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STATUS OF AN INLET CONFIGURATION TRADE STUDY FOR THE DOUGLAS HSCT

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PROPULSION/AIRFRAME INTEGRATION TECHNOLOGY
Task Order No.2

An inlet concept integration trade study for an HSCT is being conducted under contract to NASA LeRC. The HSCT mission has a supersonic cruise Mach number of 2.4, and a subsonic cruise Mach number of 0.95. The engine selected for this study is the GE VCE (variable cycle engine) with FLADE (fan on blade).

Six inlet configurations will be defined. Inlet configurations will be axisymmetric and rectangular mixed-compression inlets in single-engine nacelles. Airplane performance for each inlet configuration will be estimated and then compared. The most appropriate inlet configuration for this airplane/engine combination will be determined by September 1991, as shown in table 1.

Tasks	1991											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1.0 Preprare Detailed Plan												
2.0 Define Reference Vehicle and Mission												
3.0 Obtain GE FLADE VCE Engine Air Flow												
4.0 Inlet Conceptual Designs												
5.0 Nacelle/Airframe Integration												
6.0 Airframe/Nacelle CASES Mission Performance												
7.0 Program Management					m		m		m		f	
m - meeting f - finish												

Table 1. PAIT Task Order No.2 Schedule

DAC HSCT CONFIGURATION

The 300-passenger aircraft (figure 1) has a takeoff gross weight of about 750,000 lb. The engines are GE VCE with FLADE with rated thrust of about 60,000 lb.

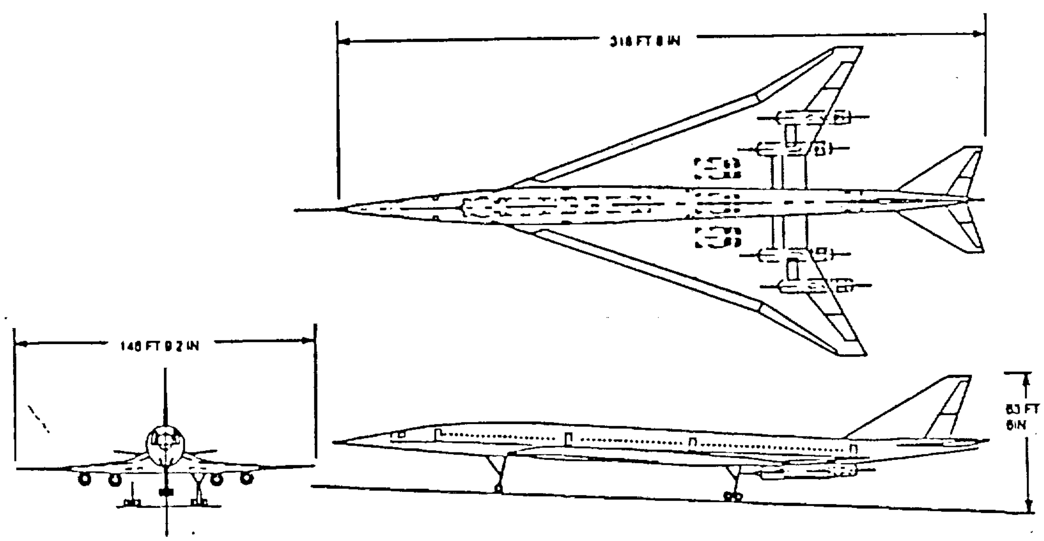

Figure 1. HSCT Configuration

GENERAL ELECTRIC FLADE ENGINE

The VCE (variable cycle engine) is surrounded by a FLADE (fan on blade) bypass duct. The FLADE provides for higher airflows and lower noise levels at takeoff, and lower specific fuel consumption at subsonic cruise conditions. The FLADE duct contains a fan stage made up of extended VCE fan blades. The duct also contains variable inlet guide vanes and variable exit area for flow-rate control.

