfer Line.
  - Valve Box/Uninsulated Line.

Common Cryogens supply (Sheet 3/3)



LAr/GAr Filtration (NP-04)



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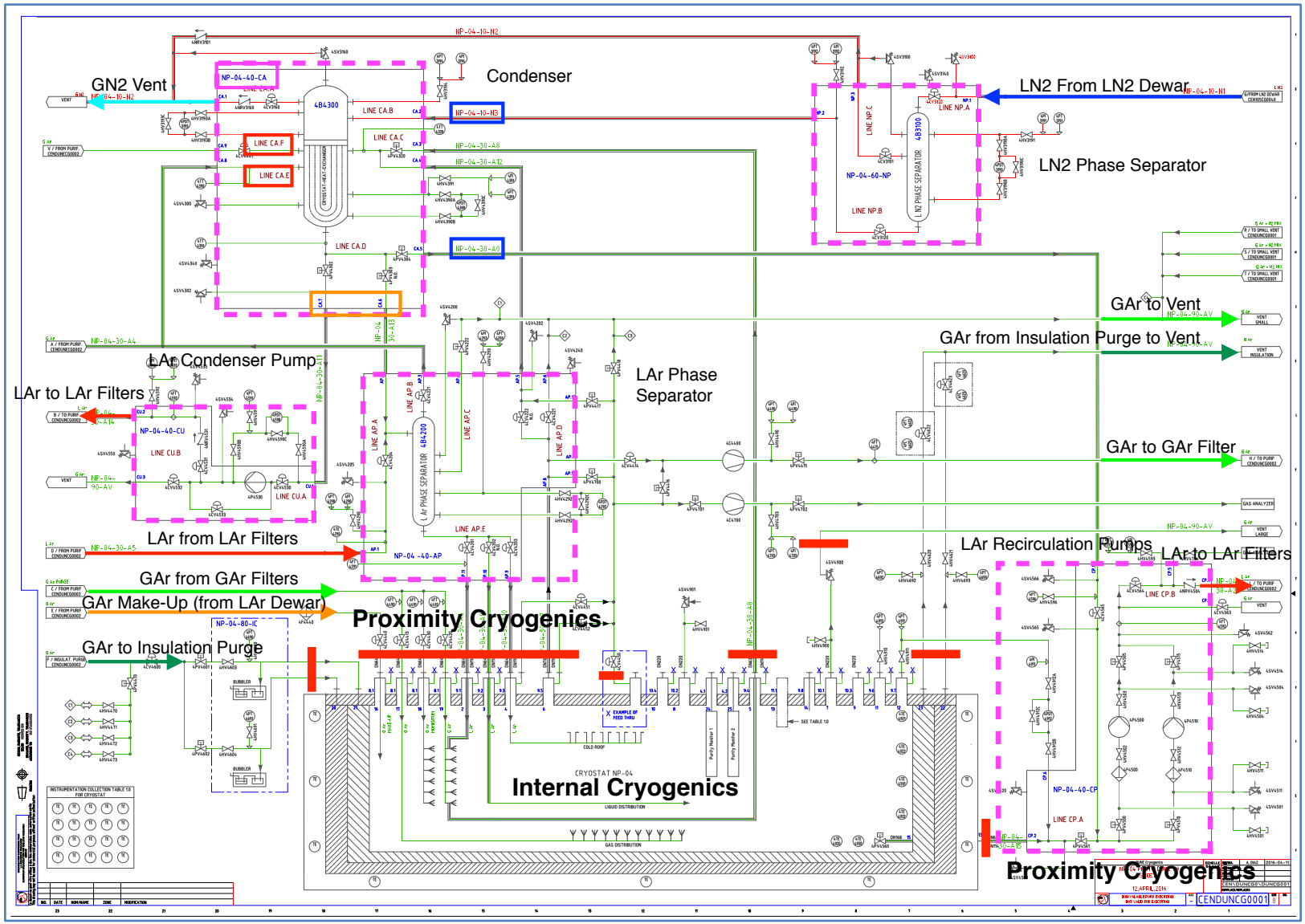
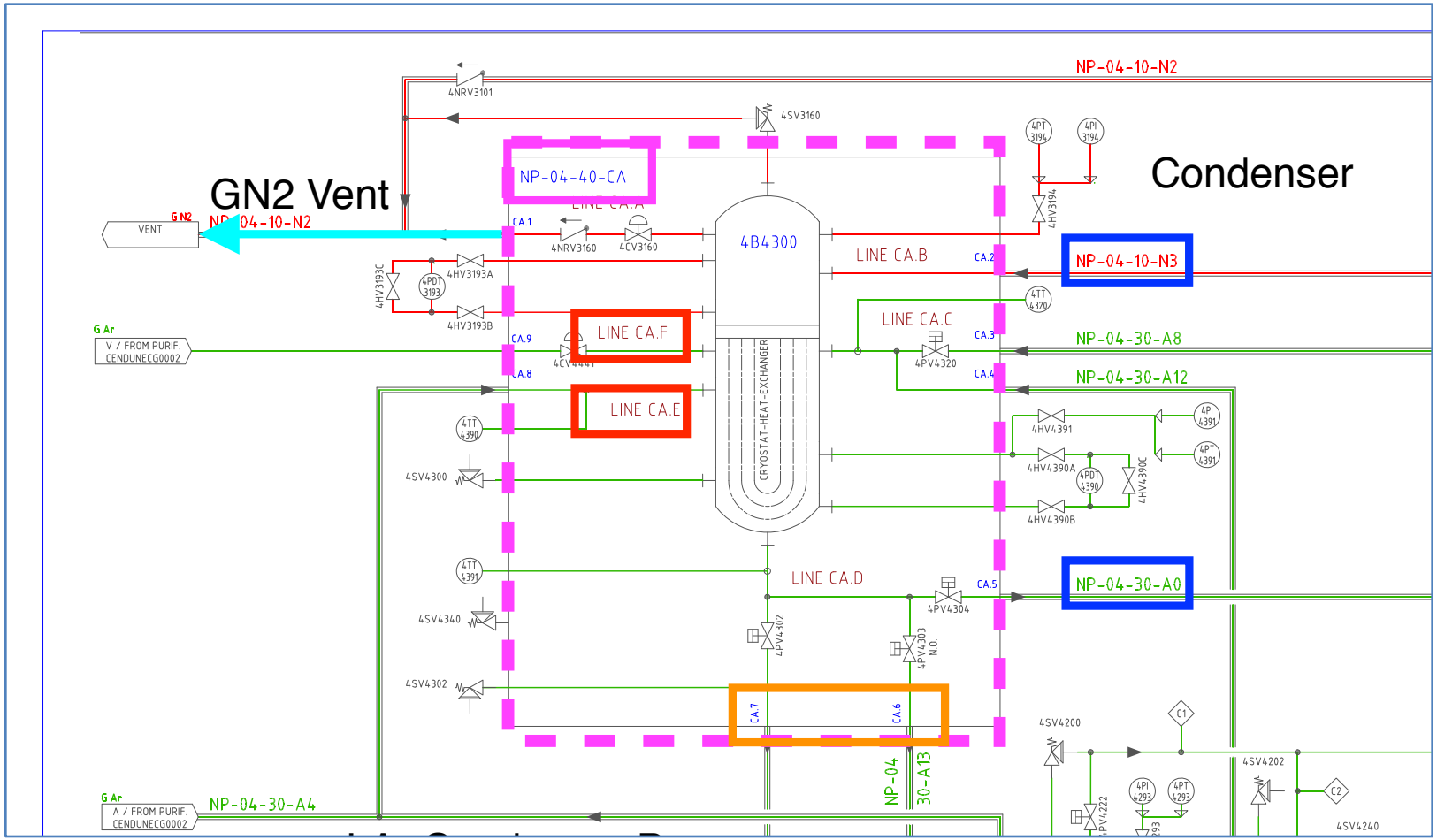
Cryostat (NP-04)

