



Accelerator Science and Technology Centre

CCLRC Daresbury Laboratory

Vacuum Science Group

Vacuum Systems

**Acceptance Tests for Vacuum Vessels, Components and
Assemblies for ASTeC**

R J Reid

CCLRC Daresbury Laboratory
Warrington WA4 4AD

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1. Introduction

1.1 Definitions

Reference should be made to ASTEC-VAC-QCD-spc-001 *Definitions Relevant to Quality Control Documentation* for the definitions of various terms used in this document.

1.2 Applicability

- 1.2.1 This specification describes the normal acceptance tests that shall be applicable to any vacuum item required for ASTeC.
- 1.2.2 Any manufacturing documentation for a vacuum item shall state the pressure region in which the item or items will work. Unless stated to the contrary in such manufacturing documentation, the acceptance tests as described in this document for that pressure region shall be deemed to apply.
- 1.2.3 Unless it is specifically stated otherwise in the manufacturing documentation, then it shall be assumed that all vacuum items for ASTeC are required for use in a clean vacuum and will therefore satisfy the cleanliness requirements specified in this document.

2. General Procedures and Equipment

2.1 Vacuum Items which are Vacuum Vessels

- 2.1.1 Where the vacuum item is capable of being treated as a vacuum vessel, then unless otherwise agreed the item shall be made vacuum tight by means of flanges and gaskets appropriate to the pressure region in which it is to work.

2.2 Vacuum Items which are not Vacuum Vessels

- 2.2.1 Where the vacuum item is not capable of being treated as a vacuum vessel, then for these acceptance tests it shall be enclosed in a suitable vacuum vessel appropriate to the pressure region in which it is to work. This vessel shall satisfy the following conditions:
 - 2.2.1.1 It shall be capable of accommodating the vacuum item comfortably, but shall not be of such a size that its properties (outgassing rate, etc.) shall dominate the test results.
 - 2.2.1.2 It shall be tested immediately before insertion of the vacuum item and shall demonstrate that it satisfies the acceptance tests for the next lower pressure region. In the case of vacuum items for use in the XHV region, the requirements for this vessel shall be determined by ASTeC in consultation with the manufacturer of the vacuum item in each individual case.

2.3 Vacuum Pumps

- 2.3.1 Vacuum Pumps used shall be clean and appropriate to the pressure region in which the item is to be tested.
- 2.3.2 Descriptions of suitable pumps are to be found in ASTEC-VAC-QCD-spc-004 *Leak Testing of Vacuum Vessels and Assemblies*.
- 2.3.3 Normally, the item under test and the equipment used for partial pressure measurement shall have independent pumping systems which can each be isolated from the item under test by individual vacuum valves.
 - 2.3.3.1 The first pump set (the evacuation pump set) shall be capable of pumping the item under test to a suitable pressure in a reasonable time.
 - 2.3.3.2 The second pump set (the measurement pump set) shall be capable of maintaining the total and partial pressure gauges at a suitably low pressure. (See Sections 2.5.2 and 2.5.3 below.)
 - 2.3.3.3 For tests in the UHV and XHV regions where the partial pressure measurement equipment is mounted directly on the item under test or its housing, then the pump set described in Section 2.3.3.2 above may not be required.

2.4 Equipment for Total Pressure Measurement

Unless the manufacturing documentation specifies otherwise, permissible gauges for each pressure region shall be -