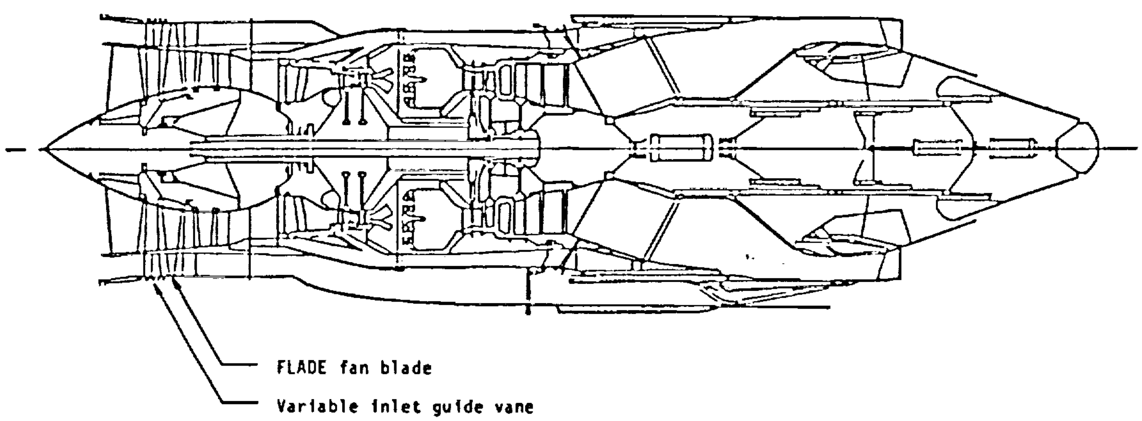

Figure 2. GE FLADE Engine

HSCT MISSION PROFILE INCLUDING CONVENTIONAL INTERNATIONAL RESERVES

The 6 inlet configurations will be evaluated by comparing airplane performance for the mission described in figure 3. The mission is the average of about 250 city-pair flights. About 25 percent of the distance traveled is at subsonic speeds.

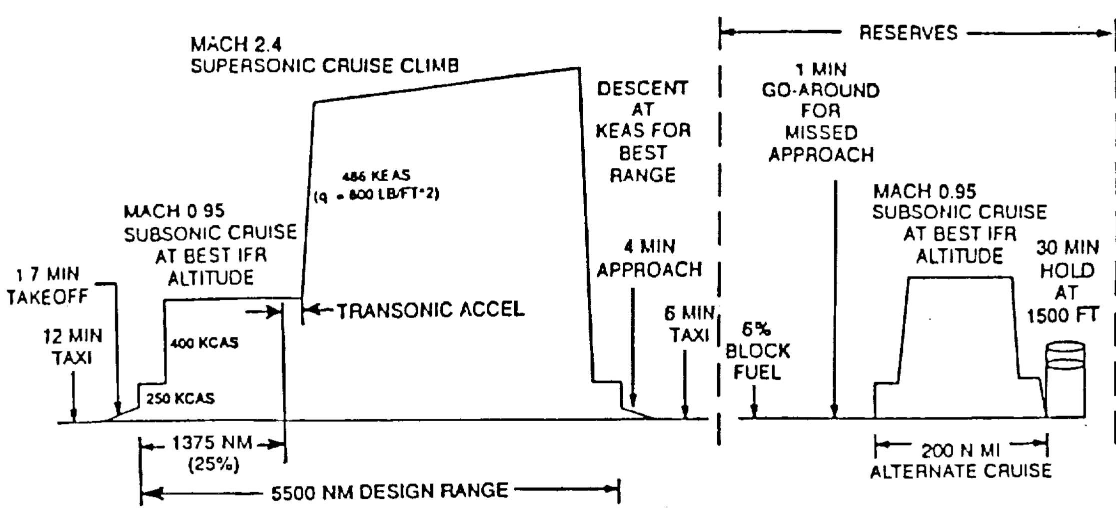

Figure 3. Mission Profile

HSCT FLOW AT INLET LOCATION

The design-point Mach number for the inlet depends on the airplane flow-field characteristics at the inlet location. At M_∞ =2.4, the average flow-field Mach number is 2.32 at both inlets (figure 4). These estimates were made using the SCRAM code (Streamline Coordinate Riemann Axial Marching Code). The code was run on the MDC CRAY XMP. Flow field estimates will also be made at M_∞ =0.95.

