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1. Scope

- 1) This document defines materials to be used as wrought material for production of flanges joined to insulation vacuum vessels and rigid tube-like insulation vacuum shells 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 wrought materials for production of beam pipe flanges and flanges at cryogenic temperature.
- 3) This document is NOT related to any other purpose as aforementioned.

2. Definitions

- 1) In terms of this document
- 2) a *cryostat flange* in terms of this document is any flange, permanently joined to a cryostat insulation vacuum shell.
- 3) a *main flange* in terms of this document is any flange; joined to a cryostat vacuum shell; which is providing an opening to fulfil the functionality the cryostat is mainly dedicated to.
- 4) an *auxiliary flange* in terms of this document is any cryostat flange directly facing the insulation vacuum and not being a main flange.

3. Codes and Standards

- 1) The choice of materials shall fulfil all criteria defined in the AD2000 Codes [1] especially [2].
- 2) Material and testing certificates as defined in [1] shall be prepared as defined in DIN EN 10204 [3].
- 3) Charpy Impact Tests shall be performed as defined in [4] and documented as defined in [3].

4. Operation Conditions and Special Properties

- 1) Due to failure mode operation a sudden rise of the cryostats inner pressure in parallel with sudden local cooling of the cryostat shell down to 220 K may occur.
- 2) The minimum energy absorption of 21 J/cm² and the average energy absorption of 28 J/cm² over 3 samples during a Charpy impact test at -50°C sample temperature must be demonstrated for each material lot used for production.
- 3) The material must demonstrate the properties of notch impact strength in the base material as well as in heat affected zones and welds.

5. Qualified Materials for Main- and Auxiliary Flanges

- 1) Only stainless steel materials are approved for the production of cryostat flanges.

5.1. Materials for Metal Sealed Flanges

- 1) Qualified materials for main- and auxiliary flanges sealed by metal based gaskets (e.g. CF, COF, Helicoflex[®]) are stainless steel forged blanks from named materials following [5] and [6]:
 - 1.4404
 - 1.4429
 - 1.4435
 as defined by [7].
- 2) Detailed specifications for forged blanks of the material numbers 1.4429 and 1.4435 are defined by [8] and [9].

5.2. Materials for Elastomer Sealed Flanges

- 1) Qualified materials for main- and auxiliary flanges sealed by elastomer gaskets are forged blanks from stainless steel materials as defined by [10].

6. Certificates and Documentation

- 1) Adequate certificates as defined by [3]
 - stating all material properties as defined by [1], especially [2]
 - stating the properties defined in chapter 4
 - dated and accredited
 shall be delivered with each lot of material in use for production.

7. References

- [1] AD 2000 Codes, Verband der TÜV e. V., Beuth Verlag GmbH, Berlin, Germany, 2009
- [2] AD 2000 Codes Technical Bulletin W10: Materials for low temperatures - Ferrous materials, Verband der TÜV e. V., Beuth Verlag GmbH, Berlin, Germany, 2009
- [3] DIN EN 10204, Metallic products - Types of inspection documents; Deutsches Institut für Normung e.V., Beuth Verlag GmbH, Berlin, Germany, 2004
- [4] DIN EN 10045-1, Charpy impact test on metallic materials; part 1: test method; Deutsches Institut für Normung e.V., Beuth Verlag GmbH, 1991
- [5] DIN EN 10088-1, Stainless steels – Part 1: List of stainless steels; Deutsches Institut für Normung e.V., Beuth Verlag GmbH, Berlin, Germany, 2005
- [6] DIN EN 10088-3, Stainless steels – Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes; Deutsches Institut für Normung e.V., Beuth Verlag GmbH, Berlin, Germany, 2005
- [7] DIN EN 10027-2, Designation systems for steel; numerical system; Deutsches Institut für Normung e.V., Beuth Verlag GmbH, Berlin, Germany, 1992
- [8] FAIR Technical Guideline Number TR2.25e: Forged blanks for Vacuum Applications Material 1.4429/ESU; GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany, 2010
- [9] FAIR Technical Guideline Number TR2.26e: Forged blanks for Vacuum Applications Material 1.4435/ESU; GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany, 2010
- [10] FAIR Technical Guideline Number TR2.32e: Cryostat Vacuum Shell Materials; GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany, 2010