THERMAL MODELING OF UMBILICAL TOWER DURING THE LIFT-OFF OF A LAUNCH VEHICLE

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Abstract

Umbilical Tower (UT) forms a critical structure along with mobile service tower, launch pedestal and jet deflectors of a rocket launch pad. UT will be exposed to severe thermal environments during lift off of the launch vehicle owing to its close proximity. UT experiences thermal loads until the launch vehicle lifts off and clears it. Hence thermal environments need to be quantified to assess the survivability of UT for subsequent missions. This paper brings out the methodology developed for estimating different thermal environments experienced by UT structure during a typical rocket launch. The engineering method result in a quick estimate of flow properties of the plume from the rocket exhaust compared to CFD, which will be computationally intensive and time consuming to arrive a converged accurate solution for heat flux estimation. ISRO's launch vehicles have first stage with Solid Rocket Motor (SRM) as core and solid motors/liquid engines as multiple strap-ons. Thermal loads to launch pad structures include radiative and convective heating from exhaust plumes. The aluminum particle laden exhaust plumes of solid rockets are dominating radiative heat source. Convective heating occurs from hot jets and direct plume impingement. The relative movement of launch vehicle with respect to UT structure is an important parameter affecting thermal environments. It varies for each launch depending on the vehicle variant and its lift-off trajectory. This calls for a detailed assessment of thermal loads for thermal adequacy studies. A finite element based thermal model for umbilical tower is also generated for thermal response studies and Thermal Protection System (TPS) design. The computed temperature levels at various location of UT structure are compared with measured values during typical lift-off. Results indicate that temperature levels of UT structure are within allowable limits and the adopted methodology can predict temperature within a maximum difference of □5%.