- 2.4.1 Low Vacuum region: Bourdon tube or mechanical diaphragm gauge. Where outgassing tests are to be conducted, a calibrated capacitance manometer gauge or similar shall be used.
- 2.4.2 Medium Vacuum region: Pirani gauge; thermocouple gauge. Where outgassing tests are to be conducted, a calibrated capacitance manometer gauge or similar shall be used.
- 2.4.3 High Vacuum region: Spinning Rotor gauge, Penning gauge; Inverted Magnetron gauge; Triode Ionisation Gauge
- 2.4.4 Very High Vacuum region: Inverted Magnetron gauge; Bayard-Alpert gauge; StabilIon™ gauge.
- 2.4.5 UHV region: StabilIon™ gauge (pressures higher than 10^{-10} mbar only); hot filament ionisation gauge with similar stability.
- 2.4.6 XHV region: Extractor gauge cross compared *in situ* with the type of gauge in Section 2.4.5 above at the start of the tests at a pressure of 10^{-9} mbar.
- 2.4.7 Provided the gauge remains within its maximum specified operating pressure, then a gauge specified here for a lower pressure region may be used in a higher pressure region.
- 2.4.8 These gauges shall normally be mounted as follows:
 - 2.4.8.1 On the evacuation pump set close to the connection to the item under test.
 - 2.4.8.2 On the measurement pump set *or*
 - 2.4.8.3 For vacuum items for use in the UHV or XHV regions directly on the item or its housing.
 - 2.4.8.4 Wherever an outgassing rate measurement is required, the total pressure gauge shall be mounted directly on the item under test or on its housing.
- 2.4.9 All total pressure gauges shall have calibrations traceable to national standards or cross comparison calibrations to such gauges as described in the document ASTEC-VAC-QCD-proc-001.

2.5 Equipment for Partial Pressure Measurement

2.5.1 Instrument

Unless agreed otherwise the equipment to carry out partial pressure measurements (*aka* residual gas analysis or rga) shall comprise a radio frequency quadrupole mass spectrometer. The basic parameters of the instrument shall be

- 2.5.1.1 Mass range: 1-200 amu
- 2.5.1.2 Resolution: Constant at 1 amu peak width at 5% peak height over whole mass range
- 2.5.1.3 Sensitivity: Defined as minimum detectable partial pressure of N₂ (mass 28).
Unless noted otherwise, for different service regimes this would normally be -
 - Low, Medium and High vacuum regions: four orders of magnitude below sampling pressure (see Section 2.5.3 below)
 - Very High Vacuum and UHV regions: 10^{-13} mbar
 - XHV region: 10^{-15} mbar

2.5.2 Mounting

- 2.5.2.1 Unless agreed otherwise, the rga instrument will be mounted on a clean pumping set, capable of achieving a base pressure of 10^{-8} mbar or at least one decade lower than that at which the acceptance tests are to be carried out, whichever is the lower pressure. Alternatively, the rga may be mounted directly

(nude) onto the vacuum item to be tested where that item is for UHV or XHV service.

2.5.2.2 Care must be taken to ensure that there is no cross talk between total and partial pressure gauges.

2.5.2.3 When mounted on a pumping set, then for tests in the Very High Vacuum, UHV and XHV regions, the connection to the item under test shall be dimensioned such that there is no significant pressure differential between the item and the pump set when the isolation valve is opened. An assessment must be made of any mass discrimination against high mass species.

2.5.3 Sampling

Where the pressure in the vacuum item under test (or its housing) will be greater than 10^{-6} mbar, a sampling stage must be introduced between the rga and the item under test, such that the pressure in the rga can be maintained at a constant value below 10^{-6} mbar. This latter pressure must be at least one decade above the base pressure at the rga when this sampling stage is closed off by a vacuum valve. The mass discrimination of this sampling stage shall have been measured with a pressure differential similar to that used for these tests.

3. Procedures for Partial Pressure Measurement

3.1 Equipment Conditioning

3.1.1 Before use, the rga instrument shall be baked to at least 200°C for 24 hours. While it is cooling down at the end of the bakeout, once the temperature is between 150°C and 100°C and the pressure in the rga is less than 1×10^{-6} mbar, the rga shall be thoroughly degassed according to the manufacturer's instructions. After degas it shall remain operational until the end of the test sequence.