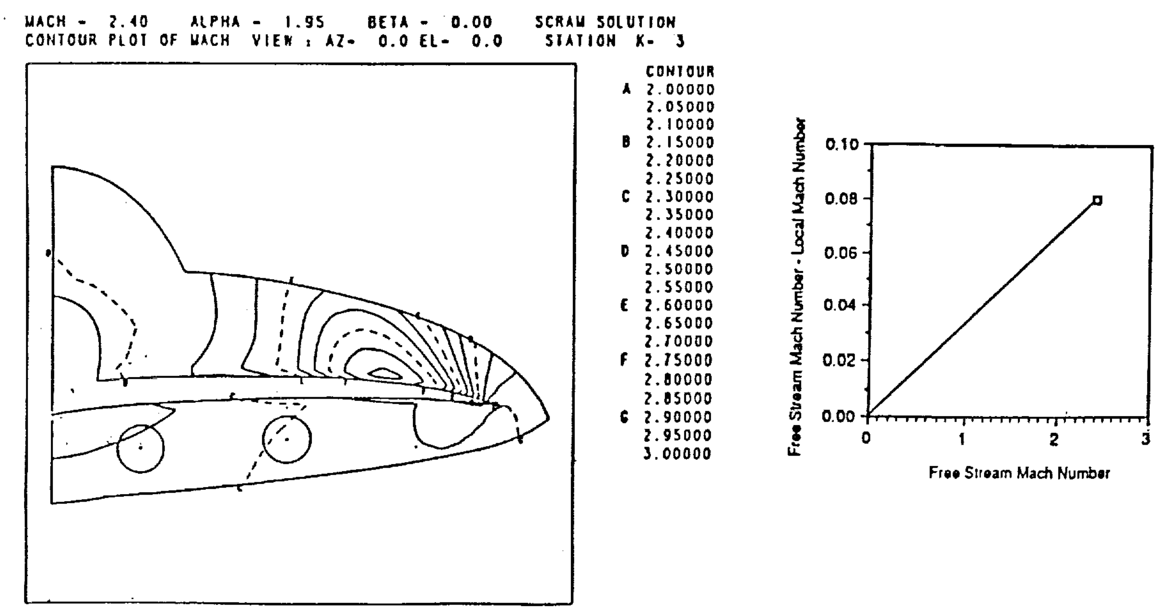

Figure 4. Flow Field at M =2.4

AXISYMMETRIC BICONE FOCUSED-COMPRESSION INLET

Inlet 2 (figure 5) has variable-diameter centerbody. Combined FLADE-inlet and bypass-exit doors are located near the engine face. Both VCE and FLADE airflow enter the main inlet at Mach numbers higher than about 0.8. At supersonic cruise, a small amount of airflow passes through the FLADE duct for cooling, through the internal inlet door. At subsonic cruise, full airflow capacity enters the FLADE through the internal inlet door.

For Mach numbers lower than about 0.8, only the VCE airflow enters through the main inlet. The FLADE airflow enters the engine through the external inlet door.

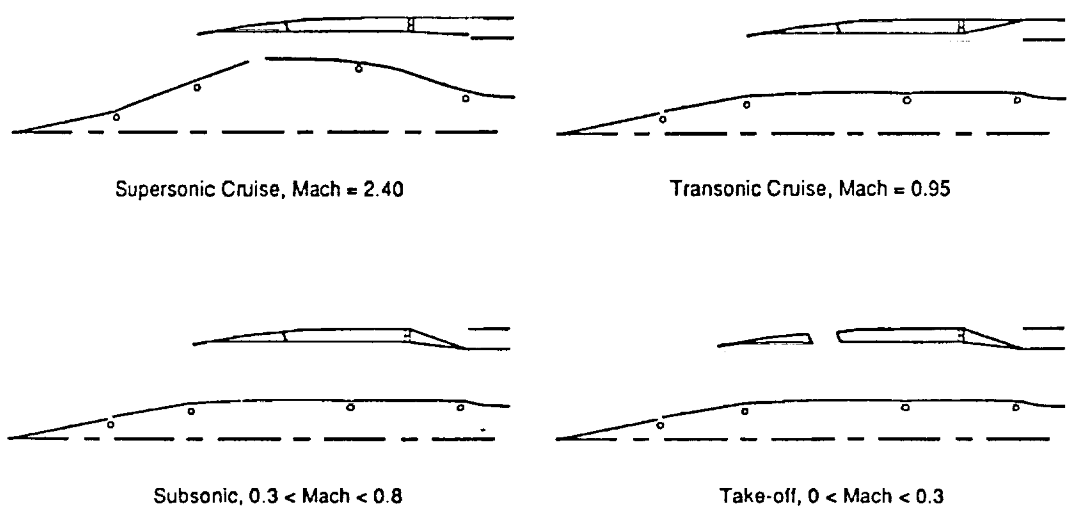

Figure 5. Axisymmetric Bicone Inlet (Inlet 2)

AXISYMMETRIC SINGLE-CONE TRANSLATING-CENTERBODY INLET

For inlet 3, VCE and FLADE airflow enter through the main inlet for Mach numbers higher than about 1.5 (figure 6). For lower Mach numbers, the FLADE airflow comes through external inlet doors. For Mach numbers equal to or lower than 0.95, full FLADE airflow capability is utilized. At higher Mach numbers, the FLADE airflow level is reduced to that required for cooling.

