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1. Scope

- 1) This document defines requirements and procedures to be executed for pressurised leak testing of tubing for conduction of liquid and gaseous cryogenic media in applications like
 - magnet cryostats,
 - cryogenic supply systems,
 - cryogenic transport systems,
 - cryogenic current lead boxes,
 - auxiliary cryogenic systems
 within FAIR accelerators.
- 2) This document is NOT related to any other purpose as aforementioned.
- 3) This document does NOT represent a replacement for any relevant technical standards in terms of 97/23/EC or the AD2000 Code.

2. Definitions

- 1) *Cryogenic media* in terms of this guideline are liquefied pressurised and non pressurised Helium (LHe) and Nitrogen (LN₂) as well as gaseous Helium (GHe) and gaseous Nitrogen (GN₂).

3. Codes and Standards

- 1) The European pressure equipment directive 97/23/EC [1] defines the legal standards for components and assemblies being recognised as pressure equipment.
- 2) The AD 2000 Code [2] defines the engineering and documentation standards in terms of pressure equipment.
- 3) The AD 2000-Technical Bulletin HP 30 [3] defines the requirements for pressure testing.

4. Basic Requirements

- 1) This test must NOT be performed with components or assemblies classified as pressure equipment in terms of [1] before being correctly certified according to [2].

4.1. Surrounding conditions

- 1) The tests must be performed in a clean, low dust and dry surrounding.
- 2) No contamination e.g. with dust, grease or oil must be accepted during testing.
- 3) The test surrounding must provide the safety standards as defined in [3].

4.2. Required Documentation

- 1) All documentation must be available on site at the date of testing.
- 2) In case of pressure equipment in terms of [1] the following documentation must be available:
 - certificate as defined in [4] of a passed pressure test according to [2]
- 3) In any case the following documentation according to [2] must be available:
 - testing certificates for all welding seams applied at the tubing,
 - documentation of all safety relevant calculations,
 - certificates proving the pressure resistance for all tube fittings, gaskets and flanges applied to the tubing.
- 4) A copy of the calibration certificate of the He – leak tester and pressure gauge in use for the tests is required and must be added to the documentation.
- 5) None of the calibration certificates must show a date of last calibration older then one year at the date of testing.
- 6) A testing protocol showing at least the content as defined in 7.1 must be prepared prior to the test procedures being executed.

4.3. Required Equipment and Media

- 1) All equipment used for the pressure test must be suitable for the applied testing pressure, e.g. in terms of pressure range and safety.
- 2) The following equipment and media is required for the tests:
 - a set of blanking flanges and seals suitable for all flanges not in use during testing,
 - compressed He gas cylinder with pressure regulator,

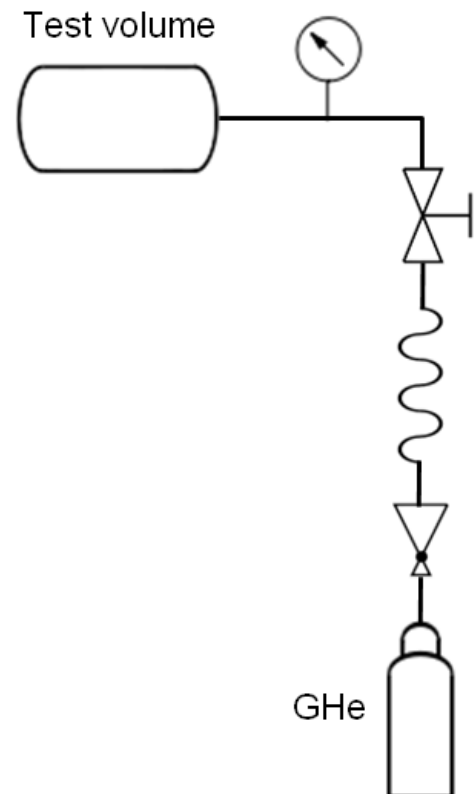


Figure 1: Pressure testing scheme

- a port flange with calibrated pressure gauge (accuracy class 0.1 or better) showing an adequate pressure range,
- He tight valve,
- flexible or rigid tube and fittings,
- calibrated He leak tester with a most sensible range of at least $1 \cdot 10^{-8}$ mbar*L/s providing a sniffing mode.

