An accurate determination of a spacecraft’s radio frequency electromagnetic field environment during launch and flight is critical for mission success. Typical fairing structures consist of a parabolic nose and a cylindrical core with diameters of 1 to 5 meters resulting in electrically large dimensions for typical operational sources at S, C and X band where the free space wavelength varies from 0.15 m to 0.03 m. These electrically large size and complex structures at present have internal fairing electromagnetic field evaluation that is limited to general approximation methods and some test data. Though many of today's computational electromagnetic tools can model increasingly complex and large structures, they still have many limitations when used for field determination in electrically large cavities.

In this dissertation, a series of test anchored, full wave computational electromagnetic models along with a novel application of the equivalent material property technique are presented to address the electrical, geometrical, and boundary constraints for electromagnetic field determination in composite fairing cavity structures and fairings with acoustic blanketing layers. Both external and internal excitations for these fairing configurations are examined for continuous wave and transient sources. A novel modification of the Nicholson Ross Weir technique is successfully applied to both blanketed aluminum and composite fairing structures and a significant improvement in computational efficiency over the multilayered model approach is obtained. The advantages and disadvantages of using commercially available tools by incorporating Multilevel Fast Multipole Method (MLFMM) and higher order method of moments (HO MoM) to extend their application of MoM to electrically large objects is examined for each continuous wave transmission case. The results obtained with these models are compared with those obtained using approximation techniques based on the Q factor, commonly utilized in the industry, and a significant improvement is seen in a prediction of the fields in these large cavity structures. A statistical distribution of data points within the fairing cavity is examined to study the nature of the fairing cavity field distribution and the effect of the presence of a spacecraft load on these fields is also discussed. In addition, a model with external application of Green's function is examined to address the shielding effectiveness of honeycomb panels in a fairing cavity. Accurate data for lightning induced effects within a fairing structure is not available and hence in this dissertation, a transmission line matrix method model is used to examine induced lightning effects inside a graphite composite fairing structure. The simulated results are compared with test data and show good agreement.

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The public is welcome to attend.