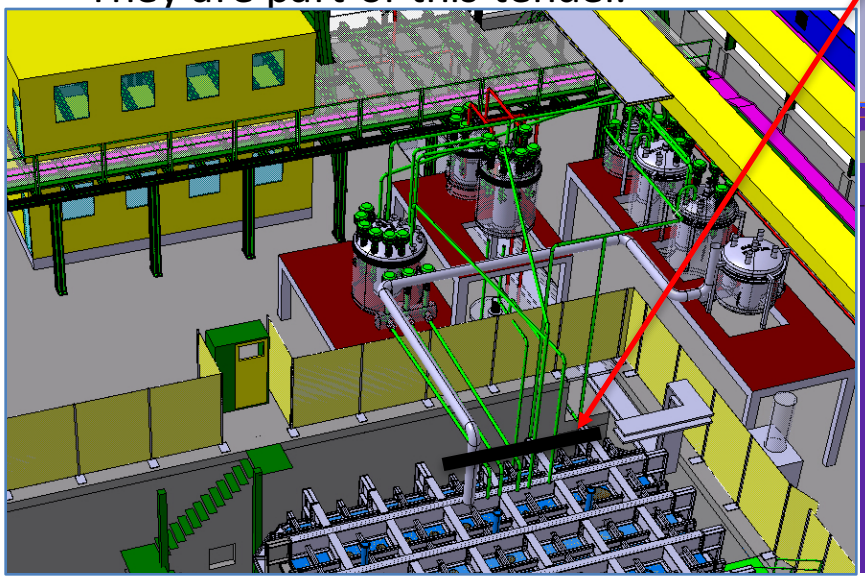


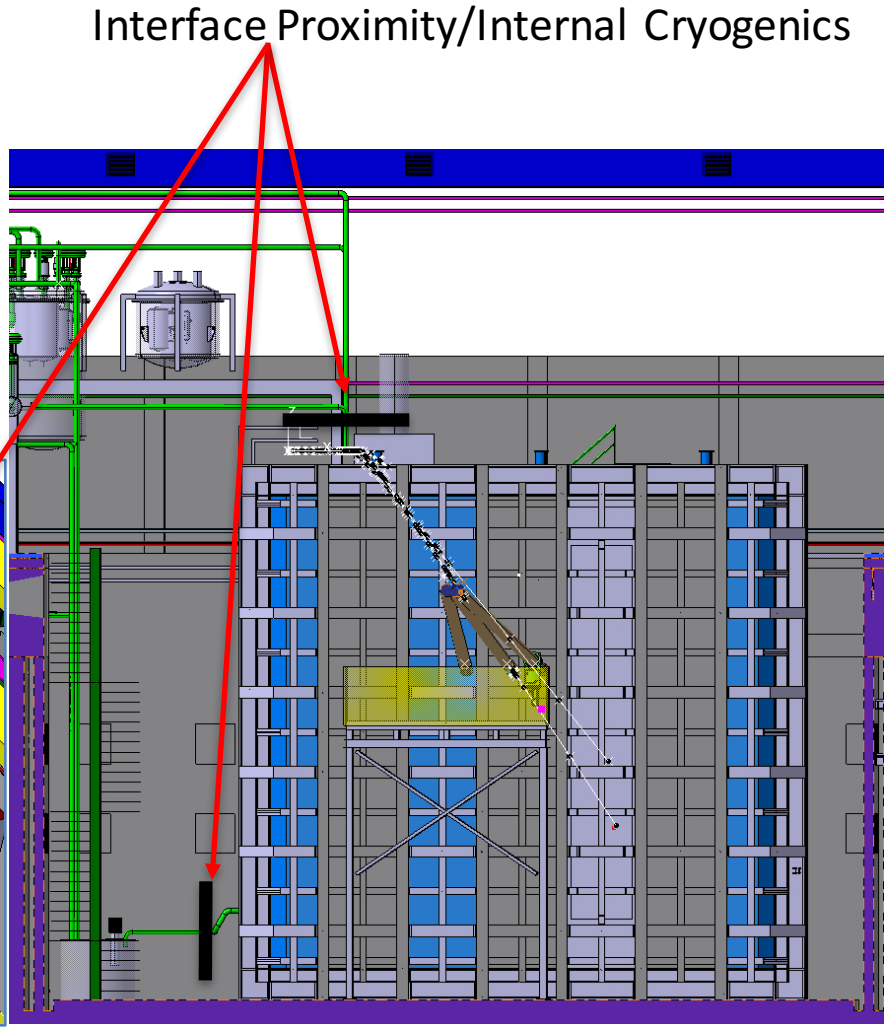
Condenser Valve Box (NP-04)



Dielectric Breaks – 1/2

- Dielectric breaks will be ceramic on all process pipes and G-10 spacers on vacuum jackets.
- CERN has experience with them.
- Will include bellows to ease the alignment.
- Each dielectric break will have its own insulation monitor (per CERN HSE).
- They are part of this tender.





Dielectric Breaks – 2/2

From: **Theresa M Shaw** tshaw@fnal.gov
Subject: RE: ProtoDUNE - Electric isolation for piping??
Date: March 23, 2016 at 1:57 PM
To: David Montanari dmontana@fnal.gov
Cc: Eric B James jameseb@fnal.gov, Theresa M Shaw tshaw@fnal.gov

TS

Hello David,
We are still planning on having an isolated cryostat for the 35T. We are preparing to begin working with CERN safety in earnest next month after reviewing some internal studies.

