



RGA for vacuum vessel acceptance tests at Daresbury Laboratories.

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Vacuum specification

A specification is needed to:

- Enable you to meet the design criteria.
- Be specific to that project, synchrotron or linear accelerator or simple vessel?
- Estimate the cost of manufacturing vessels etc.
- Be easily understood by one and all (KISS).
- Ensure the same standards are maintained by everyone.
- Enable your supplier / manufacturer to understand your requirements.
- Support your complaint if standards are not achieved.



Daresbury specifications

- Spc-001-Definitions, 5 pages,
- Spc-002-General Specifications for UHV, 11 pages,
- Spc-003-Cleaning of vacuum items, 10 pages,
- Spc-004-Leak testing of vacuum vessels, 10 pages,
- Spc-005-Acceptance tests for vacuum vessels, 16 pages,
- Spc-006-Acceptance tests for clean mechanical pumps, 14 pages,
- Spc-007-Material for vacuum flanges, 8 pages,
- Spc-008-Standard vacuum notes, 5 pages.
- Proc-001-Calibration of total pressure gauges, 11 pages,
- Proc-002-Calibration or residual gas analysers, 14 pages,
- Proc-003-Measurement of thermal outgassing, 15 pages.

Total of 119 pages of stimulating reading?

All available on the internet.



A quick reference sheet is appreciated by all.

RGA analysis specification

Operational pressure region (mbar)	General contaminants	Perfluoro-polyphenylethers (sum of peaks 69 and 77)	Chlorines (sum of peaks 35 and 37)	Comments
	To be less than this % of the total pressure			
Atmospheric to 1	5	1	1	Exclude water, 17 & 18
1 to 2x10 ⁻³	2	0.5	0.5	As above
1x10 ⁻³ to 2x10 ⁻⁶	1	0.1	0.1	If unbaked as above
1x10 ⁻⁶ to 2x10 ⁻⁹	0.5	0.1	0.1	For a baked system
1x10 ⁻⁹ to 2x10 ⁻¹¹	0.1	0.01	0.01	
1x10 ⁻¹¹ or less	0.01	0.001	0.001	

Quick reference page for DL vacuum processing.

Solvent clean is normally preferred but always check the drawing and spec for specifics. Notify us if not using solvent for cleaning.

Typical leak rates and outgassing rates for different pressure regions.

Operational pressure region (mbar)	Typical required leak rate (mbar l/s)	Typical outgassing rate (mbar l/s/cm ²)	Comment
Atmosphere to 1	1x10 ⁻²	1x10 ⁻⁴	Outgassing rate not normally required.
1 to 2x10 ⁻³	1x10 ⁻⁵	1x10 ⁻⁷	
1x10 ⁻³ to 2x10 ⁻⁶	1x10 ⁻⁷	1x10 ⁻⁹	
1x10 ⁻⁶ to 2x10 ⁻⁹	1x10 ⁻⁹	1x10 ⁻¹¹	
1x10 ⁻⁹ to 2x10 ⁻¹¹	1x10 ⁻¹⁰	1x10 ⁻¹³	
1x10 ⁻¹¹ or less	1x10 ⁻¹² or less	1x10 ⁻¹⁵ or less	Very difficult to measure.

Most components and vessels will require baking to 250°C for 24 hours after cleaning in order to achieve the required base pressure as specified on the drawing. For UHV a good base pressure after bake is better than 1x10⁻⁹ mbar.

RGA scans of 1 – 200 AMU will be required for most jobs to confirm the level of cleanliness. The following is a rough guide to what is required.

General contaminants are indicated by AMU peaks: 39, 41, 42, 43, 45 and above, excluding those in the table below which are special cases.

