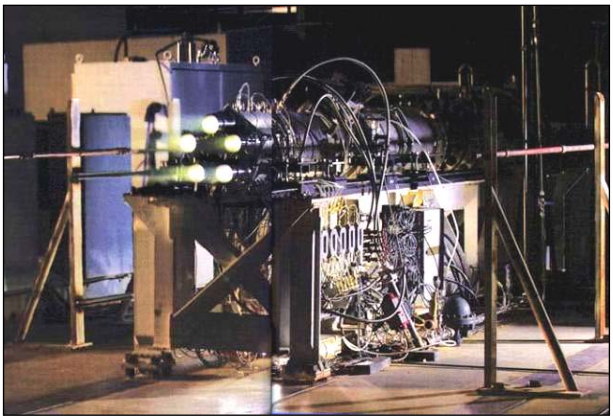
NAWCWD Quick Facts — Thermal Dynamics Test Facility (T–Range)

China Lake & Point Mugu, CA NAVAIR

Mission. Conducts research and development (R&D) testing of air-breathing engines, liquid rocket engines, and solid rocket transition to liquid propulsion systems and subcomponents.



Unique Features. This is a high-pressure, hot-gas blow down to atmosphere facility that can replicate Mach 4 at sea level. It is one of only a few facilities of its kind nationwide that can support full-scale tactical missile rocket to air-breathing engine transition testing.

Cost / Time Savings. Unexpected failures of ceramic radomes in early flight testing lead to manufacturers qualification testing. In combination with experts in thermal and structural analysis and computational fluid dynamics, cost-effective testing is performed in order to reliably predict mission survival without the need for expensive flight testing. Simulations save money! The laboratory is a modern computer controlled facility typically requiring only three personnel to operate.

RDT&E. T-Range also provides free-jet testing to simulate the aerothermal environment for Mach 4 sea level flight. Using a patented variable Mach number diffuser concept, it can simulate both the heating and shear for supersonic and hypersonic flight environments for material and component testing.

T-Range tests a variety of tactical-sized missile components. IR imaging cameras estimate the surface temperature, and high-speed digital video help to determine location and modes of failure for missile RF and IR domes. T-Range has performed high-energy laser testing to understand and quantify missile component vulnerability. The support of air-breathing propulsion systems includes ramjet engine and inlet performance and rocket-to-air breathing propulsion transition testing. Test setup and data reduction are supported by experts in computational fluid dynamics and thermal and structural analysis.

Types of Testing / Service

- **Air-Breathing Engine Testing.** Static testing of ramjets, scramjets, and pulse detonation engines
- **Liquid Rocket Engine Testing.** Static firing of fueled rocket engines
- **Rocket Engine Component Testing.** Fuels, fuel-management systems, inlets, insulators, combustors, and actuation devices
- **Solid Rocket Motor Testing.** Static firing of small instrumented rocket motors, igniters, gas generators, and pyrotechnic devices

High-Speed Video Image of Type II Finish Radome at Time of Failure

Size / Description / Scope. 110,000 SF open-air test facility with systems for compressed air, oxygen, nitrogen, propane, water, and hydrogen. The facility can test items with up to 250 pounds of Class 1.1 and 10,000 pounds of Class 1.3 energetic material. This facility is located within the Propulsion Test Area. One vault contains high-speed instrumentation.
Annual Test Events: 5 to 30. **Year Opened:** 1962. **Plant Value:** $6M+.

Main Facilities

Air-Breathing and Aerotherm Capabilities. Static-fire tests are conducted on air-breathing engines such as ramjets, scramjets, pulse detonation engines, divert bi-propellant propulsion, and expendable turbine systems as well as engine components such as fuels, inlets, insulators, combustors, and fuel management systems. Instrumented rocket motors and pyrotechnic devices are also static fired. Flight conditions can be simulated to Mach 4, from sea level to 80,000 feet altitude, in operational environments of -53 to 93°C (-65 to 200°F).

Multiple Test Bays. Propulsion research takes place in a collection of specialized laboratories that take a new energetic molecule from first conception, through formulation, to evaluation of its performance and hazards use in an all-up weapon.

Equipment

- Facility air heater capable of 30 lb_m/sec at 1,000 psi and 600 or 4,000°F at lower flow rates
- Small-scale blow-down nozzle (high Reynolds number capability)
- Thrust stand capability between 5 and 5,000 pounds
- Small-scale jet fuel storage and delivery system with temperature conditioning
- Equipment to sample detonation wave fronts

Instrumentation

- Data acquisition system is capable of recording up to 120 channels with full signal conditioning, 40 channels with limited conditioning, and 96 channels of thermocouple conditioning with linearization on-the-fly
- 20 channels dedicated for flow meter (turbine) conditioning and conversion. All these channels have a sample rate of 200K samples per second sustained per channel with 12-bit analog to digital conversion. In addition, there are 48 channels that can be sampled at 500K samples per second.
- Surveillance camera, high-speed digital video as well as IR video
- Schlieren system
- Signal conditioning for flow meters, thermocouples, strain gauges, pressure transducers, and accelerometers
- Pressure transducers capable of capturing detonation wave forms
- 16-channel digital sequencer
- Security / explosive storage containers
- Test stand capabilities include air velocities to Mach 4 and temperature elevation of blow-down gas to 2,200°F

Recognition / Awards. Articles in major magazines: *Aviation Week and Space Technology* (Fasthawk and M-Dot Corp turbopump); *Surface Warfare Magazine* (Fasthawk); *Popular Science* Magazine in September 2003 (pulse-detonation engine test). Two engineers received patents for low cost wind tunnel for supersonic and hypersonic aerothermal testing.