What this means for the cry system is that we would like dielectric breaks on all piping entering/exiting the cryostat. The breaks should be close to the cryostat structure. Each break will be required to have an insulation monitor on it – this is a CERN safety requirement. I attach some links below to the monitors recommended by CERN.

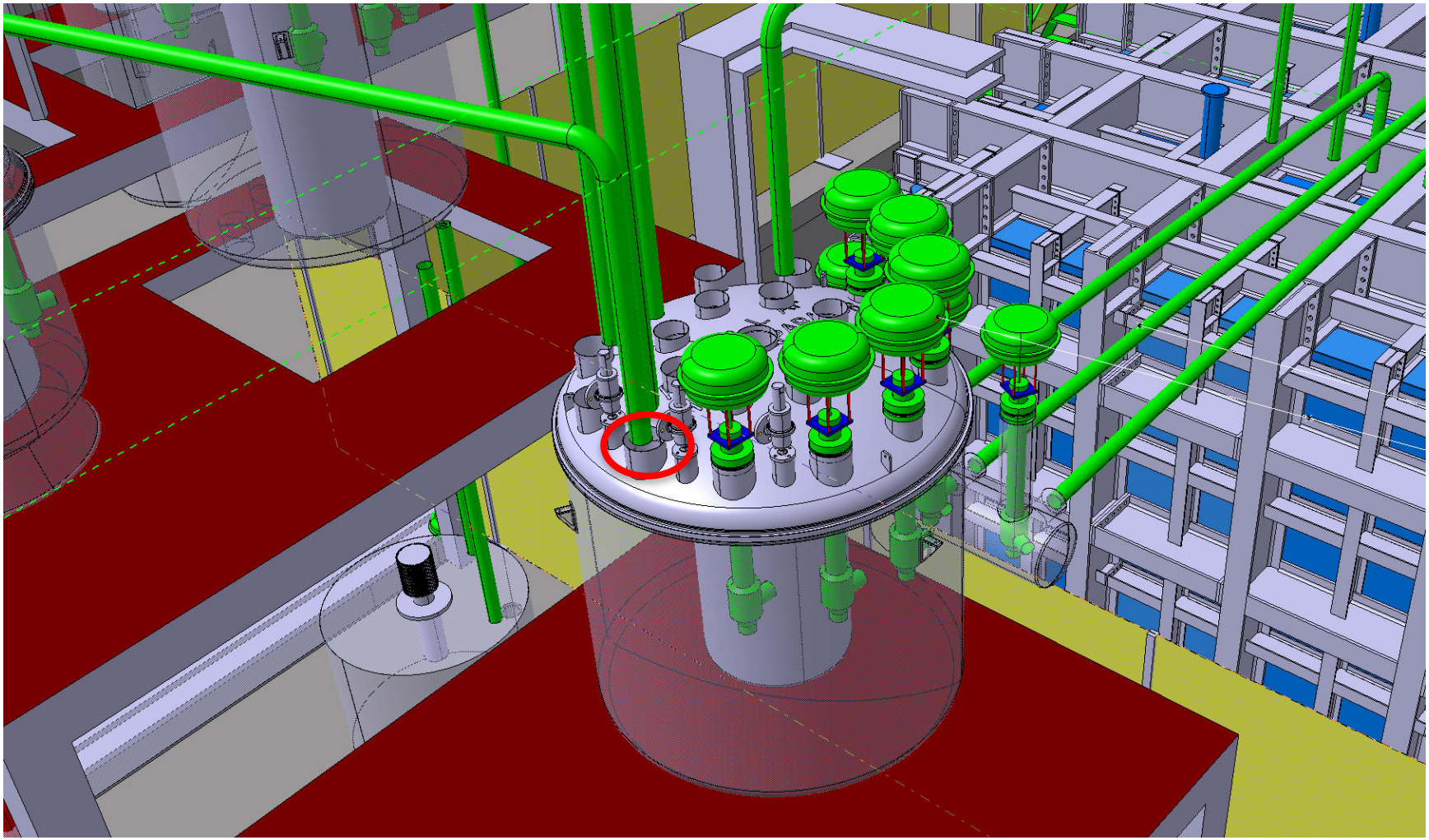
"For insulation monitoring, we typically use Schneider Vigilohm products or Socomec ISOM units.
http://www.socomec.com/files/live/sites/systemsite/files/DOCUMENTATION/SCP_hors_cata/doc_53041.pdf
http://www.schneider-electric.com/download/ww/en/details/2186945-Vigilohm-IM10---Insulation-monitoring-device/

Also, if our plan is approved, just like at 35T, the detector electronics would run off a special transformer isolated (except via safety ground) from building ground while the cryogenics equipment would run off available building power.