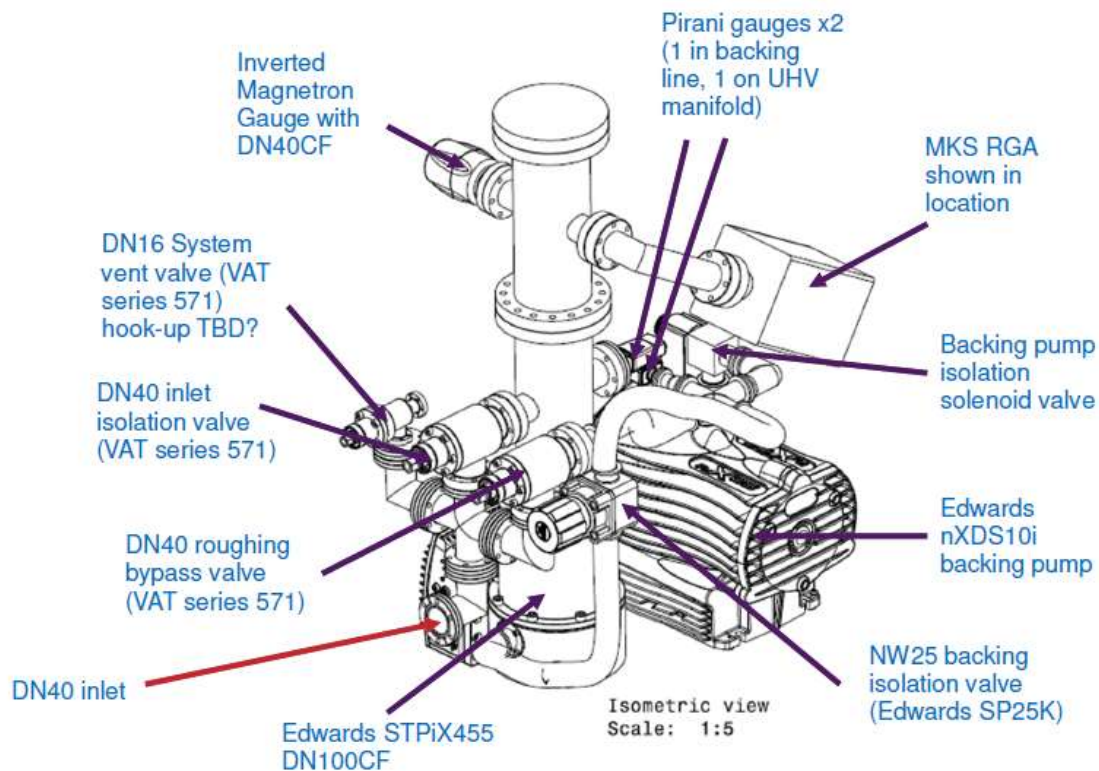
Operational pressure region (mbar)	General contaminants.	Perfluoro-polyphenylethers (sum of peaks 69 and 77)	Chlorines (sum of peaks 35 and 37)	Comments
	To be less than this % of the total pressure			
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1x10 ⁻¹¹ or less	0.01	0.001	0.001	

When quoting for vacuum work to the ASTEC specification please price for the each of the following individually:

