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NASA TECH BRIEF

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Elimination of Rocket Engine Asymmetric Loads During Tests at Sea Level

The problem:

The J-2 rocket engine experiences severe asymmetric nozzle loads during the period of transition from ignition to mainstage operation when tested at sea level. The 27.5:1 area ratio nozzle is designed to operate in an environment of 2.5 psi to vacuum and suffers from gaseous separation problems in the 14.7 psi test environment.

The solution:

A secondary injection concept may be employed by either of two methods. First, a 360° tubular manifold with injection ports uniformly spaced about its periphery; second, a secondary injection fluid such as gaseous nitrogen introduced at the turbine exhaust inlet to the thrust chamber. The manifold would replace the present diffuser in such a way that the engine could be gimballed with the manifold in place. An alternate method would use two 180° sections in a ground support installation arranged in a manner that would permit their retraction from the nozzle to allow gimballing.

The secondary injection fluid could be either gaseous (GN_2, GH_2, air, etc.) or liquid (H_2O, LH_2, etc.) depending on availability. Gaseous injections would provide high performance, but, since only ground testing is involved, water should suffice. The injected water, converted to steam, creates an opposition to the primary nozzle flow. This should cause a controlled symmetrical flow separation in the nozzle and thus eliminate the spasmodic separation (side loading) that would otherwise occur. When mainstage operation is reached, secondary injection is terminated in order to derive valid thrust data.

Notes:

1. In addition to eliminating side loading, these concepts should result in increased thrust and could be incorporated in flight hardware for launch and low altitude (booster) application.
2. This development is in conceptual stage only, and as of date of publication of this Tech Brief, neither a model nor prototype has been constructed.

Patent status:

No patent action is contemplated by NASA.

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Category 05

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