Please let me know if you see any problem with these requests.

Thanks,
Terri

Example of a valve box and interface with Transfer Line



Example of Interface sheet 1/5 (From NP-04)

					n.a.	Not applicable																
					(*)	Not a Process Pipe																
	Equipment	Interfacing TAG	Interfacing port	Interfacing type	Process Pipe	Process Description	Physical interface			Maximum allowable		Operating conditions				Maximum allowable mechanical loads						Notes
							DN	Outer Diameter	Thickness	Pressure	Temperature	Pressure	Temperature	Nominal Mass flow rate	Max Mass flow rate	Fx	Fy	Fz	Mx	My	Mz	
								mm	mm	[Bar abs]	[K]	[Bar abs]	[K]	[g/s]	[g/s]	[N]	[N]	[N]	[N.m]	[N.m]	[N.m]	
	NP-04-40-CA	NP-04-10-N2	CA.1	Y	X	GN2 Vent	TBD	TBD	TBD	10	300	2.500	90.0	50.0	100	TBD	TBD	TBD	TBD	TBD	TBD	
				Y	vacuum	(*)	TBD	TBD	TBD	1.5	300	vacuum	300.0	n/a	n/a	TBD	TBD	TBD	TBD	TBD	TBD	
		NP-04-10-N3	CA.2	Y	X	LN2 Inlet to Heat Exchanger	TBD	TBD	TBD	10	300	2.500	86.0	50.0	100	TBD	TBD	TBD	TBD	TBD	TBD	
				Y	vacuum		TBD	TBD	TBD	1.5	300	vacuum	300.0	n/a	n/a	TBD	TBD	TBD	TBD	TBD	TBD	
		NP-04-30-A8	CA.3	Y	X	GAr return from cool down	75	76	TBD	10	300	1.070	90.0	100.0	100.0	TBD	TBD	TBD	TBD	TBD	TBD	
				Y	vacuum	(*)	TBD	TBD	TBD	1.5	300	vacuum	300.0	n/a	n/a	TBD	TBD	TBD	TBD	TBD	TBD	
		NP-04-30-A12	CA.4	Y	X	GAr return from cryostat	TBD	TBD	TBD	10	300	1.070	90.0	50.0	Risk Analysis	TBD	TBD	TBD	TBD	TBD	TBD	
				Y	vacuum	(*)	TBD	TBD	TBD	1.5	300	vacuum	300.0	n/a	n/a	TBD	TBD	TBD	TBD	TBD	TBD	
		NP-04-30-A0	CA.5	Y	X	LAr to Main LAr pumps	TBD	TBD	TBD	10	300	1.030	87.0	50.0	50.0	TBD	TBD	TBD	TBD	TBD	TBD	
				Y	vacuum	(*)	TBD	TBD	TBD	1.5	300	vacuum	300.0	n/a	n/a	TBD	TBD	TBD	TBD	TBD	TBD	
		NP-04-30-A13	CA.6	Y	X	LAr to Phase Separator	TBD	TBD	TBD	10	300	1.030	87.0	50.0	100	TBD	TBD	TBD	TBD	TBD	TBD	
				Y	vacuum	(*)	TBD	TBD	TBD	1.5	300	vacuum	300.0	n/a	n/a	TBD	TBD	TBD	TBD	TBD	TBD	
		NP-04-30-A11	CA.7	Y	X	LAr to Condenser Pump	TBD	TBD	TBD	10	300	1.030	87.0	50.0	50.0	TBD	TBD	TBD	TBD	TBD	TBD	
				Y	vacuum	(*)	TBD	TBD	TBD	1.5	300	vacuum	300.0	n/a	n/a	TBD	TBD	TBD	TBD	TBD	TBD	
		NP-04-30-A4	CA.8	Y	X	GAr from purification and phase separator	TBD	TBD	TBD	10	300	1.03-1.50	transient 300-88	??	100.0	TBD	TBD	TBD	TBD	TBD	TBD	The Operating Pressure during the cool down of the LAr Filters will be higher. During the cool down of the cryostat we will need to increase the pressure inside the LAr Phase Separator to be able to push the LAr through the cool down nozzles. We would need 0.7 bar, which we can provide partly with LAr head (~0.2m) and partly increasing the pressure inside the LAr Phase Separator.
				Y	vacuum	(*)	TBD	TBD	TBD	1.5	300	vacuum	300.0	n/a	n/a	TBD	TBD	TBD	TBD	TBD	TBD	
		CV4441	CA.9	X	X	Fresh GAr to Condenser	TBD	TBD	TBD	10	300	10.000	300.0	100.0	Risk Analysis	TBD	TBD	TBD	TBD	TBD	TBD	
		SV3160		Y		Safety Device LN2 Heat Exchanger	TBD	TBD	TBD	10	300	10.000	87.0	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	
		SV4300		Y		Safety Device LAr Heat Echanger	TBD	TBD	TBD	10	300	10.000	87.0	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	
		SV4302		Y		Safety Device LAr outlet line	TBD	TBD	TBD	10	300	10.000	87.0	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	
		SV4340		Y	vacuum	safety device vacuum vessel	TBD	TBD	TBD	1.5	300	vacuum	300.0	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	
				Y	X	LAr Inlet from Condenser	TBD	TBD	TBD	10	300	layout	87.0	50.0	50.00	TBD	TBD	TBD	TBD	TBD	TBD	It is the hydrostatic height.

