



Technical Guideline

Number

7.18e

B-MT

Testing the Cleanliness of Cryostat Insulation Vacuum Components

Status

2011-05-31

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1. Scope

- 1) This document defines requirements and processes to be executed for the testing of the surface cleanliness of cryostat insulation vacuum components 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 dedicated to
 - any Ultra High Vacuum component,
 - inner, beam vacuum related- and outer surfaces of beam conducting components,
 - inner surfaces of tubing and vessels for transport or storage of cryogenic media,
 - instrumentation and devices for generating, measuring and controlling insulation vacuum (e.g. vacuum pumps, vacuum gauges, valves),
 - multi layer insulation blankets and their components.

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) *High Vacuum* (HV) in terms of this document is a vacuum of the pressure range between 10^{-3} mbar to 10^{-8} mbar.
- 3) *Insulation vacuum* in terms of this document is an HV being generated within a cryostat for the purpose of reducing heat transport by convection.
- 4) An *insulation vacuum component* in terms of this document is a technical system, being part of a cryostat and showing at least one surface which faces the insulation vacuum space, but not being an ultra high vacuum component.

3. Basic Requirements

3.1. Surrounding conditions

- 1) The testing shall be performed in a clean, low dust and dry surrounding.
- 2) Any contamination of tested components due to the surrounding conditions must be avoided.
- 3) For testing, sufficient lighting conditions are required, to be able to detect even minor contaminations.

3.2. Required documentation

- 1) A protocol form, complying with the requirements as defined in 7.1, must be prepared for test documentation purposes.
- 2) The quality documentation of any cleaning process applied to the component must be available on site at the date of testing.

3.3. Required equipment and media

- 1) The following equipment and media is required for the test processes
 - Lint- and dust free gloves (e.g. NBR gloves)
 - Oil-, grease and dust free clothing
 - Compressed air gun providing oil free compressed air
 - min. 6 bar
 - Class 1.3.1 (as defined by [1])
 - Lint free and abrasion resistant clean wiping cloths
 - Isopropanol
 - Light source, luminous flux ≥ 500 lm, colour temperature ≈ 6000 K ("white" light)
 - Loupe (magnification ≥ 3 x)
 - Suitable mirror devices to view hidden surfaces



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- Suitable wiping tools to reach hidden surfaces
- Cleaned closures for all openings of the component being tested
- Clean packaging for the component being tested

4. Test preparation

- 1) The object being tested must be placed stable on a clean, low dust and dry base.
- 2) The testing personnel must wear clean clothing and gloves as defined by 3.3.
- 3) In case of vacuum vessels
 - the vessel must be tested without any interior,
 - all flanges must be opened.
- 4) All tooling for use during testing must be cleaned from oil, grease and dust or other contaminations.
- 5) Inner vacuum related surface of components to be tested must be illuminated.
- 6) For certain tests, solvent wetted (Isopropanol) cloths must be available.

5. Test procedures

- 1) For cleanliness testing the procedures as described by 5.1 to 5.6 shall be performed following the listed sequence.
- 2) In case any process can not be applied due to non existing entities, e.g. gaps and holes, or only vacuum related surfaces exists, it shall be skipped.

5.1. Testing for oxide films

- 1) All vacuum related metallic surfaces must be looked over for any obvious oxidation film or visible annealing colours. Areas, not being accessible directly shall be viewed by the use of adequate mirror devices.
- 2) In case oxide films or areas showing annealing colours are registered, those surfaces must be cleaned anew by applying an adequate cleaning method. The test must be repeated.

5.2. Testing gaps and holes in vacuum related surfaces

- 1) All vacuum related gaps and holes must be blown out by compressed air (oil free air only) while covering it with a solvent (Isopropanol) wetted cloth to catch any blown out contamination.
- 2) After the blow out process the cloth must be dried from solvent by ventilating and checked for visible contamination with grease, oil, dust, or other solid or liquid substances. This check must be performed by the use of a loupe and under a bright lighting.
- 3) In case the dried wiping cloth shows a smell of grease, oil or other chemicals the tested gap or hole must be declared as contaminated.

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- 4) In case of contaminations, the affected gap or hole must be cleaned anew by applying an adequate cleaning method. The test must be repeated.

5.3. Testing vacuum related surfaces

- 1) All vacuum related surfaces must be looked over for any obvious contamination with dust, grease, oil or other solid or liquid substances. Areas, not being accessible directly shall be viewed by the use of adequate mirror devices.
- 2) A more detailed check must be performed by applying a wiping test using a clean wiping cloth. For this purpose all vacuum related surfaces must be carefully wiped with a clean wiping cloth. Surface areas not being accessible directly shall be wiped by the use of adequate tooling.