3.1.2 When the rga housing has cooled to room temperature and the pressure has dropped to a value below that at which the tests are to be carried out (that is the pressure in the rga during the tests), the test system shall itself meet the criteria for cleanliness appropriate to the service regime for the vacuum item under test, except that all percentages shall be reduced by a factor of 10 (i.e. if the permitted partial pressure of a contaminant in the test piece is 0.1% of the total pressure, then the test equipment shall not exhibit a partial pressure of that component in excess of 0.01%)

3.2 Instrument Set-up: Low to High Vacuum Regions

3.2.1 The rga shall have been characterised so that its mass discrimination is known over the mass range of the unit for the detector to be used in the tests using the procedures described in the document ASTEC-VAC-QCD-proc-002.

3.2.2 The system containing the analyser shall have been pumped until the pressure is at its base value. (See Sections 2.5.2 and 2.5.3 above).

3.2.3 Pure dry nitrogen or a similar inert gas shall be bled into the high vacuum side of the pump set until the pressure has risen to that at which the test shall be carried out.

3.2.4 If the Faraday plate detector is to be used, the sensitivity of the rga shall, if possible, be adjusted according to the manufacturer's procedures such that the total pressure value obtained by summing all the partial pressures in the measured residual gas spectrum, corrected for the mass discrimination of the gauge and for the relative sensitivities of the species present is equal to the pressure measured on the total pressure gauge.

3.2.5 If the electron multiplier detector is to be used, then the sensitivity of the rga shall be set by adjusting the high voltage applied to the electron multiplier so that the total pressure value obtained by summing all the partial pressures in the measured residual gas spectrum, corrected for the mass discrimination of the gauge and for the relative sensitivities of the species present, is equal to the pressure measured on the total pressure gauge.

- 3.2.6 The nitrogen bleed shall be turned off and the measurement system pumped down to its base pressure.

3.3 Instrument Set-up: Very High Vacuum, UHV and XHV Regions

- 3.3.1 The rga shall have been characterised so that its mass discrimination is known over the mass range of the unit for the electron multiplier detector using the procedures described in the document ASTEC-VAC-QCD-proc-002.
- 3.3.2 The system containing the analyser shall have been pumped until the pressure is at its base value.
- 3.3.3 If a separate measurement pump set is used for the rga, then immediately prior to taking a set of measurements, the rga shall be cross-compared to a UHV or XHV total pressure gauge on the measurement pump set as follows.
- 3.3.3.1 Pure dry nitrogen or a similar inert gas shall be bled into the high vacuum side of the pump set until the pressure has risen by about two orders of magnitude (but no higher than 10^{-8} mbar)
- 3.3.3.2 The sensitivity of the rga shall be set by adjusting the high voltage applied to the electron multiplier so that the total pressure value obtained by summing all the partial pressures in the measured residual gas spectrum, corrected for the mass discrimination of the gauge and for the relative sensitivities of the species present, is equal to the pressure measured on the total pressure gauge.
- 3.3.3.3 The nitrogen (or similar gas) bleed shall then be switched off and the measurement system pumped down to its base pressure.
- 3.3.4 If the rga and total pressure gauges are both installed on the item under test then a calibration figure will be obtained using a similar technique to that above, *after* a first set of rga spectra has been obtained. This figure will be used to mathematically adjust the first set of data.
- 3.3.4.1 Pure dry nitrogen shall be bled into the vacuum item under test or it's housing until the pressure has risen by about two orders of magnitude (but no higher than 10^{-8} mbar).
- 3.3.4.2 The sensitivity of the rga will then be adjusted as in 3.3.3.2 above.
- 3.3.4.3 The item under test shall be pumped down to its base pressure. A second residual gas spectrum shall then be obtained.
- 3.3.4.4 If there are found to be any significant differences between the first (corrected) set of data and the second measured set of data, then ASTeC must be consulted before proceeding further.

