This Technical Guideline is valid for beam vacuum components only. It is not applicable for insulation vacuum cryostat vessels.

1.) Helium leak check

After final assembling and cleaning of the vacuum chamber, vacuum tank or vacuum component a helium leak check has to be carried out. The leak test procedure depends on the volume of the object to be tested.
Vacuum chambers (e.g. tubes) and vacuum components with a volume of $V < 1\ m^3$ can directly be connected to a leak test device as shown in Fig. 1.

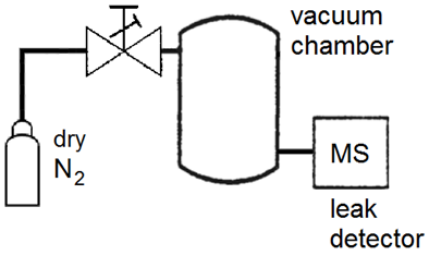

Fig. 1: General leak detection setup

Large-volume vacuum tanks with a volume of $V \geq 1\ m^3$, however, must be leak checked as shown in Fig. 2. This leak test setup, of course, can also be used for vacuum chambers and vacuum components with volumes of $V < 1\ m^3$.

For leak detection a calibrated leak detector is to be used only. The calibration can be performed using the internal test leak, which is integrated in all common standard leak detectors, or with an appropriate external calibrated test leak.

The vacuum chamber, vacuum tank or vacuum component must then be enveloped by a suitable encasement in order to carry out an integral leak check. Typically, a polyethylene foil sleeve is used. GHe must then be injected into the encasement so that the entire vacuum chamber or component is exposed to high He concentration. It must be ensured that the polyethylene foil sleeve or bag is gas-tight.
The reading of the leak detector must be recorded continuously during the entire testing time.

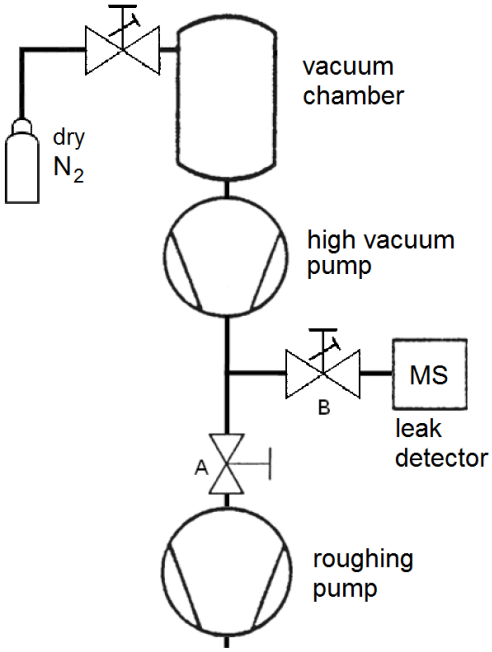

Fig. 2: Leak detection setup for large-volume tanks

<u>Acceptance criterion:</u> The leak test is declared as passed if during the entire **testing time of $t \geq 10$ min** the leak rate is $\boldsymbol{q_{He} \leq 1 \cdot 10^{-10}}$ **mbar·ℓ/s**.

The documented q_{He} vs. t chart is part of the acceptance test protocol and must be provided. The helium background, which has to be subtracted prior to the test, must also be documented in detail.
If the leak rate reading tends to increase steadily towards the acceptable limit of $\mathbf{1 \cdot 10^{-10}}$ **mbar·ℓ/s** at the end of the testing time, the testing time must be increased to 20 min. If the leak rate exceeds the maximum value in this extended measuring time, the leak check has to be aborted and the leak test is declared as failed. In this case the local tracer probe leak technique has to be applied in order to locate the leak.

2.) Measurement of outgassing rate

The surface related outgassing rate of the vacuum-facing surfaces must be measured. If not otherwise specified, a surface related outgassing rate **after an adequate pump-down time** (which must be documented in detail) of

Acceptance criterion: $q_{out} \leq 5 \cdot 10^{-10}$ **mbar·ℓ/s/cm²**

must be demonstrated. This acceptance criterion also applies to vacuum chambers or large-volume vacuum tanks in which **built-in components** may be installed. Outgassing rate measurements can be carried out using various techniques, e.g. pressure-rise/accumulation method, throughput method, ultimate pressure method, etc. The measuring setup has to be documented in detail, including an accurate description of the measuring method and all measuring devices.

3.) Measurement of the residual gas composition

The residual gas composition of the vacuum chamber, vacuum tank or vacuum component has to be measured **after an adequate pump-down time** (which must be documented in detail). The RGA spectrum is part of the acceptance test protocol. The RGA type to be used shall have a lower partial pressure measuring limit of at least **≤ 5 · 10^{-12} mbar** (Faraday cup) and must be sensitive in a mass range of at least **0 ... 100 amu**.

Acceptance criteria:

- The dominant mass peak must be H_2O (18 amu = reference peak).
- The mass peak 28 amu has to be at least **10 times** lower compared to the reference peak.
- The mass peaks > 18 amu to < 44 amu (except 28 amu) have to be at least **100 times** lower compared to the reference peak.
- The mass peaks > 44 amu have to be at least **1000 times** lower compared to the reference peak.

If the acceptance criteria are not met, it is suggested to increase the pump-down time, or a subsequent cleaning of the vacuum chamber, vacuum tank or vacuum component must be carried out.
RGAs typically provide an ion current vs. mass number scan. However, some modern RGAs convert the ion current into an *approximate* partial pressure and instead display a partial pressure vs. mass number plot. The abovementioned criteria apply regardless of the display mode of the used RGA, i.e. the peak heights (either *p* [mbar or Pa] or *I* [A]) are decisive.
The ion current (or partial pressure) axis of the RGA spectrum must be represented using a logarithmic scale, displaying the most meaningful data range and covering at least 4 decades. Furthermore, all relevant RGA parameters (particularly all relevant detector settings) must be documented in the acceptance test protocol.
The acceptance criteria also apply to vacuum chambers with RF gaps and vacuum chambers or large-volume vacuum tanks in which **built-in components** may be installed.