Fabrication, cleaning, leak test, bake, RGA scan



Daresbury test rig used on ELI-NP project

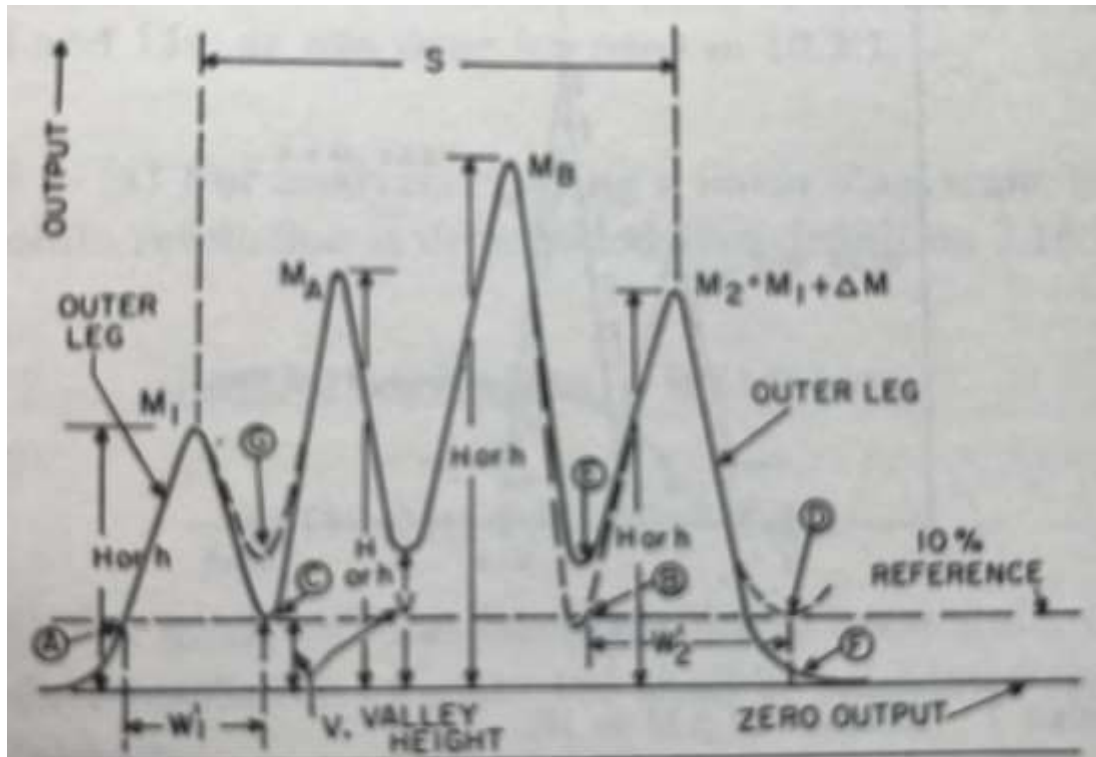


A few tips

1. RGA scan the test cart before connecting to test piece.
2. The cart should be at least an order of magnitude better than the spec you are testing to.
3. The cart should be isolate-able from the test piece.
4. The cart should provide a work top for laptop.
5. Scans and job record stored centrally rather than on the laptop.
6. Check that RGA can see helium, use a test leak.
7. Are the SEM and faraday modes equally tuned.
8. Use analogue mode (my preference) rather than bar-chart, it is more accurate (see next slide for peak shapes).