3.4 Recording of RGA Spectra

- 3.4.1 Spectra may be recorded either on paper or digitally. In either case a hard copy containing sufficient data to ensure compliance with the specification shall be attached to the test certificate issued as described below.
- 3.4.2 Where the partial pressures are recorded using a linear scale, the spectrum shall be recorded at a sufficient number of nominal sensitivities so that the proper relationship between the peak amplitudes of the various species can be determined.
- This shall be achieved by recording spectra firstly at the scale on which the dominant mass species are shown as "on-scale" peaks, and then recording spectra with the sensitivity increasing one decade at a time until the sensitivity is such that the appropriate cleanliness criteria (see Appendix 2) can be sensibly determined or maximum sensitivity is reached, whichever comes first.
- 3.4.3 If the rga output is presented as an ion current rather than as a partial pressure, a measured conversion figure obtained by cross calibration against a calibrated standard total pressure gauge shall be supplied.

4. Procedure for Carrying Out Outgassing Tests

Full details of such procedures will be found in the document ASTEC-VAC-QCD-proc-003. The individual requirements for each pressure region are outlined in Section 5 below.

5. Acceptance Tests for Vacuum Items for Low Vacuum Service

5.1 Preparatory Work

The vacuum item shall be thoroughly degreased in accordance with the appropriate sections of ASTeC Specification ASTEC-VAC-QCD-spc-003 *Procedures for the Cleaning of Vacuum Items*.

5.2 Acceptance Tests

5.2.1 Leak Rate

5.2.1.1 The vacuum item shall be leak tested according to the procedures of ASTEC-VAC-QCD-spc-004 *Leak Testing of Vacuum Vessels and Assemblies*. The maximum leak rate detected shall be less than that specified in the manufacturing information.

5.2.1.2 A typical standard value for this pressure region is shown for guidance in Appendix 1.

5.2.2 Base Pressure

The item shall reach its specified base pressure in the specified time using an agreed pumping set. The pressure shall be measured with one of the total pressure gauges listed in Section 2.4.1 above. Unless otherwise specified, the gauge need not be calibrated but the reading must be demonstrated to be reasonable.

5.2.3 Outgassing Rate

5.2.3.1 It will be unusual for an outgassing rate measurement to be required in this pressure region. However a typical value is shown for guidance in Appendix 1.

5.2.3.2 Such tests shall be carried out using a rate-of-rise method. An absolute, calibrated pressure gauge such as a capacitance manometer shall be used for this measurement

5.2.4 Residual Gas Analysis

5.2.4.1 An rga spectrum shall be taken by sampling into an rga system (see 2.5.3 above). The spectrum shall be recorded when the total pressure in the rga system and the measured partial pressures have been stable (to within 1%) for a period of at least 5 minutes. The spectrum shall be corrected for the mass discrimination of the sampling stage before applying the mass filter mass discrimination and the relative sensitivity corrections.

5.2.4.2 The analysed spectrum shall meet the appropriate criteria as defined in Appendix 2.

5.3 Test Certificate

A suitable test certificate shall be issued (see Section 11 below.)

6. Acceptance Tests for Vacuum Items for Medium Vacuum Service

6.1 Preparatory Work

The vacuum item shall be thoroughly degreased in accordance with the appropriate sections of ASTeC Specification ASTEC-VAC-QCD-spc-003 *Procedures for the Cleaning of Vacuum Items*.

6.2 Acceptance Tests

6.2.1 Leak Rate

6.2.1.1 The vacuum item shall be leak tested according to the procedures of ASTEC-VAC-QCD-spc-004 *Leak Testing of Vacuum Vessels and Assemblies*. The maximum leak rate detected shall be less than that specified in the manufacturing information.

6.2.1.2 A typical standard value for this pressure region is shown for guidance in Appendix 1.

6.2.2 Base Pressure

The item shall reach its specified base pressure in the specified time using an agreed pumping set. The pressure shall be measured with one of the total pressure gauges listed in Section 2.4.2 above. Unless otherwise specified, the gauge need not be calibrated but the reading must be demonstrated to be reasonable.

6.2.3 Outgassing Rate

6.2.3.1 It will be unusual for an outgassing rate measurement to be required in this pressure region. However a typical value is shown for guidance in Appendix 1.

