



Presented at NDE2002, to predict. assure. improve. www.nde2002.org
National Seminar of ISNT, the Indian Society for Non Destructive Testing
Hotel Taj Connemara and Raja Muthiah Hall, Chennai, 05. – 07. 12. 2002

Leak Detection and Vacuum Engineering Practices for Commissioning and Condition Monitoring of Cryogenic Equipment at Launch Complex – Sriharikota

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Abstract

The Geo-stationary Satellite Launch Vehicle (GSLV) of Indian Space Research Organisation (ISRO) is intended to place INSAT/GSAT class communication satellites in Geo-transfer orbit and employs a Cryogenic stage. The engine that powers this Cryostage uses Liquid Hydrogen (LH₂) as fuel and Liquid Oxygen (LOX) as oxidiser. In order to fill the propellants as part of ground operations at Launch Complex - Sriharikota, various constituent facilities of the 'Launch Complex Cryogenic Facilities' have been set up which comprises of Liquid Hydrogen, Liquid Oxygen and Liquid Nitrogen storage/ transfer circuits and high pressure Compressed gases facilities. A typical facility includes Cryogenic Storage Vessel, process equipments like pumps, heat exchangers, vaporisers, accumulators/drain tanks, Super-Insulated Piping and cryogenic flow components.

The erection, testing, commissioning and qualification of these equipments, transfer piping and facilities demands the application of various Non-Destructive Engineering practices like DP tests, X-ray methods, Leak detection and Vacuum engineering techniques. Apart from the above, the same practices can be effectively utilised for the condition monitoring purposes also as part of maintenance requirement. The Cryogenic process fluids like Hydrogen, Oxygen and Nitrogen are handled at temperatures 20.4 K (-253 C), 90.4 K (-183 C) and 77.4 K (-196 C) respectively. Due to the thermo-physical properties of these cryogenic fluids, the leak tightness demand of Cryogenic equipment and Super Insulated piping is critically of the order of 1×10^{-8} - 1×10^{-7} mbar-l/sec. Hence, thousands of weld joints have to be 100% qualified through the above specification range. Similarly, the overall hermitivity/ in-leakage is to be maintained at controlled levels inline with the above specification.

This paper summarises the various Leak detection methods adopted and the non-destructive Vacuum practices followed and maintained at Launch Complex Cryogenic Facilities – Sriharikota. The above methods and practices are validated through the Liquid Cryogenic propellant trails as well as during the course of actual propellant filling operations of GSLV Launch during the chronological preparations of Launch.