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TESTING AND QUALIFICATION OF BOOSTER FLEX SEALS FOR S200 SOLID ROCKET BOOSTER

Abstract

S200 Solid booster developed for LVM3 launch vehicle employs flex nozzle capable of vectoring to 7.8deg.Flex seal located in the submerged region of the nozzle enables vectoring of the nozzle under the influence of actuation load applied on the nozzle divergent. During the motor operation, S200 Flex seal is subjected to an ejection load of 7360kN due to the net nozzle wall pressure corresponding to the motor MEOP of 5.88MPa. Vectoring of the nozzle is necessitated during motor operation at varying chamber pressure up to MEOP based on the control demand. Hence the flex seal had to be qualified by suitably simulating the expected flight loads with margin. Though ISRO has enough experience in the development of flex nozzle systems for smaller solid rocket motors viz, ϕ1m & ϕ2m, considering the quantum jump in the size and resulting high flex seal spring stiffness and total flex nozzle torque, series of systematic testing scheme to be conceived and realized to characterize the flex seal. Spring stiffness of the flex seal with and without thermal boot at ambient pressure was evaluated to confirm the adequacy of actuation system load capability for the development activities. Test facilities catering to the ambient vectoring tests and vectoring under pressure were conceived with a provision to simulate the pressure/ejection loads and orientation of the actuators along with kinematic linkages.Flex seal level development and qualification tests were carried out using the facilities developed and all parameters including the flex seal axial and vectoring stiffness, hysteresis at different pressure and stroke linearity evaluated using the dedicated battleship version actuation system. Prior to use in static firing of the motor, flex seal system along with flight version actuation system was tested in integrated level simulating the MI of the movable nozzle to demonstrate the combined performance of flex nozzle and actuation system. Sensitivity of MI on the control system performance demonstrated. Ageing characterization revealed maximum of 8% increase in stiffness for 5 year old flex seals against 32% increase expected based on specimen test results.

Beyond 5 years stiffness remained unaltered. Normal performance of the flex seal system was witnessed in three static tests. Static tested flex seals were refurbished and subjected to regular acceptance level loads successfully demonstrating the reuse capability. Flight qualification of the flex seal system was proven in successful maiden LVM3-X flight, in which performance of the flex nozzle system was satisfactory.