5. Test Preparation

- 1) All relevant preparations and safety precautions as defined in [3] for performing a gas-pressure test must be prepared.
- 2) A setup as described in Figure 1 must be prepared.
- 3) The test setup itself up to the test volume must be proven as pressure resistant and He tight within the relevant pressure range.

6. Checks and Tests

- 1) For pressure testing the checks and tests 6.1 to 6.3 must be performed following the listed sequence.

6.1. Document and Certification Check

- 1) All documentation listed in 4.2 must be checked for completeness.
- 2) In case of incomplete documentation, the vacuum test must be declared as failed.

6.2. Pressure Drop Test

- 1) The basic leak tightness must be demonstrated by applying the pressure drop method.
- 2) Only He gas must be used for pressurising.
- 3) The test pressure being applied must be calculated as the maximum allowed pressure for the technical system.
- 4) Due to operation conditions of the tubing (within insulation vacuum surrounding) the additional pressure difference of 1 bar must be considered when calculating the test pressure.
- 5) The applied inner pressure must be proven as constant for at least 24 h.
- 6) In case of a pressure drop more then 0.1 % during 24 h, the leak test must be declared as failed.



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6.3. Pressurised He Leak Test

- 1) In case of any pressure drop, leaks must be detected by applying a He sniffing test as long as the test volume is still pressurised.
- 2) Existing leaks must be marked and documented.

7. Documentation

- 1) All relevant certificates must be provided with the documentation.
- 2) All described checks and tests must be documented in a testing form agreed by the contracting entity.
- 3) The original documentation must be handed out to the contracting entity.
- 4) A digital copy must be stored in EDMS following relevant guidelines for EDMS access and usage. The EDMS storage must be agreed with the contracting entity.
- 5) Any measured values must be documented in writing within a protocol as defined as follows.

7.1. Testing Protocol Requirements

- 1) The complete testing protocol must show comprehensible structure and content documenting each single test being executed.
- 2) The following information must be at least documented within the cover sheet:
 - test identification,
 - address of Company or Institute,
 - identification of Department,
 - names of testing personnel,
 - name of quality testing leader,
 - date and time,
 - identification of tested object,
 - serial number of tested object,
 - test result,
 - number of pages (including photo prints).
- 3) The measurement equipment in use must be documented at least with
 - device identification,
 - serial number,
 - date of last calibration,
 - applied measuring range.
- 4) All tests, described in the chapter 6 must be documented at least with
 - brief description of testing process,
 - test schemes if applicable (e.g. vacuum scheme),

- relevant device settings,
 - registered non-conformities,
 - nominal values,
 - measured values,
 - ambient temperature, pressure and relative humidity,
 - photos of non-conformities (if applicable),
 - single ratings,
 - full test rating
- in clearly separated chapters.

- 5) In case a component failed the test and was repaired, the documentation of the repair work must be delivered within the documentation of the repeated and passed test.
- 6) All defined tests and procedures must be signed by the executing personnel.
- 7) A conclusion page must indicate the all over test result clearly. In case the full acceptance test failed a brief explanation must be stated.
- 8) The protocol must be crosschecked and signed by a person, responsible for the product quality of cryostat vacuum vessels.

8. References

- [1] Directive 97/23/EC, European parliament and the council of the European Union, <http://eur-lex.europa.eu>, 1997
- [2] AD 2000-Code; Verband der TÜV e. V.; Beuth Verlag GmbH; Berlin; Germany; 2009.
- [3] AD 2000-Technical Bulletin HP 30, Durchführung von Druckprüfungen; Verband der TÜV e. V.; Beuth Verlag GmbH; Berlin; Germany; 2009
- [4] AD 2000-Technical Bulletin HP 512, Schlußprüfung und Druckprüfung; Verband der TÜV e. V.; Beuth Verlag GmbH; Berlin; Germany; 2009