- 3) Approximately

- once per wiped $\frac{1}{4}$ square meter of extensive areas,
- once times per $\frac{1}{2}$ meter of tubing,
- four times (on distributed positions) per component if smaller than 1 square meter of surface,

the wiping cloth must be checked for gathered contaminations. This check must be performed by the use of a loupe and under bright lighting.

- 4) In case the wiping cloth shows visible contaminations with dust, grease, oil or other solid or liquid substances, the surface must be declared as contaminated.
- 5) In case the wiping cloth shows a smell of grease, oil or other chemicals the surface must be declared as contaminated.
- 6) In case of contaminations, the surface must be cleaned anew by applying an adequate cleaning method. The test must be repeated.

5.4. Testing vacuum Flanges

- 1) All flanges, being related to HV must be looked over for any obvious contamination with dust, grease, oil or other solid or liquid substances.
- 2) A more detailed check must be performed by applying a wiping test using a clean wiping cloth. For this purpose the sealing surfaces and vacuum related flange surfaces must be carefully wiped with a clean wiping cloth.
- 3) Once per flange, the cloth must be checked for gathered contaminations after wiping. This check must be performed by the use of a loupe and under a bright lighting. In case the wiping cloth shows contaminations with dust, grease oil or other solid or liquid substances, the flange must be declared as contaminated.
- 4) In case the wiping cloth shows a smell of grease, oil or other chemicals the flange must be declared as contaminated.
- 5) In case of contaminations the affected flange must be cleaned anew by applying an adequate cleaning method. The test must be repeated.



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5.5. Testing gaps and holes in non vacuum related surfaces

- 1) All gaps and holes must be blown out by compressed air (oil free air only) while covering it with a cloth to catch any blown out contamination.
- 2) After the blow out process the cloth must be checked for visible (with the eyes only) contamination with grease, oil dust, or other solid substances.
- 3) In case the dried wiping cloth shows a smell of grease, oil or other chemicals the gap or hole must be declared as contaminated.
- 4) In case of contaminations, the affected gap or hole must be cleaned anew by applying an adequate cleaning method. The test must be repeated.

5.6. Testing non vacuum related surfaces

- 1) All outer surfaces, not being related to HV must be looked over for any obvious contamination with dust, grease, oil or other solid or liquid substances.
- 2) A more detailed check must be performed by applying a wiping test using a clean wiping cloth. For this purpose the complete outer surfaces must be roughly wiped with a clean wiping cloth.
- 3) Approximately
 - once per wiped square meter of extensive area,
 - once per meter of tubing
 the wiping cloth must be checked for gathered contaminations. In case the wiping cloth shows visible (with the eyes only) contaminations with dust, grease, oil or other solid or liquid substances, the surface must be declared as contaminated.
- 4) In case the wiping cloth shows a smell of grease, oil or other chemicals the surface must be declared as contaminated.
- 5) In case of contaminations the outer surface must be cleaned anew by applying an adequate cleaning method. The test must be repeated.

6. Component Protection

- 1) After the testing being completed, all openings of the tested object must be carefully closed with adequate and clean closures.
- 2) HV components for installation in HV surrounding, must be protected from being contaminated by packing in adequate and clean packaging.

7. Documentation

- 1) Any test procedure shall be documented within a protocol as defined as follows.
- 2) All described checks and tests shall be documented in a testing form, agreed by the contracting entity.

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7.1. Testing protocol requirements

- 1) The testing protocol shall show comprehensible structure and content documenting each single test executed.
- 2) The following information shall 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).



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- 3) All performed tests, as described in the chapter 5, shall be documented at least with
- brief description of testing process,
 - registered non-conformities,
 - test results,
 - photos of non-conformities (if applicable),
 - single ratings,
 - full test rating
- in clearly separated chapters.
- 4) All defined tests and procedures shall be signed by the executing personnel.
- 5) A conclusion page shall indicate the all over test result clearly.
- 6) The protocol shall be crosschecked and signed by a person, responsible for the product quality of cryostat vacuum vessels.
- 7) The original testing protocol shall be handed out to GSI.
- 8) A digital version shall be stored in EDMS following the relevant guidelines for EDMS access and usage. The EDMS storage shall be agreed with the contracting entity.

8. References

- [1] ISO 8573-1: Compressed air - Part 1; Contaminants and purity classes; International Organization for Standardization, Beuth Verlag GmbH, Berlin, Germany, 2010