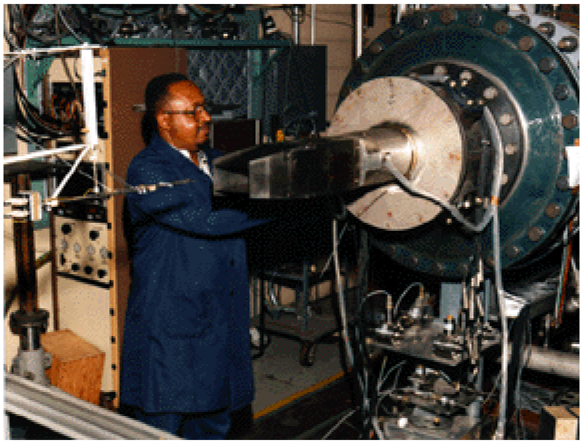
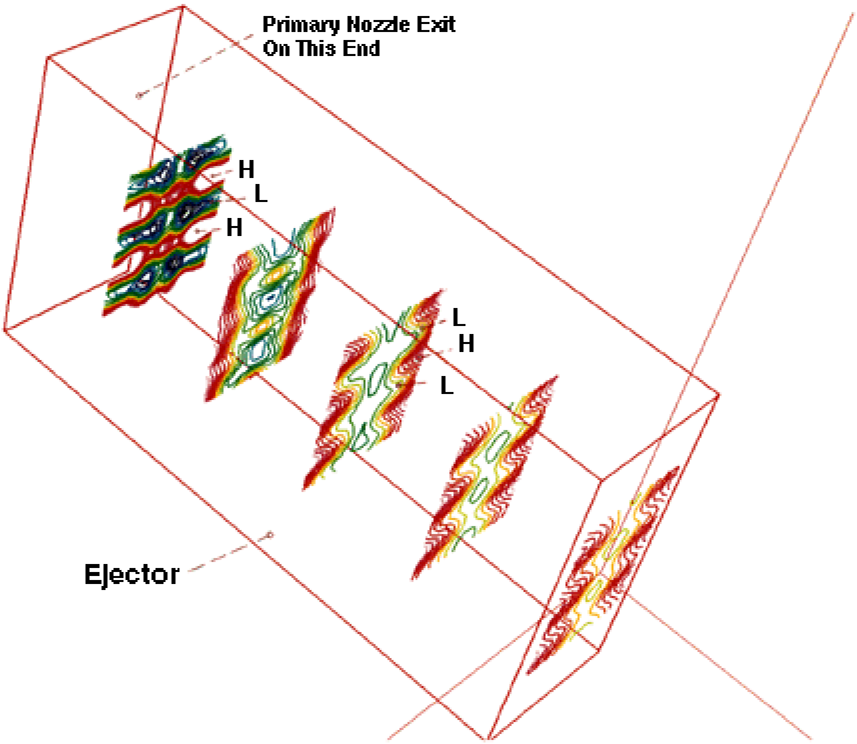
Internal Mixing Studied for GE/ARL Ejector Nozzle



Mixer-ejector nozzle mounted on the jet facility.

To achieve jet noise reduction goals for the High Speed Civil Transport aircraft, researchers have been investigating the mixer-ejector nozzle concept. For this concept, a primary nozzle with multiple chutes is surrounded by an ejector. The ejector mixes low-momentum ambient air with the hot engine exhaust to reduce the jet velocity and, hence, the jet noise. It is desirable to mix the two streams as fast as possible in order to minimize the length and weight of the ejector.

An earlier model of the mixer-ejector nozzle was tested extensively in the Aerodynamic Research Laboratory (ARL) of GE Aircraft Engines at Cincinnati, Ohio. While testing was continuing with later generations of the nozzle, the earlier model was brought to the NASA Lewis Research Center for relatively fundamental measurements. Goals of the Lewis study were to obtain details of the flow field to aid computational fluid dynamics (CFD) efforts and obtain a better understanding of the flow mechanisms, as well as to experiment with mixing enhancement devices, such as tabs. The measurements were made in an open jet facility for cold (unheated) flow without a surrounding coflowing stream. The photo shows the experimental setup. Distributions of streamwise vorticity as well as turbulent stresses were obtained using hot-wire anemometry for a low nozzle pressure ratio. Pitot probe surveys were conducted for higher nozzle pressure ratios.



Mean velocity distribution within the ejector.

The figure shows the mean velocity distribution inside the ejector. The outline of the interior of the ejector is shown for reference. The distribution exhibits a cellular pattern because of varying velocities through the primary and secondary chutes. Corresponding streamwise vorticity data show that pairs of counter-rotating vortices originate from the chutes and persist over the entire length of the ejector. The velocity distributions also reveal, with increasing downstream distance, an interchanging of low-velocity regions (marked with an *L*) with adjacent high-velocity regions (marked with an *H*). This occurs because of the action of the streamwise vortices as fluid is continually transported laterally by the vortex pairs. Although the data shown are for a low-pressure ratio, corresponding distributions at higher pressure ratios exhibit a similar behavior, in some cases, with the interchanging occurring more than once within the ejector.

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