Contribution ID: **191** Type: **Poster Presentation (120m)**

Cryogenic helium valves deflection and relaxation in ESS linac cryogenic distribution system

Thursday 25 July 2024 10:15 (15 minutes)

Large scientific facilities make extensive use of cold helium in different thermodynamic states for cryostating of superconducting cavities or magnets. The helium is supplied to cryomodules by cryogenic distribution system which may contain tens of valve boxes and hundreds of cryogenic valves. Cryogenic control valves are considered as a critical part of every cryogenic distribution system not only due to their importance for realization of different operation modes of the system, but also due to low mechanical stability of the valves resulting from their specific design. As the valves actuators and positioners are located in room temperature, the valves create thermal bridges between room and low temperature elements. To protect these components from freezing and reduce undesirable but unavoidable heat inputs into the cryogenic temperature environment, the heat conduction through the body and stem of the valves need to be strongly reduced. It can be achieved by using low thermal conductivity materials as stainless steel or G-10 (epoxy resin-glass fibers composite), reducing the cross sectional area of the conduction path and increasing its length. These requirements are contradictory from mechanical point of view as imply a thin and elongated, thus, susceptible to lateral deformations valve stems and bodies construction. The valve deformations may result from stresses produced during their manufacturing, improper transport, welding of the valve with valve box vessel and process pipes or cyclic thermal and pressure loads during the cool-down and warm up of cryogenic system. The commissioning of European Spallation Source linear accelerator cryogenic distribution system revealed valve deflections, partly combined with lack of the valve tightness. An optical method of noninvasive measurement of long-stem cryogenic valve straightness has been elaborated and compared with direct deflection measurements. The allowable value of the valve deflection has been estimated on the basis of mechanical analysis and the procedure of the deformed valve relaxation has been proposed and successfully implemented. The deflected valve correction does not require a full cut of the valve box and is limited to a minimal intervention at the upper part of the valve. The paper presents the method, its validation by the opening of one of the valve boxes and provides the limits of the method applicability.

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Session Classification: Thu-Or13

Track Classification: Tracks ICEC 29 Geneva 2024: ICEC 03: Expanders, pumps, compressors, regenerators and other components