6.2.3.2 Such tests shall be carried out using a rate-of-rise method. An absolute, calibrated pressure gauge such as a capacitance manometer shall be used for this measurement

6.2.4 Residual Gas Analysis

6.2.4.1 An rga spectrum shall be taken by sampling into an rga system (see 2.5.3 above). The spectrum shall be recorded when the total pressure in the rga system and the measured partial pressures have been stable (to within 1%) for a period of at least 5 minutes. The spectrum shall be corrected for the mass discrimination of the sampling stage before applying the mass filter mass discrimination and the relative sensitivity corrections.

6.2.4.2 The analysed spectrum shall meet the appropriate criteria as defined in Appendix 2.

6.3 Test Certificate

A suitable test certificate shall be issued (see Section 11 below.)

7. Acceptance Tests for Vacuum Items for High Vacuum Service

7.1 Preparatory Work

The vacuum item shall be thoroughly cleaned in accordance with the appropriate sections of ASTeC Specification ASTEC-VAC-QCD-spc-003 *Procedures for the Cleaning of Vacuum Items*.

7.2 Acceptance Tests

7.2.1 Leak Rate

7.2.1.1 The vacuum item shall be leak tested according to the procedures of ASTEC-VAC-QCD-spc-004 *Leak Testing of Vacuum Vessels and Assemblies*. The maximum leak rate detected shall be less than that specified in the manufacturing information.

7.2.1.2 A typical standard value for this pressure region is shown for guidance in Appendix 1.

7.2.2 Base Pressure

The item shall reach its specified base pressure in the specified time using an agreed pumping set. The pressure shall be measured with one of the total pressure gauges listed in Section 2.4.3 above. Unless otherwise specified, the gauge shall have been cross compared within the previous three months to a gauge with a calibration traceable to national standards.

7.2.3 Outgassing Rate

7.2.3.1 An outgassing rate measurement may be required in this pressure region. A typical value is shown for guidance in Appendix 1.

7.2.3.2 Such tests shall be carried out using a rate-of-rise method. A calibrated total pressure gauge such as a spinning rotor gauge or a Penning gauge shall be used for this measurement

7.2.4 Residual Gas Analysis

7.2.4.1 An rga spectrum shall be taken by sampling into an rga system (see 2.5.3 above). The spectrum shall be recorded when the total pressure in the rga system and the measured partial pressures have been stable (to within 1%) for a period of at least 5 minutes. The spectrum shall be corrected for the mass discrimination of the sampling stage before applying the mass filter mass discrimination and the relative sensitivity corrections.

7.2.4.2 The analysed spectrum shall meet the appropriate criteria as defined in Appendix 2.

7.3 Test Certificate

A suitable test certificate shall be issued (see Section 11 below.)

8. Acceptance Tests for Vacuum Items for Very High Vacuum Service

8.1 Preparatory Work

The vacuum item shall be thoroughly cleaned and processed in accordance with the appropriate sections of ASTeC Specification ASTEC-VAC-QCD-spc-003 *Leak Testing of Vacuum Vessels and Assemblies*.

8.2 Acceptance Tests

8.2.1 Leak Rate

8.2.1.1 The vacuum item shall be leak tested according to the procedures of ASTEC-VAC-QCD-spc-004 *Leak Testing of Vacuum Vessels and Assemblies*. The maximum leak rate detected shall be less than that specified in the manufacturing information.

8.2.1.2 A typical standard value for this pressure region is shown for guidance in Appendix 1.

8.2.2 Base Pressure

The item shall reach its specified base pressure in the specified time using an agreed pumping system. The pressure shall be measured with one of the total pressure gauges listed in Section 2.4.4 above. Unless otherwise specified, the gauge shall have been cross compared within the previous three months to a gauge with a calibration traceable to national standards.

8.2.3 Outgassing Rate

8.2.3.1 An outgassing rate measurement will usually be required in this pressure region. A typical value is shown for guidance in Appendix 1.