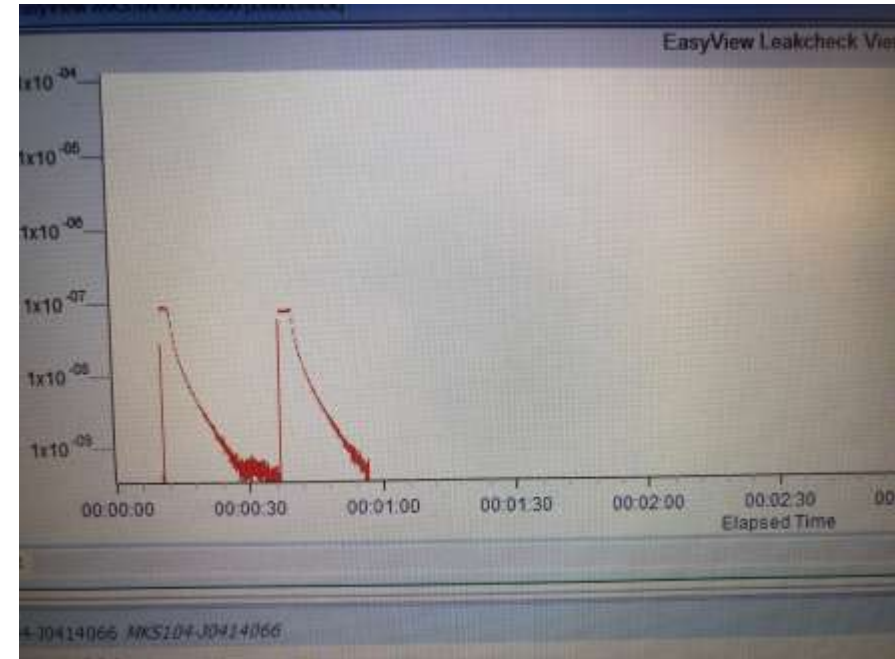
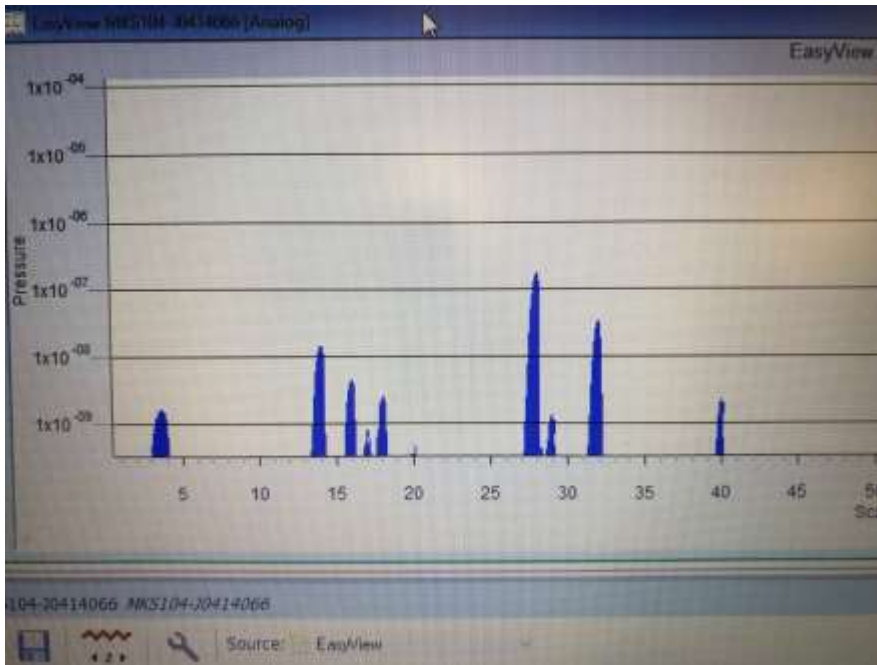
Peaks should be set up to look like this.



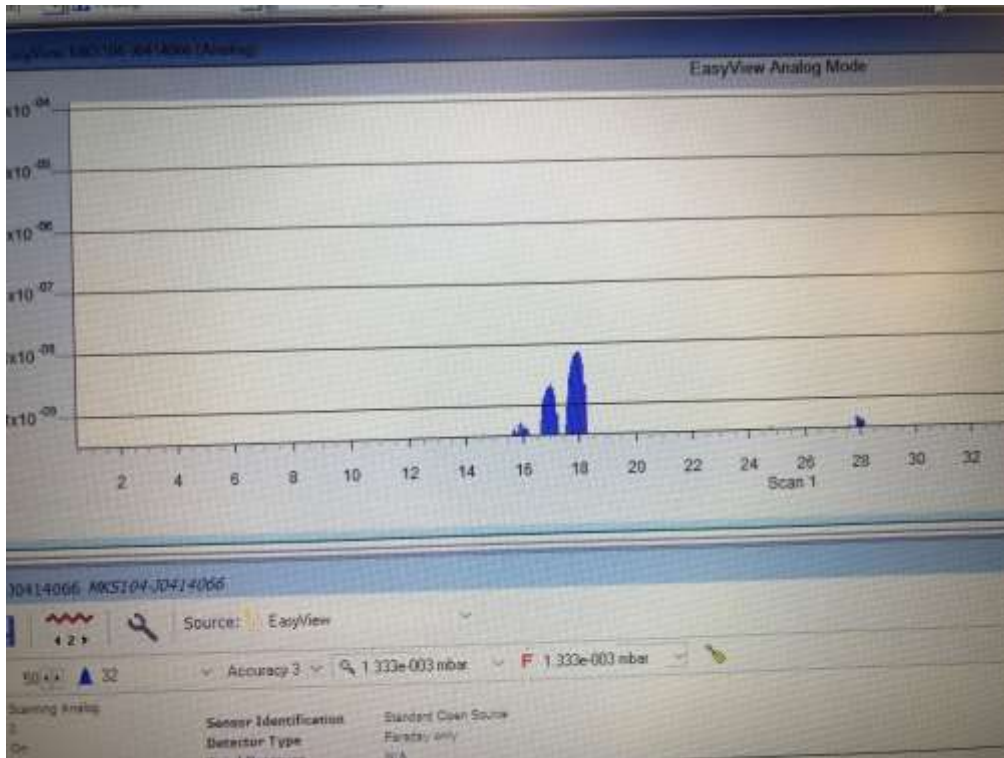
Extract from Partial Pressure Analysers and analysis.
Monte J. Drinkwine & David Lichtman



