Characterization and Accurate Modeling of Rocket Engine Nozzle Side Loads

Objective

The proposed research is to develop a methodology to accurately predict the character and magnitude of the fluid loading and to quantify the structural response due to this loading at any location in the engine system. This methodology will build upon the techniques used in the FASTRAC side load determination and will update the other analytical and empirical tools developed previously. By increasing the accuracy and confidence of the side load predictions, a more realistic and less over-conservative value can be used in engine system design, which is critical for low cost and light weight. In addition, a set of guidelines, or "rules of thumb", will be generated that can be used by engine designers to aid in the selection of a basic nozzle shape that will minimize the effect of the side load. The refined analytical methodology and guidelines will be generated by an extensive series of analytical modeling of both the fluid flow and the structure, testing of full-scale and sub-scale rocket nozzles, and statistical evaluation of the data and rational transitioning of this data into the analytical models. These detailed analytical techniques and guidelines should help to contribute to a new generation of low-cost, reliable rocket engines for space transportation.

Why Needed

The effort will result in: 1) documented literature and industrial survey and handbook of historical databases and appropriate testing methods for determining side loads on rocket engines; 2) well described, test-verified methodology to accurately predict the character and magnitude of nozzle side loads resulting from separation, and to quantify the structural response due to this loading at any location in an engine system; and 3) a set of rough guidelines, or "rules of thumb," that can be used by engine designers to select a basic nozzle shape that will minimize the effect of the side load. The accurate determination of the side load on rocket nozzles and the calculation of the structural response throughout the rest of the engine is critical for the design of lightweight, reliable rocket engines. This technology development is therefore critical to MSFC's mission as the NASA Center of Excellence in Propulsion.

Point of Contact

Andy Brown / ED21
Phone: 256-544-1584
Email: andrew.m.brown@msfc.nasa.gov

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