8.2.3.2 Such tests shall be carried out either using a rate-of-rise method or an orifice flow technique. A calibrated total pressure gauge such as a StabilIon™ gauge shall be used for this measurement

8.2.4 Residual Gas Analysis

8.2.4.1 An rga spectrum shall be taken. The spectrum shall be recorded when the total pressure and the measured partial pressures have been stable (to within 1%) for a period of at least 15 minutes.

8.2.4.2 The analysed spectrum shall meet the appropriate criteria as defined in Appendix 2.

8.3 Test Certificate

A suitable test certificate shall be issued (see Section 11 below.)

9. Acceptance Tests for Vacuum Items for Ultra High Vacuum Service

9.1 Preparatory Work

The vacuum item shall be thoroughly cleaned and processed in accordance with the appropriate sections of ASTeC Specification ASTEC-VAC-QCD-spc-003 *Procedures for the Cleaning of Vacuum Items*.

9.2 Acceptance Tests

9.2.1 Leak Rate

9.2.1.1 The vacuum item shall be leak tested according to the procedures of ASTEC-VAC-QCD-spc-004 *Leak Testing of Vacuum Vessels and Assemblies*. The maximum leak rate detected shall be less than that specified in the manufacturing information.

9.2.1.2 A typical standard value for this pressure region is shown for guidance in Appendix 1.

9.2.2 Base Pressure

The item shall reach its specified base pressure in the specified time using an agreed pumping system. The pressure shall be measured with one of the total pressure gauges listed in Section 2.4.5 above. Unless otherwise specified, the gauge shall have been cross-compared within the previous three months to a gauge with a calibration traceable to national standards.

9.2.3 Outgassing Rate

9.2.3.1 An outgassing rate measurement will usually be required in this pressure region. A typical value is shown for guidance in Appendix 1.

9.2.3.2 Such tests shall be carried out using a rate-of-rise method. The total pressure gauge used for this measurement shall have been cross-compared within the previous three months to a gauge with a calibration traceable to national standards. The gauge shall have had its subsequent history of use documented.

9.2.4 Residual Gas Analysis

9.2.4.1 An rga spectrum shall be taken. The spectrum shall be recorded when the total pressure and the measured partial pressures have been stable (to within 1%) for a period of at least 15 minutes.

9.2.4.2 The analysed spectrum shall meet the appropriate criteria as defined in Appendix 2.

9.3 Test Certificate

A suitable test certificate shall be issued (see Section 11 below.)

10. Acceptance Tests for Vacuum Items for Extreme High Vacuum Service

10.1 Preparatory Work

The vacuum item shall be thoroughly cleaned and processed in accordance with the appropriate sections of ASTeC Specification ASTEC-VAC-QCD-spc-003 *Procedures for the Cleaning of Vacuum Items*.

10.2 Acceptance Tests

10.2.1 Leak Rate

10.2.1.1 The vacuum item shall be leak tested according to the procedures of ASTEC-VAC-QCD-spc-004 *Leak Testing of Vacuum Vessels and Assemblies*. The maximum leak rate detected shall be less than that specified in the manufacturing information.

10.2.1.2 A typical standard value for this pressure region is shown for guidance in Appendix 1.

10.2.2 Base Pressure

The item shall reach its specified base pressure in the specified time using an agreed pumping system. The pressure shall be measured with one of the total pressure gauges listed in Section 2.4.6 above. Unless otherwise specified, the gauge shall have been cross-compared within the previous three months to a gauge with a calibration traceable to national standards.

10.2.3 Outgassing Rate

10.2.3.1 An outgassing rate measurement will usually be required in this pressure region. A typical value is shown for guidance in Appendix 1.

10.2.3.2 Such tests shall be carried out using a rate-of-rise method. The total pressure gauge used for this measurement shall have been cross-compared within the previous three months to a gauge with a calibration traceable to national standards. The gauge shall have had its subsequent history of use documented.

10.2.4 Residual Gas Analysis

10.2.4.1 An rga spectrum shall be taken. The spectrum shall be recorded when the total pressure and the measured partial pressures have been stable (to within 1%) for a period of at least 15 minutes.