Process parameters of the lines connected to the valve boxes:

- Port name and type.
- Process pipe or not.
- Description.
- Dimensions → Vendor's task.
- Maximum allowable conditions (Pressure and Temperature).
- Operating conditions (Pressure, Temperature, Flow rate).
- Maximum mechanical loads → Vendor's task.

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Example of Interface sheet 2/5 (From NP-04)

Note: the values come from the spreadsheet "Interface sheet". If they are updated there, they are automatically udpated here as well.

NP-04-40-CA					
Description	**Tag**	**Nominal Mass Flow Rate**	**Max Mass Flow Rate**	**Max Pressure Drop**	**Outer Diameter**
[-]	[-]	g/s	g/s	mBar	mm
GN2 Vent	Line CA.A	50	100		TBD
LN2 Inlet	Line CA.B	50	100		TBD
GAr Cool-down Inlet (From CA.3 to condenser)	Line CA.C	100	100		76
GAr Inlet from Cryostat (From CA.4)	Line CA.C	50	Risk Analysis		TBD
LAr outlet to CA.7 and CA.5	Line CA.D	50	50		TBD
LAr line to CA.6	Line CA.D	50	100		TBD
GAr inlet from Purification (CA.8)	Line CA.E	??	100		TBD
Fresh GAr to Condenser (CA.9)	Line CA.F	100	Risk Analysis		TBD
NP-04-40-CU					
Description	**Tag**	**Nominal Mass Flow Rate**	**Max Mass Flow Rate**	**Max Pressure Drop**	**Outer Diameter**

Process parameters of the pipes inside the valve boxes:

- Description
- Nominal and max flow rate.
- Max pressure drop → Vendor's task.
- Outer diameter → Vendor's task.

Example of Interface sheet 3/5 (From NP-04)

Note: the values come from the spreadsheet "Interface sheet". If they are updated there, they are automatically udpated here as well.

Description	Max Mass Flow Rate	Max Pressure Drop	Cold Pipe size OD		Notes about Mass Flow Rate
[-]	g/s	mBar/m	mm		
NP-04-10-N1	100	2.0	TBD		Ok
NP-04-10-N2	100	1.0	TBD		Max
NP-04-10-N3	100	2.0	TBD		Ok
NP-04-30-A0	50	1.0	TBD		Ok
NP-04-30-A1	1860	1.0	TBD		Ok
NP-04-30-A2	1860	1.0	TBD		All the same
NP-04-30-A3	1860	1.0	TBD		Ok
NP-04-30-A4	1860	1.0	TBD		Max
NP-04-30-A5	1860	1.0	TBD		Ok
NP-04-30-A6	100	1.0	TBD		Ok
NP-04-30-A7	Risk Analysis	0.5	TBD		Ok
NP-04-30-A8	100	0.5	76		Ok
NP-04-30-A9	1860	1.0	TBD		Ok
NP-04-30-A10	25	1.0	TBD		Ok
NP-04-30-A11	50.00	1.0	TBD		Ok
NP-04-30-A12	Risk Analysis	0.5	TBD		Ok
NP-04-30-A13	100	1.0	TBD		Ok
NP-04-30-A14	50	1.0	TBD		Ok
NP-04-30-A15	1860	1.0	TBD		Ok
NP-04-30-A16	1860	1.0	TBD		Ok

Note 1: some Transfer Lines have "Tees" and multiple design conditions. We have assumed the highest values the same size for the full TL.

