ABSTRACT:

Propulsion systems meant for Remote Sensing and Communication applications in satellites have built in them propulsion feed systems for reaction control, attitude control, orbit raising and station keeping purposes. These propulsion systems have propellant feed lines carrying propellants from tankages to thrusters. OTIG (Orbital Tungsten Inert Gas) welding is widely employed for the welding of the feed lines made up of 6mm and 10mm diameter stainless steel tubes of 0.7mm thickness. These weld joints need to be leak proof and strong and any defect in them will lead to propellant leakage resulting in the failure of the whole mission which means wastage of lot of efforts and millions of dollars. Such failures seriously offset the programmatic goals and the national need. To ensure perfect weld joints, systematic process optimization and rigorous testing and qualification are essential. This research work is focused on improvement of the OTIG welding process.

Questions of interest are, the need for development of propulsion system with zero defect using well defined welding process, appropriate testing methods for weld joints and analyzing test results for finding best methods for implementation. Detailed literature survey has been carried out on the OTIG welding process to study similar techniques which are adapted to suit satellite feed line welding purpose. The objective of the thesis is studying the current OTIG welding process, data collection and analysis of the defects observed and to suggest and validate methodologies to improve the present status. Data collection based on 18 satellites feed line welding defects and failure analysis were carried out using FMECA, RCA, FTA, Pareto charts etc. The results have brought out important process parameters such as Current, RPM, Gap between electrode and tube affecting the weld joints. The effect of the process parameters such as Current, RPM, Gap between electrode and tube and their interaction effect are quantitatively obtained by performing design of experiments (DOE) and analysis of variance (ANOVA). The optimized values achieved by the study are current 18.35 Amps, electrode rotation 10 rpm and gap between electrode and job 0.8 mm. The weld specimen quality was verified in accordance with the quality specifications for space applications and found satisfactory. The experimental findings are thus validated.

Further stress-strength interference (SSI) technique is applied to compute the weld joint reliability considering the strength and porosity of the weld joints. Improvement of reliability of the weld joints due to the suggested process parameter settings is also computed to validate the findings.

The investigations carried out yielded fruitful results which are not only useful for development of reliable satellite propulsion feed system but also can be applied for many similar applications.

Key words: Propulsion, Optimization, OTIG, FMECA, RCA, FTA, DOE, SSI, feed line or plumb line welding.