10.2.4.2 The analysed spectrum shall meet the appropriate criteria as defined in Appendix 2.

10.3 Test Certificate

A suitable test certificate shall be issued (see Section 11 below.)

11. Test Certificates

Unless otherwise specified, a test certificate conforming to Vac/VA/Cert/001 shall be issued for each vacuum item.

Appendix 1

Typical Standard Leak Rates and Outgassing Rates for Different Pressure Regions

Pressure Region*	Typical Leak Rate (mbar l sec⁻¹)	Typical Outgassing Rate (mbar l sec⁻¹ cm⁻²)	Comment
Low Vacuum	10 ⁻²	10 ⁻⁴	Outgassing rates not usually relevant in this region
Medium vacuum	10 ⁻⁵	10 ⁻⁷	
High Vacuum	10 ⁻⁷	10 ⁻⁹	
Very High Vacuum	10 ⁻⁹	10 ⁻¹¹	
UHV	10 ⁻¹⁰	10 ⁻¹³	
XHV	<10 ⁻¹²	<10 ⁻¹⁵	Special techniques required to measure leak and outgassing rates

* See ASTEC-VAC-QCD-spc-001 *Definitions relevant to Quality Control Documentation*

Appendix 2

Standard Limits of Acceptability of Species Present in a Residual Gas Spectrum Appropriate to Different Pressure Regions

Notes

1. The residual gas spectrum shall have been recorded over 1 –200 amu
2. The spectrum shall have been corrected for sampling error, mass discrimination and species relative sensitivities (see Appendix 3)
3. These limits are expressed in terms of percentages of the total pressure in the system, corrected as indicated
4. The definition of “general contaminants” is the sum of the partial pressures of all peaks present in the residual gas spectrum of mass to charge ratio (amu) equal to 39, 41-43 and 45 and above (*excluding* any above 45 specifically listed in the table below). Also to be excluded from this summation are any peaks related to the rare gases xenon (i.e. 132, 129, 131) and krypton (i.e. 84, 86, 83)

Pressure Region	General Contaminants	Perfluoropolyphenyle thers Sum of (peak at 69 and 77 amu)	Chorinated species (Sum of peaks at 35 and 37 amu)	Comment
Low Vacuum	5	1	1	Excluding water (sum of 17 and 18 amu) from the total pressure
Medium Vacuum	2	0.5	0.5	
High Vacuum	1	0.1	0.1	If unbaked, excluding water as above
Very High Vacuum	0.5	0.1	0.1	Assuming system baked
UHV	0.1	0.01	0.01	
XHV	0.01	0.001	0.001	At 10^{-10} mbar 0.001% is 10^{-15} mbar

Appendix 3

Relative Sensitivities for Species Detected by a “Standard” Quadrupole RGA

Notes

1. In all cases it is preferable to use either the measured sensitivities of species for the instrument in use, or the manufacturer’s generic sensitivities for that type of instrument. Relative sensitivities are very dependent on ion source geometry and conditions. Therefore this data must be treated with extreme caution. Unfortunately, there is no “standard” data available.
2. The data in the table are ion source sensitivities. To obtain the species sensitivity of the rga these must be multiplied by the mass discrimination of the mass filter.
3. The dataset is, in fact, that determined for hot cathode ionisation gauges. The operation of a typical ion source for UHV use is similar. The data is summary data taken from Table 7.2 in P.A. Redhead, J P Hobson and E V Kornelsen “The Physical Basis of UHV”, AVS Classics Series, New York (1993). The listed values are the averages of the values for gauges 1-9 of that table, excluding gauge 5, and are normalised to argon.

Gas species	Average relative sensitivity
Ar	1.00
He	0.14
Ne	0.24
Kr	1.41
Xe	2.14
N ₂	0.63
H ₂	0.29
Cl ₂	0.64
CO	0.65
O ₂	0.71
NO	0.61
CO ₂	1.03
HCl	1.20
CH ₄	1.11