Transfer lines and process parameters.

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Example of Interface sheet 4/5 (From NP-04)

	Description	Interface point 1	Cold Pipe connection 1	Vacuum Connection 1	Interface point 2	Cold Pipe connection 2	Vacuum Connection 2	Note
	NP-04-10-N1	LN2 dewar	Welded	Vacuum barrier	NP.1	Welded	Welded sleeve	
					Tee on line from NP-02	Welded	Welded sleeve	
	NP-04-10-N2	NP.3	Welded	Welded sleeve	Atmosphere	Open	Vacuum barrier	
		CA.1	Welded	Welded sleeve				
	NP-04-10-N3	NP.2	Welded	Welded sleeve	CA.2	Welded	Welded sleeve	
	NP-04-30-A0	CA.5	Welded	Welded sleeve	CP.1	Welded	Welded sleeve	
	NP-04-30-A1	FL.3	Welded	Welded sleeve	Tee on NP-04-30-A2	Welded	Welded sleeve	
	NP-04-30-A2	F1.3	Welded	Welded sleeve	CP.4	Welded	Welded sleeve	
		F2.3	Welded	Welded sleeve	Tee w NP-04-30-A1	Welded	Welded sleeve	
		PM.1	Welded	Welded sleeve	Tee w NP-04-30-A14	Welded	Welded sleeve	
	NP-04-30-A3	F1.2	Welded	Welded sleeve	PM.2	Welded	Welded sleeve	
	NP-04-30-A4	F1.1	Welded	Welded sleeve	AP.3	Welded	Welded sleeve	
		F2.1	Welded	Welded sleeve	CA.8	Welded	Welded sleeve	
	NP-04-30-A5	PM.4	Welded	Welded sleeve	AP.1	Welded	Welded sleeve	
	NP-04-30-A6	AP.11	Welded	Welded sleeve	Close to Cryostat Port 9.1	Welded	Vacuum barrier	Point 2 is after the Dielectric Break.
	NP-04-30-A7	AP.8	Welded	Welded sleeve	Close to Cryostat Port 9.5	Welded	Vacuum barrier	Point 2 is after the Dielectric Break.
	NP-04-30-A8	CA.3	Welded	Welded sleeve	Close to Cryostat Port 9.4	Welded	Vacuum barrier	Point 2 is after the Dielectric Break.
	NP-04-30-A9	AP.10	Welded	Welded sleeve	Close to Cryostat Port 9.2	Welded	Vacuum barrier	Point 2 is after the Dielectric Break.
	NP-04-30-A10	AP.9	Welded	Welded sleeve	Close to Cryostat Port 9.3	Welded	Vacuum barrier	Point 2 is after the Dielectric Break.
	NP-04-30-A11	CA.7	Welded	Welded sleeve	CU.1	Welded	Welded sleeve	
	NP-04-30-A12	AP.5	Welded	Welded sleeve	CA.4	Welded	Welded sleeve	
	NP-04-30-A13	CA.6	Welded	Welded sleeve	AP.2	Welded	Welded sleeve	
	NP-04-30-A14	CU.2	Welded	Welded sleeve	Tee on NP-04-30-A2	Welded	Welded sleeve	
	NP-04-30-A15	CP.2	Welded	Welded sleeve	Close to Cryostat Port 13.1	Welded	Vacuum barrier	Point 2 is after the Dielectric Break.
	NP-04-30-A16	F2.2	Welded	Welded sleeve	PM.3	Welded	Welded sleeve	

Transfer lines and interface points/types.

Example of Interface sheet 5/5 (From NP-04)

Note: the values come from the spreadsheet "TL Process Pipes Parameters". If they are updated there, they are automatically udpated here as well.

