Contents

1. Scope

1) This document defines requirements and tests to be executed as acceptance test of rigid thermal shields 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 the test of complete cryogenic modules as listed above.
3) This document does NOT represent an inspection process description in terms of the relevant standards for pressure equipment.
4) This document is NOT related to any other purpose as aforementioned.

2. Definitions

1) A *cryostat* in terms of this document is a technical system enclosing another technical system to be operated at temperatures far below room temperature (e.g. 4.5K).
2) A *thermal shield* in terms of this guideline is an actively (by cooling tubes) or passively (by thermalisation straps) cooled construction of sheet metal inside a cryostat shielding a cold technical system from exceeding radiation heat load.

3. Basic Requirements

1) To prevent contamination the thermal shield must be handled with gloves only.

3.1. Surrounding conditions

1) The acceptance test must be performed in a clean, low dust and dry surrounding.
2) The general light conditions at the working place must be adequate for visual inspections.

3.2. Required Documents for testing

1) All documents stated as follows must be available on site at the date of testing.
2) All documents and certificates as defined in [3] must be available.
3) One set of technical drawings of the thermal shield must be available. The set of drawings must provide at least the following information:
   - complete assembly configuration,
   - all main dimensions,
   - all relevant test dimensions,
   - all relevant form and position tolerances,
   - complete welding definition.
4) In case of serial tests of a class of objects identical in construction, a copy of confirmation by the contracting entity for completeness of the following documentation is sufficient:
   - a set of technical drawings with release note of the contracting entity,
   - a set of technical drawings of tooling and equipment for production and testing with release note of the contracting entity,
   - engineering documentation as described within the specification, related to the relevant object.
5) In case of serial tests of a class of objects including pressurised tubing and being identical in construction, a copy of the confirmation by the contracting entity for completeness of the following documentation is sufficient
   - documentation of safety relevant calculations according to [2],
   - documentation of a hazard analysis for the relevant object according to [2],
   - process description of all welding processes applied,
   - operation manual in German and English Language according to [1].
6) Documentation not in common must be available separately for each entity.
7) One set of technical drawings of special tooling and equipment for production and testing must be available.
8) Only original drawings or copies of drawings showing a valid release note by the contracting entity are admitted.

9) All protocols of the dimensional tests performed during production must be available.
10) A testing protocol showing at least the content as defined in 5.1 must be prepared prior to the test procedure being executed.
11) Calibration certificates for the measurement instrumentation in use must be available. None of the calibration certificates must show a date of last calibration older then one year at the date of testing.

3.3. Required Equipment

1) A set of appropriate, cleaned and well calibrated measurement tools for geometrical measurements at the thermal shield must be prepared.
2) Lint-free respectively powder-free clean gloves are required for handling.
3) A suitable digital camera for photographic documentation must be available.
4) An additional high illuminance light source (e.g. gooseneck lamp) must be available.

4. Checks and Tests

1) Within the acceptance test procedure at least all tests and checks as defined in the chapter 4.1 to 4.9 must be executed and documented.
2) After finishing the tests, any volume which was evacuated during testing processes must be vent with dry gaseous nitrogen by applying a slight over pressure (max. 0.3 bar over pressure).

4.1. Document and Certification Check

1) The documents as listed in 3.2 must be checked for completeness.
2) In case of documents missing, the acceptance test must be declared as failed.

4.2. Cursory inspection

1) All entities building the thermal shield must be checked at least for
   - completeness,
   - correct orientation,
   - visible damages,
   - visible deformations

   and any other obvious non-conformities with the correlating drawings and specifications.
2) In case of any non-conformity the test must be declared as failed.

4.3. Welding Inspection of non pressurised components

1) For welding of none pressurised components the tests as described in 4.3.2) to 4.3.4) must be performed.
2) Where ever possible the existence and basic correctness of all welding in terms of [3] respectively [5] must be checked compared to correlating drawings.

