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# NASA TECH BRIEF

*Marshall Space Flight Center*



## Study Aids Accuracy of Turbopump Axial Thrust Analysis

A turbopump test program was conducted to verify the theory used in calculating axial thrust. Previously, large discrepancies had been noted between actual and calculated thrust at certain operating conditions. These discrepancies were attributed to large pressure forces over each component and to the accuracy with which these pressures and pressure gradients could be calculated. Full-size turbine pressure data were virtually nonexistent, and previous turbine axial thrust values were calculated from model coldflow data. The coldflow approach was inadequate because of the variations between hot fire and coldflow conditions; consequently, turbopump axial thrust redline pressures could not be accurately determined.

The turbopump used in the test program was instrumented with (a) proximity transducers for measuring shaft position, (b) a strain gage thrust bearing carrier to measure axial thrust, and (c) internal pressure taps to define component pressure gradients used in thrust calculations. Variations in pump component axial thrust and pressure gradients were correlated to varying turbopump operating speeds, different liquid oxygen and fuel pump inlet pressures at constant Q/N (where Q = capacity, and N = rotation speed), changes in liquid oxygen and fuel pump flowrates at constant speed, the use of liquid nitrogen instead of liquid oxygen in the LOX pump, balance cavity pressure oscillations, turbine pressure ratio changes, and changes in axial shaft position.

Analytical procedures previously used to calculate pump axial thrust values at defined operating conditions were improved. Important relationships regarding axial thrust behavior were verified or established, and turbine pressure gradient data under hot fire conditions were obtained.

### Note:

Requests for further information may be directed to:

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### Patent status:

No patent action is contemplated by NASA.

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