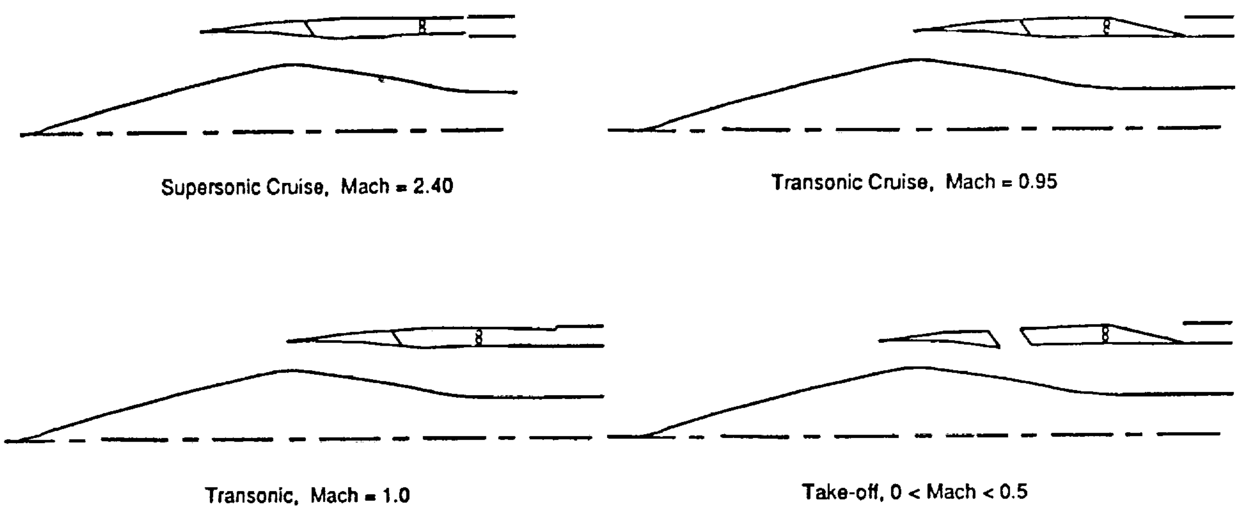

Figure 6. Axisymmetric Single-Cone Inlet (Inlet 3)

SUPERSONIC COMPRESSION AT DESIGN POINT

The supersonic-diffuser shock systems are shown below for inlets 2 and 3 at the design point. These figures are based on method of characteristics analyses. Inlet 1 (not shown) is much like inlet 2 but with less external compression.