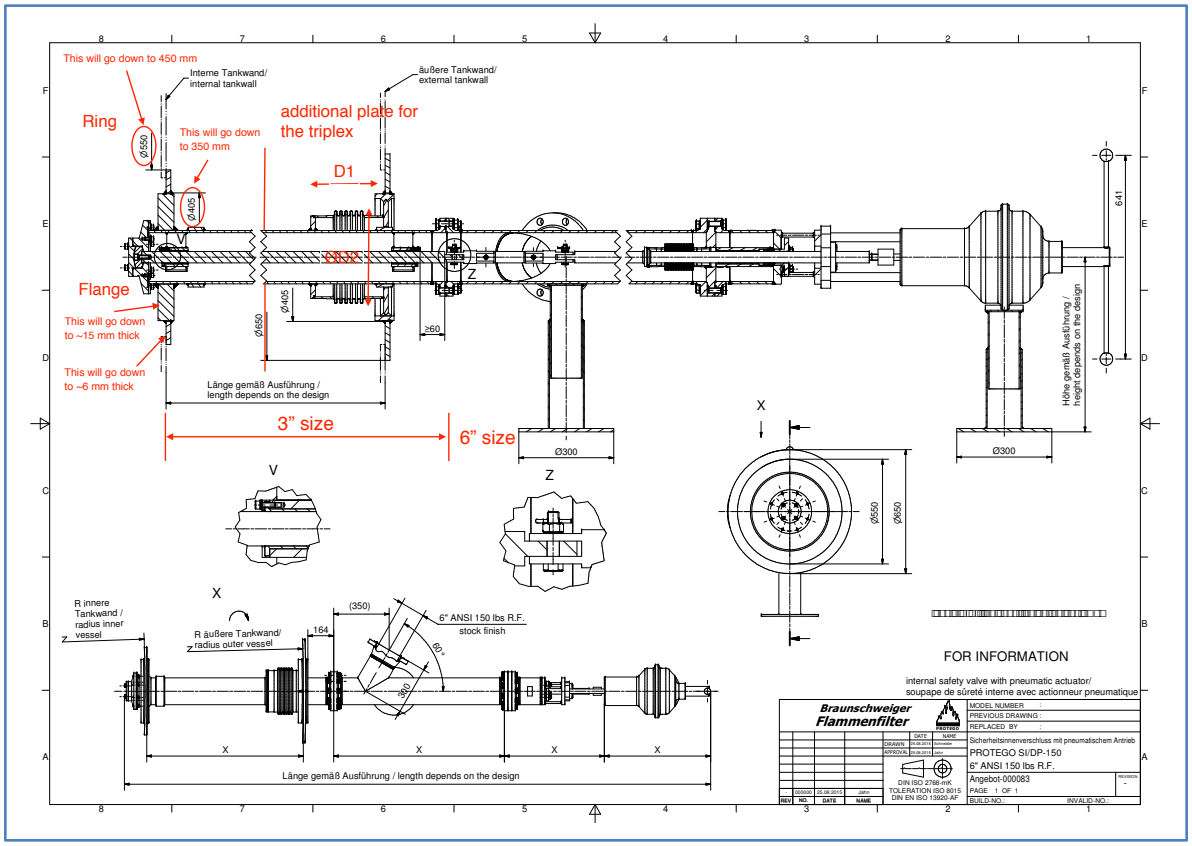
NP-04-40-CA					
Description	**Interface Point**	**Interface type**	**Cold Pipe connection**	**Vacuum Connection**	**Cold Pipe size OD**
[-]	[-]	[Y/Z]	[-]	[-]	mm
NP-04-10-N2	CA.1	Y	Welded	Welded sleeve	TBD
NP-04-10-N3	CA.2	Y	Welded	Welded sleeve	TBD
NP-04-30-A8	CA.3	Y	Welded	Welded sleeve	76
NP-04-30-A12	CA.4	Y	Welded	Welded sleeve	TBD
NP-04-30-A0	CA.5	Y	Welded	Welded sleeve	TBD
NP-04-30-A13	CA.6	Y	Welded	Welded sleeve	TBD
NP-04-30-A11	CA.7	Y	Welded	Welded sleeve	TBD
NP-04-30-A4	CA.8	Y	Welded	Welded sleeve	TBD
Non insulated	CA.9	Z	Welded	N/A	TBD
NP-04-40-CU					

Types of interfaces with the valve boxes:

- Name and type.
- Cold pipe connection.
- Vacuum connection.
- Cold pipe size → Vendor's task.

Side Penetration

- The implementation of the Protego design within the GTT membrane cryostat design is ongoing and proceeding well.
- New drawing available (specific for this project), but proprietary.



Summary

- We have identified the **type, size and location** of the penetrations (through the cryostat top and sides) for the cryogenic services and instrumentation.
- We have identified the **interfaces** between the Proximity and Internal Cryogenics: they will be outside of the cryostat, where the dielectric breaks (part of this tender) will be located.
- The **interfaces** between Proximity and External are internal to the selected vendor: both sides are part of this tender.
- We have developed the **interfaces** between the various parts with process parameters, type and location of connections that the vendor will need to design to.

Thanks