Leaking?

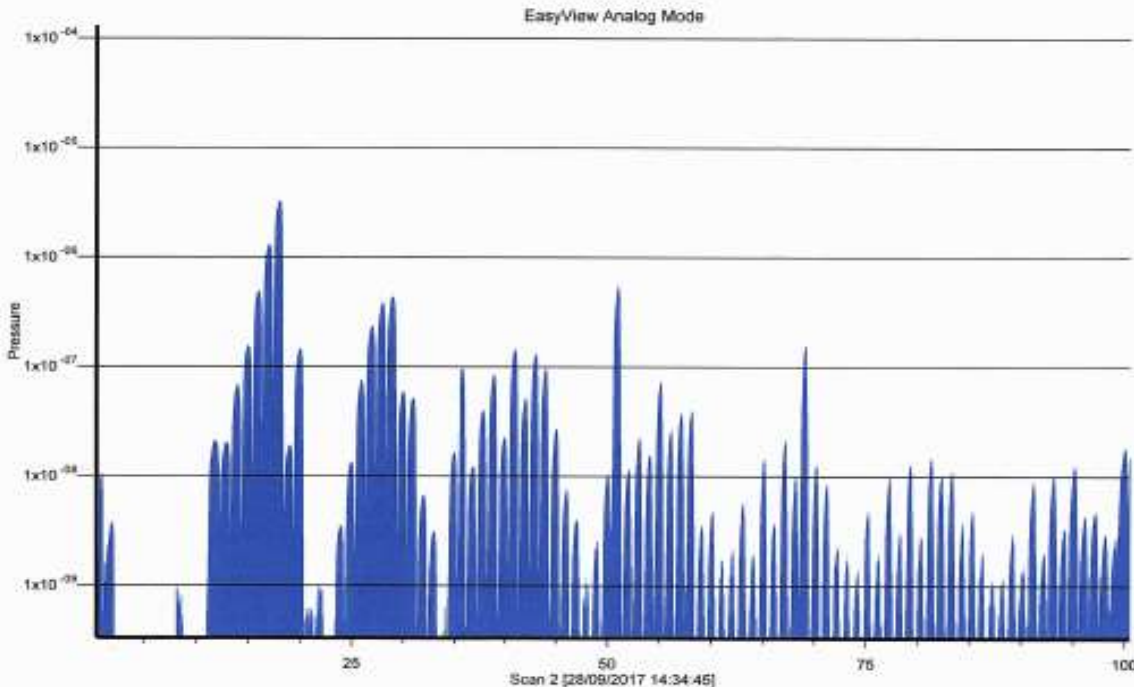


Leak resolved, scan as expected.



Pressure recovered quickly once the leak was identified. Not able to easily quantify the leak using an RGA, need to use a leak detector.

Does the scan meet the spec?