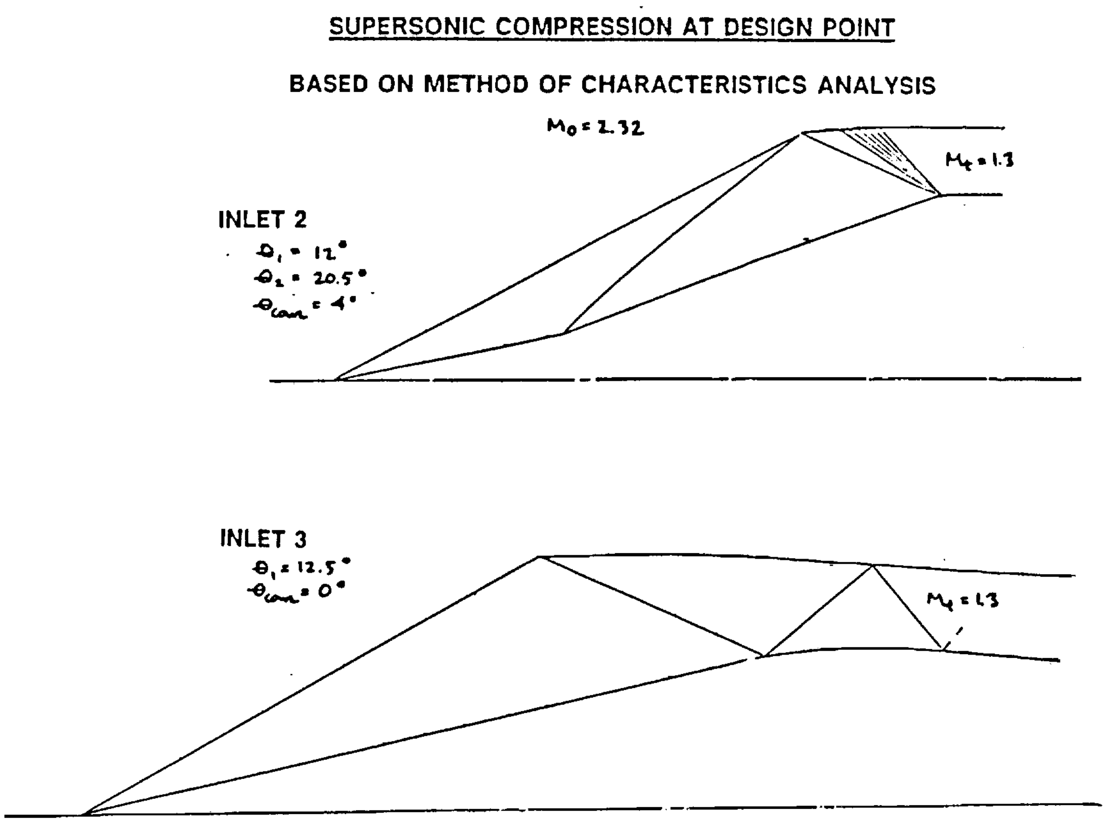

Figure 7. Supersonic Compression at Design Point

INLET PRESSURE RECOVERY

Inlets 1 and 2 are similar and have the same estimated pressure recovery except in the external-compression regime. Inlet 3 has higher pressure recovery than inlet 2 at supersonic cruise (based on NASA data for single cone and bicone inlets). At subsonic cruise conditions inlet 3 has lower recovery because the FLADE airflow is not removed from the main-duct outer wall but enters from the external FLADE inlet. At static conditions, inlet 3 has lower recovery for the VCE flow due to higher airflow per area through the main inlet. Pressure recovery for the inlets is compared in figure 8.

