

DESIGN, MANUFACTURING AND IN-SODIUM TESTING OF AM350-WELDED DISC BELLOWS FOR FBTR CONTROL ROD DRIVE MECHANISM

Friday 22 April 2022 13:54 (12 minutes)

Control Rod Drive Mechanisms (CRDM) along with their control rods are used for control and safe shut down of Fast Breeder Test Reactor (FBTR). Lower part of CRDMs which is partially immersed in sodium and nested ripple type welded disc bellows are used to prevent entry of sodium to the annular spaces between the concentric tubes in the lower part. Translation bellows are used to prevent the entry of sodium between translation tube and tube sheath. Welded disc bellows are selected for this application because of requirements of large stroke to length ratio and low stiffness. During SCRAM, the bellows are compressed from their free length at a peak speed of 2.4 m/s. Design and manufacturing of the welded disc bellows is not addressed in standard design codes for bellows such as standards of Expansion Joint Manufacturers Association (EJMA). Design of the bellows was carried out by detailed inelastic analysis. The material data required for design and analysis of the bellows was generated in house. Detailed study for selection of the materials for bellows was carried out and AM350 (precipitation hardened stainless steel) was selected as one of the material of construction of the bellows. Manufacturing of the large stroke welded disc bellows in AM350 which can withstand the loads experienced during SCRAM is first of its kind in India. During this work, various challenges in design, analysis, manufacturing and quality assurance of the bellows were addressed. Procedure and special tooling required for heat treatment of the bellows assembly was established. Indigenously developed translation bellows were subjected to extensive testing including 500 cycles of fast drop testing (Simulating the movements during SCRAM) in air at room temperature and 170 cycles in sodium at 530°C. Subsequently, ten numbers of translation bellows were manufactured for service in the reactor.

Country/Int. organization

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Session Classification: 5.3 Experimental Programs II

Track Classification: Track 5. Test Facilities and Experiments