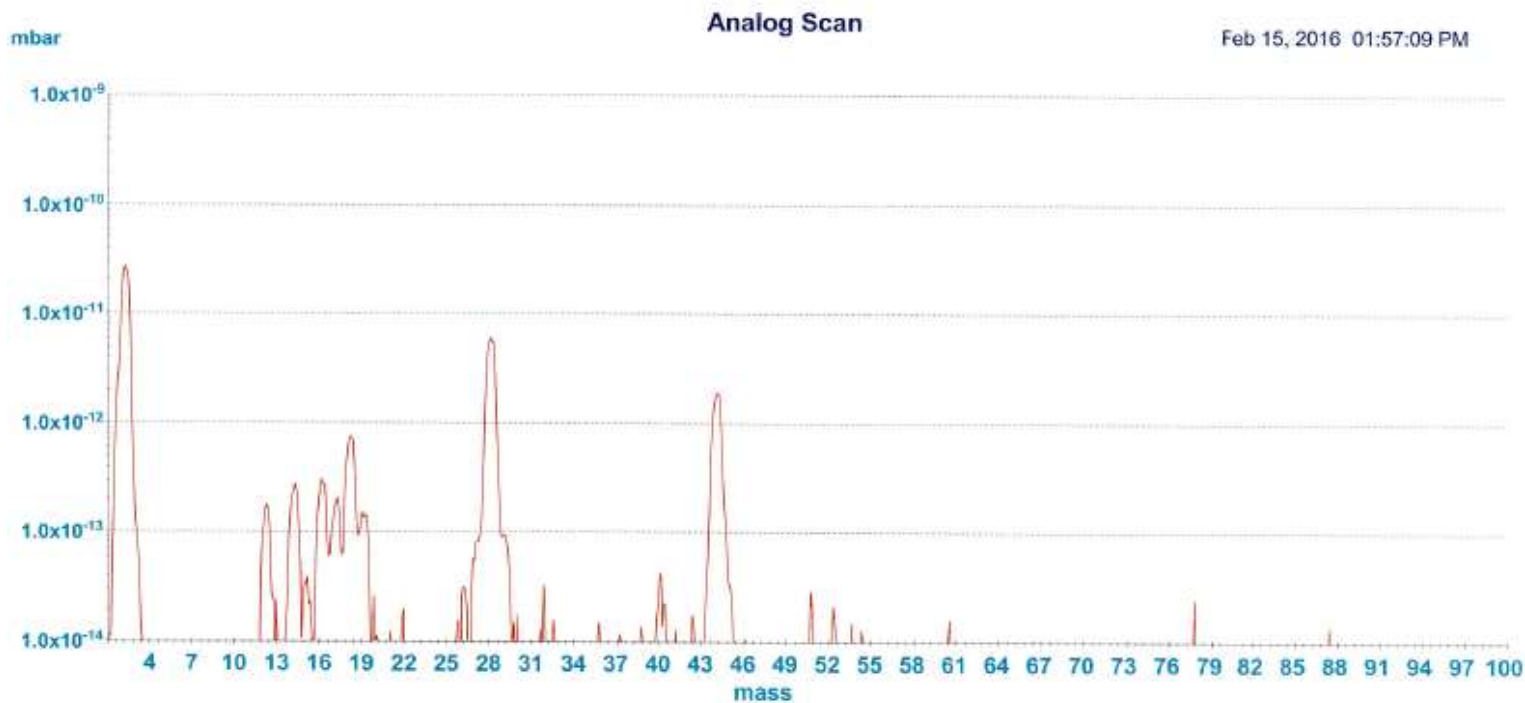


Operational pressure region (mbar)	General contaminants.	Perfluoro - polyphenylethers (sum of peaks 69 and 77)	Chlorines (sum of peaks 35 and 37)	Comments
	To be less than this % of the total pressure			
Atmospheric to 1	5	1	1	Exclude water, 17 & 18
1 to 2×10^{-3}	2	0.5	0.5	As above
1×10^{-3} to 2×10^{-6}	1	0.1	0.1	If unbaked as above
1×10^{-6} to 2×10^{-9}	0.5	0.1	0.1	For a baked system
1×10^{-9} to 2×10^{-11}	0.1	0.01	0.01	
1×10^{-11} or less	0.01	0.001	0.001	

