The Langley Mach 8 variable-density hypersonic tunnel is located in Building 1247D and is under the direction of the Aero-Physics Division. This tunnel is used for fundamental aerodynamic and fluid dynamic investigations over large Reynolds number ranges using pressure and heat-transfer measurements. The test medium is air and is heated by a combination of Dowtherm and electrical resistance. Model mounting consists of sting mount with injection mechanism. The tunnel has an axially symmetric contoured nozzle. The test-section diameter is 13 inches, and the test core size is 4 inches to 14 inches depending on pressure. It exhausts into a vacuum tank or atmosphere. Examples of operating conditions are as follows:

- Stagnation pressure, psia: 15 to 2930
- Stagnation temperature, °R: 1160 to 1510
- Mach number: 7.5 to 8.0
- Reynolds number per foot: $0.1 \times 10^6$ to $12.0 \times 10^5$
- Running time, sec, for:
  - Exhausting into vacuum tank: 90
  - Exhausting into atmosphere: 600
Email notes regarding Mach 8 heater

- Information below is based on conversations between Mike DiFulvio and John Warren. The heater is designed for 3000 psi and 1050 deg-F with a 40-42 lbm/sec mass flow. I am ruling out the possibility of post-heater, cold-air injection because, flow quality issues aside, it would drop the free stream temperature below the condensation line. Similarly, I am dubious about jury-rigging hypotheses for modifications to an old heater as a basis for operations for the next 25 years.

- So here are my conclusions

- 1) The heater temperature does not present a problem for Mach 6 to Mach 8 designs, but would becomes a limiter for Mach 9 and greater (see first plot of Re_vs_T0_limited)
- 2) The heater pressure rating cuts into the achievable Re for Mach 8 and above (see second plot of Re_vs_P0_limited)
- 3) The mass-flow rating of 40-42 lbm/sec is a killer. This is a LOT lower than the 100 lbm/sec we first thought we might have and limits the system to Re=8.1E6/ft at 16-inch core, or ReL=10.8E6/ft (see 3rd plot of Re_vs_mdot-annotated). For a better comparison of core-size and Re/ft vs mdot, see final plot Mach8_legacy

- Best case operation gives about a 40% increase in Reynolds number over our current best High-Re condition in 20-Inch Mach 6 Air. In my opinion, that would not achieve our goal of bringing a world-class, high-Re testing capability to Langley - i.e. a 100% increase in Reynolds number. It seems to me that a new heater is needed to get us to where we want to be.
Re vs $P_0$ limited

Theoretical Tunnel Capabilities Map
Supply Pressure Requirements

Max Reynolds number based on present center air-handling capabilities (100 lbm/s mass flow and 5000 psi supply pressure)

"New" nozzles assume expansion to condensation line with 16-in. test core
Re vs m-dot limited

Theoretical Tunnel Capabilities Map
Supply Mass-Flow Requirements

Approximate "legacy" operating condition of Mach 8 VDT:
Re=12e6/ft at 32 lbm/sec with 14-inch axisymmetric core diameter

Mach 8 QT heater is limited to 40 lbm/sec. Therefore max is Re=8E6/ft with 16-in. x 16-in., 2-D test core

"New" nozzles assume expansion to condensation line with 16-in. test core
Mach 8 legacy condition

Theoretical Mach 8 Nozzle Size vs Supply Mass Flow

Approximate "legacy" operating condition of Mach 8 VDT: $Re=12e6/ft$ at 32 lbf/sec with 14-inch axisymmetric core diameter

Plot was generated for Mach=8, but these lines are nearly constant with Mach number

Current max $Re$ capability is $Re=7.5E6/ft$ with 16-in. x 16-in. test core in LaRC 20-Inch Mach 5 Air Tunnel.

Thus, legacy Mach 8 VDT condition represents only a 40% increase over current best

20-Inch Mach 5: $7.5E6/ft \times 16-in. = 10E6/ft$ vs Mach 8 VDT: $12E6/ft \times 14-in. = 14E6/ft$