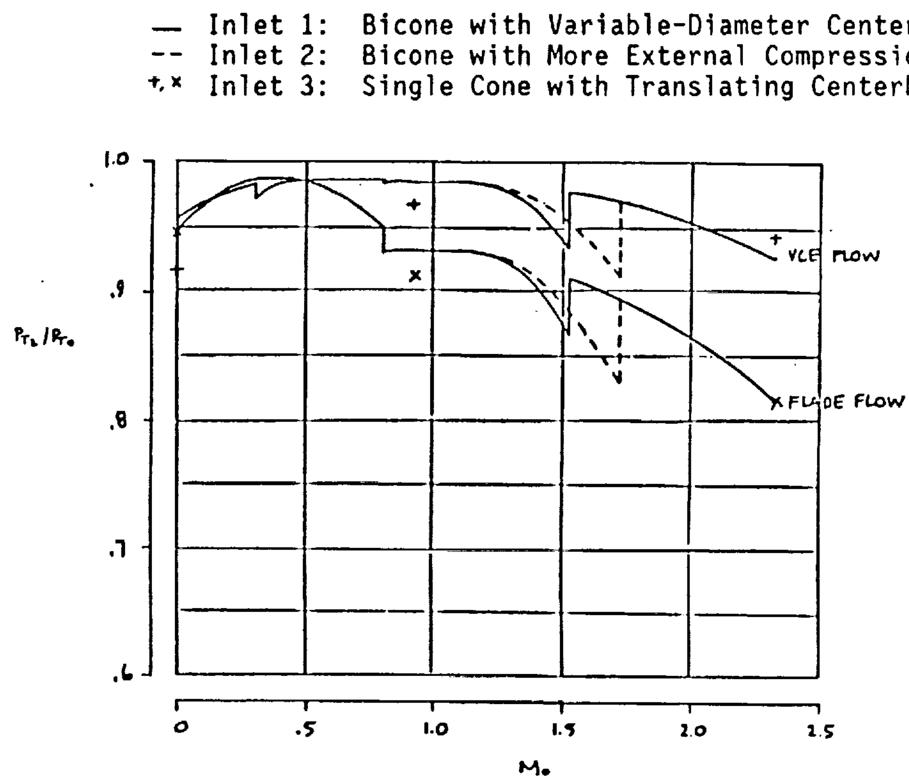

Figure 8. Inlet Pressure Recovery

INLET AIRFLOW CAPABILITY

Inlet 3 has the same inlet airflow capability as inlets 1 and 2 for Mach numbers less than or equal to 0.95. (The external FLADE inlet doors of inlet 3 are fully open in this regime.) For Mach numbers higher than 0.95, inlet 3 delivers all of the VCE airflow requirement, but only the cooling airflow requirement of the FLADE. Airflow capability for the inlets is compared in figure 9.

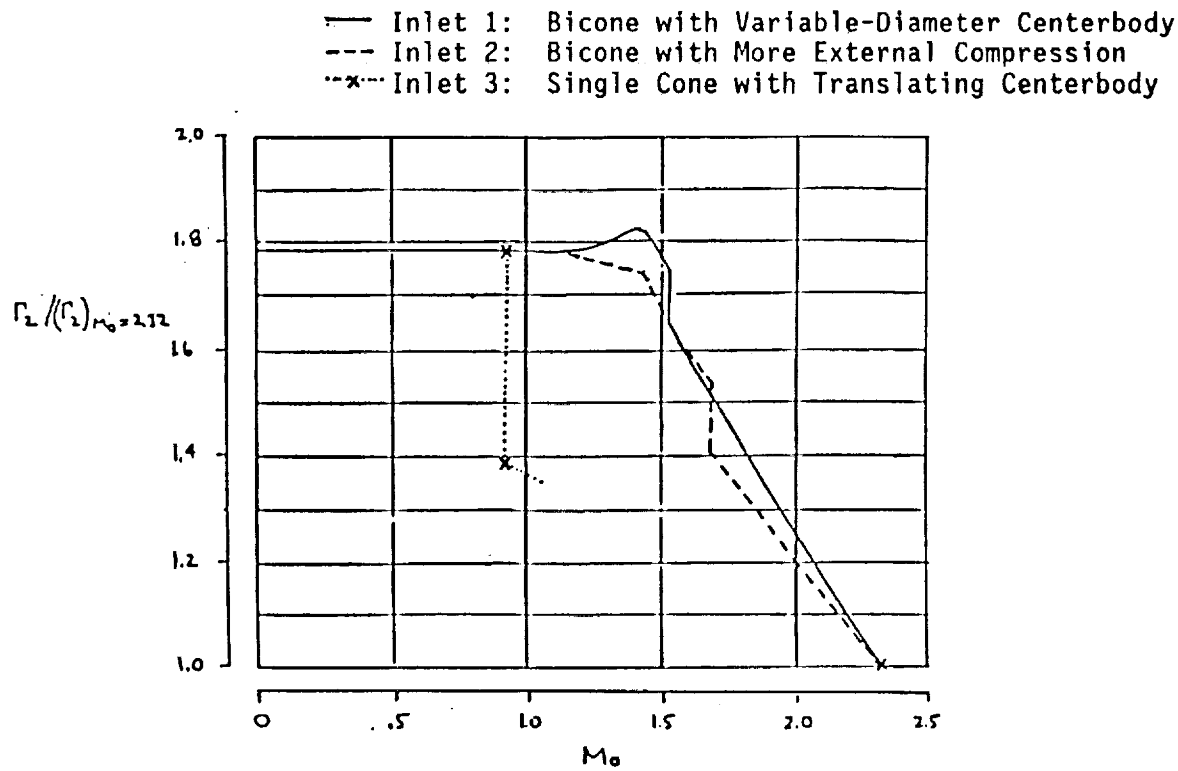

Figure 9. Inlet Airflow Capability

NEAR-TERM WORK

Task 4.0 INLET CONCEPTUAL DESIGNS

Finish inlet 3 lines

Start inlet 4 lines (rectangular with vertical ramps)

Initiate drag estimates, mechanical design, and weight estimates

Task 5.0 NACELLE/AIRFRAME INTEGRATION

Initiate CFD Analysis

Task 6.0 AIRFRAME/NACELLE MISSION PERFORMANCE

This work will start when engine performance is available