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DESIGN, DEVELOPMENT & QUALIFICATION OF HUMAN RATED SOLID ROCKET BOOSTER FOR GAGANYAAN MISSION

Abstract

As part of ISRO's prestigious GAGANYAAN programme, existing S200 strap-on solid boosters of GSLV MkIII launch vehicle is human rated and designated as HS200 Motor. Earlier, S200 motor was developed as the strap on motor for GSLV MkIII launch vehicle towards achieving the payload capability to launch 4t class satellite in the geosynchronous orbit. The same launch vehicle is identified for the prestigious GAGANYAAN mission. The robustness of the existing S200 motor design had been demonstrated successfully through three static tests and seven flights. Human rated designs are adopted for S200 motor subsystems by following two basic principles, Improved factor of safety (FoS) in design of hardware and thermal protection system Redundant O-rings for segment joints. Motor interfaces have been reinforced by adding additional defenses to improve reliability. Improvements with respect to raw material screening and processing are also implemented as part of HS200 Motor development. Design guidelines for HS200 have been generated based on ISRO's vast experience in development of solid rocket motors. HS200 solid rocket motor is having three segments, 3.2m diameter loaded with 204 tons of HTPB based propellant with submerged nozzle of AR 11.8. Flex nozzle is similar to S200 configuration expect for the introduction of dual ply bias wrapped throat insert, increased liner thickness at divergent exit to achieve higher margins, Ply orientation change in NEL NIL, throat diameter of 897mm. FNC with newly introduced electromechanical actuation system (EMA) are integrated 90 apart for thrust control vectoring. HS200 Motor is provided with the existing S200 pyrogen igniter having 24 lobed star grain with improvements

such as integral head end, twin seal TBI. Existing philosophy of sym-sorting of propellant raw materials will be followed for HS200 flight motors. To improve the O-ring compression and fill ratio as per ISO 3601-2 standard, CSD of O-rings, groove dimensions are modified in Motor/Igniter/Nozzle hardware interfaces. With the above design improvements and to establish the human rated margins for the subsystems, HS200 ST motor static test was successfully conducted in May 2022. Exhaustive instrumentation was implemented for the monitoring of chamber pressure, strain gauge, deflection/displacement, temperature, vibration, acoustics, shock, heat flux, etc. The observed motor performance was normal and the design changes incorporated towards human rating requirements were successfully demonstrated. This paper provides details on the development and human rating aspects incorporated in the solid rocket booster and its validation through hot test.