3) Where ever possible the welding must be checked for cleanliness. No obvious oxide films are allowed.
4) Accumulations of welding beads must be registered and documented.
5) In case of any non-conformity, oxide films or any contamination the test must be declared as failed.

4.4. Cleanliness Test

1) A cleanliness test as described in [6] must be applied to the outer and inner surface of the thermal shield.
2) In case the cleanliness test was failed, the acceptance test must be declared as failed.

4.5. Dimensional Tests

1) Functional dimensions and positions of the most important interfaces e.g.
   - flanges,
   - support structures,
   - thread holes or through holes acting as interfaces to adjacent assemblies

   must be cross checked according to existing measurement protocols and drawings.
2) In case of non-conformity with the correlating documentation, the test must be declared as failed.

4.6. Pressurised Leak Test

1) In case cryogenic tubing being part of the thermal shield a pressurised leak test must be performed as defined in [7].
2) In case of the pressurised leak test was failed, the acceptance test must be declared as failed.

4.7. Residual Moisture Test

1) In case cryogenic tubing being part of the thermal shield a residual moisture test must be performed as defined in [8].
2) In case of the residual moisture test was failed, the acceptance test must be declared as failed.

4.8. Flow Rate Test

1) In case cryogenic tubing being part of the thermal shield a flow rate test must be performed as defined in [9].
2) In case of the flow test was failed, the acceptance test must be declared as failed.

4.9. He leak Test

1) In case He leak testing is applicable due to the design of any cryogenic tubing being part of the thermal shield, testing must be performed as described in [10].

2) In case the He leak test was failed, the acceptance test must be declared as failed.

5. Documentation

1) Any measured values, detected failures, faulty entities or other non-conformities must be documented in writing and also with a photo whenever possible.
2) All described checks and tests must be documented in a testing form agreed with the contracting entity.
3) The original testing protocol must be handed out to the contracting entity.
4) A digital version must be stored in EDMS following relevant guidelines for EDMS access and usage. The EDMS storage must be agreed with the contracting entity.

5.1. Testing Protocol Requirements

1) The testing protocol must show comprehensible structure and content documenting each single test executed.
2) The following information at least must be 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,
   - used measuring range.
4) All tests, described in the chapter 4 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,
   - photos of non-conformities (if applicable),

- single test ratings,
- full test rating

in clearly separated chapters.

5) The pressurised leak test must be documented as described in [7].
6) The He leak test must be documented as described in [9].
7) All defined tests and procedures must be signed by the executing personnel.
8) A conclusion page must indicate the all over test result clearly. In case the acceptance test failed a brief explanation must be stated.
9) The protocol must be crosschecked and signed by the person, responsible for the product quality of cryostat thermal shields.

5.2. Photographic documentation

1) Wherever the inspection of any entities is showing a non conformity, a photography clearly documenting the situation must be taken.
2) In case of deformations, scratches, visible contaminations etc. an adequate scale must be shown for comparison within the picture.

6. References

[1] Directive 97/23/EC, European parliament and the council of the European Union, http://eur-lex.europa.eu, 1997
[2] AD 2000 Codes; Verband der TÜV e. V.; Beuth Verlag GmbH; Berlin; Germany; 2009
[3] Technical Guideline No. 10.13e: Documentation and Certificates for Cryostat Thermal Shields
[4] Technical Guideline No. 3.1e: Constructive Design of Welding Seams for Vacuum Chambers
[5] Technical Guideline No. 3.17e: Design of thick-walled Vacuum Chambers
[6] Technical Guideline No. 7.18e: Testing Surface Cleanliness of High Vacuum components
[7] Technical Guideline No. 7.24e: Pressurised Leak Testing of Cryogenic Tubing
[8] Technical Guideline No. 7.27e: Residual Moisture Testing of Cryogenic Tubing
[9] Technical Guideline No. 7.26e: Flow Rate Testing of Cryogenic Tubing
[10] Technical Guideline No. 7.23e: He Leak Testing of Cryogenic Tubing