	mbar	%
Total pressure from scan	6×10^{-6}	
General contaminants	1.35×10^{-6}	22
Chlorines	3×10^{-8}	0.5
Perfluoro-polyphenylethers	2.1×10^{-7}	15



Manufacturer removed job from oven too early



Email to me said they were ready to ship, had removed item from the oven, were the scans OK?
My reply, sorry looks like a leak, please retest.
Answer to me, yes we thought there might have been a leak but we hoped it would be OK.
Out come = small leak on weld, needed further work.



External RGA via email

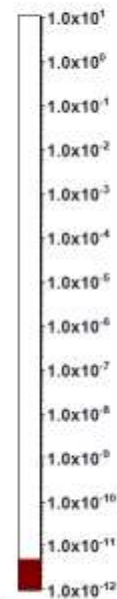
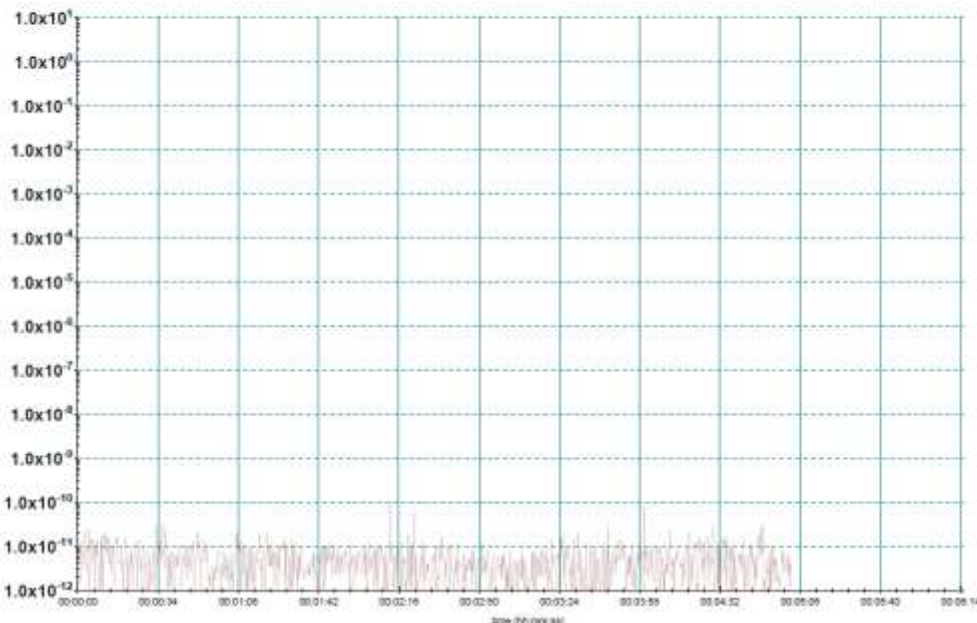


Initial Leak Test

Helium (4)

Torr 5.0E-12

LOW



Isolate job & RGA from pump set?
They want to remove from rig quickly due to process pressure.
More scans required if problem seen.

Issues encountered over the years

- Using wrong gas when leak detecting
- RGA not tuned to correct AMU, i.e. mass 4
- RGA scan of pump set rather than job.
- Different types of RGA
- Blown filaments
- No degas facility
- No dedicated pump sets, unknown history.
- Operator experience, trained or partially trained.
- Pressure to get the job out.
- Dirty welds hiding leaks
- Leaks appear during and after baking.
- RGA RF cables not bake-able to 250°C.
- RGA connectors only bake-able to 80°C





Thank you.