# The Naval Air Propulsion Center Story
# Trenton New Jersey – 1953-1998

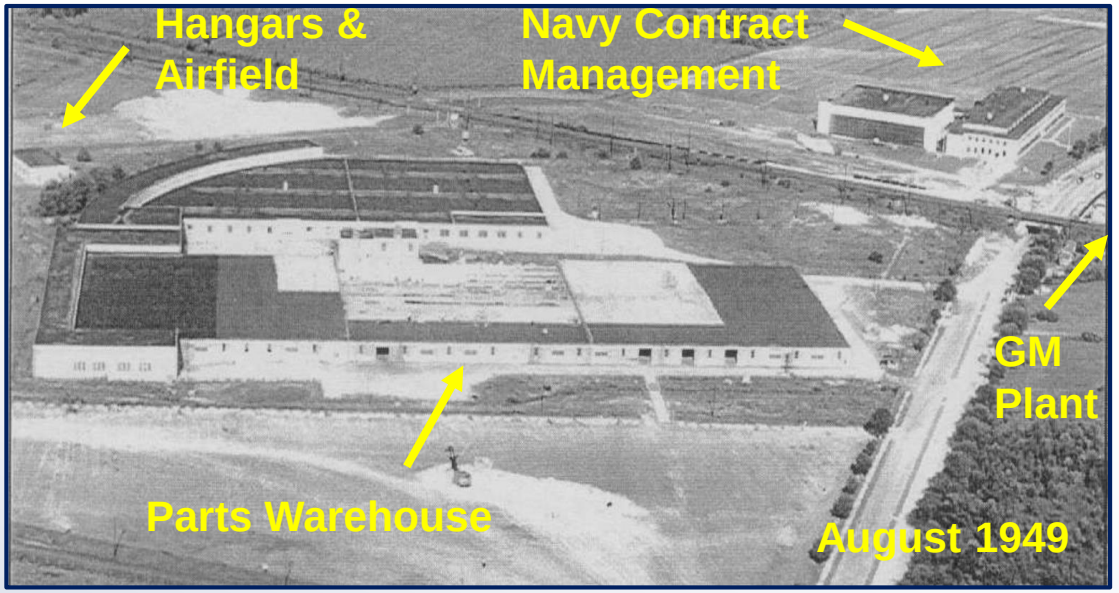
*November 16, 2018*

*Presented to:*
**TETWG #100**

*Presented by:*
**Tom Weiss**

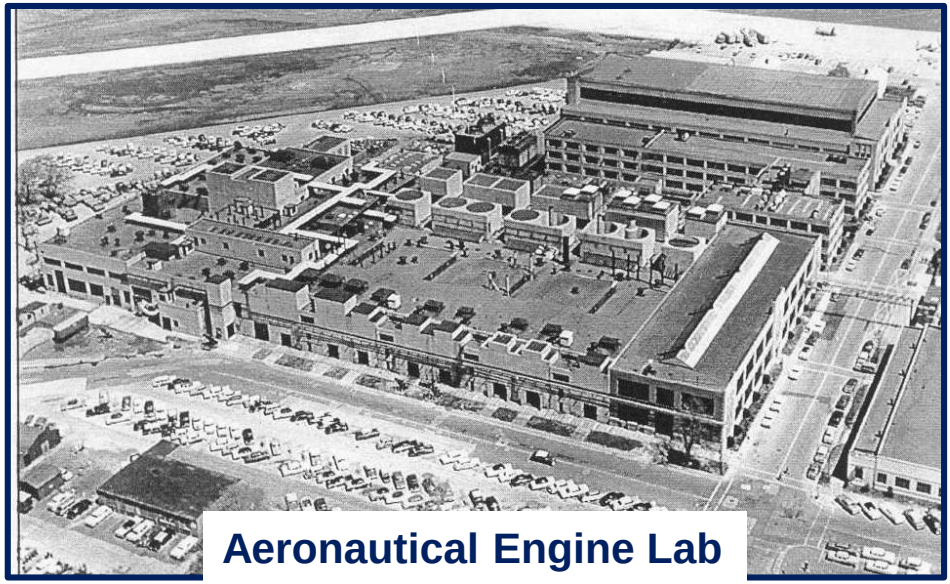
# The World War II Period – The Trenton Site

- Eastern Aircraft Division of GM created 2 Jan 1942
- 5 East Coast Plants to build Grumman aircraft
- Trenton Plant for TBF Avenger torpedo aircraft
- First aircraft delivered on 11 Nov 1942 (9 months)
- Airfield was operated by Chase Aircraft.
  - Test flew each aircraft and prepped to delivery
- 13 months to build the first 1000 aircraft



# The Decision to Build – 1942-47

- Turbine Engine testing need conceived during World War 2
- Realized the need for large gas turbine engines in the future
- Requirement:
  Ground testing under repeatable, controlled, environmental and flight conditions to minimize the risk and cost of flight testing



**Aeronautical Engine Lab**

- 1942, Bureau of Aeronautics, Power Plant Design Division, began studies of an advanced aeronautical turbine laboratory. The study concluded “there are no laboratories available either in the commercial industry or the government capable of conducting dynamometer tests of large full-scale internal combustion turbines under simulated altitude condition” and “conversion or modification of existing facilities for gas turbine testing would be both uneconomical and unsatisfactory”.
- Aeronautical Engine Lab (AEL) in Philadelphia deemed inadequate
- Navy Bureau of Aeronautics decided to build a facility in 1944. Estimated cost $6.6M for 100 pps airflow.
- Trenton site selected in 1946, site was already owned by the War Assets Administration.

# The First "Trenton"

- Testing on Mt. Washington New Hampshire in 1947/48
- Air Force had Project Summit there in 1945.
- Winds 30-140 mph (230 record) and temps as low as -46F
- Navy to test Navy engines, Air Force would provide the test site
- First turbojet engine operated under controlled icing conditions.
- Used a McDonnell XFD-1 Phantom I airplane with 2 Westinghouse J30 Turbojets
- Additional tests conducted on test stands in 1948
- Proved a "turbojet could be rendered inoperative in less than one minute in severe icing storm".

## Test Jet Engines On Mt. Washington

CONCORD, N. H. (UP)—Rugged civilian teams in laboratories literally chained to the weather-walloped peak of this state's 6,288-foot Mt. Washington are constantly engaged in research designed to save the lives of servicemen.

Night and day, jet engines roar in a battle against winter flying risks atop the mountain whose summit is said to be stormier than the polar ice cap.

Wild winds lash the peak four months a year, hitting 75 to 110-mile-an-hour velocities. In 1930, the world's wind record was clocked atop "Mt. Misery"—230 mph!

Temperatures skid to minus 46 degrees, and, on objects exposed overnight, rime has been known to build up to a thickness of seven feet.

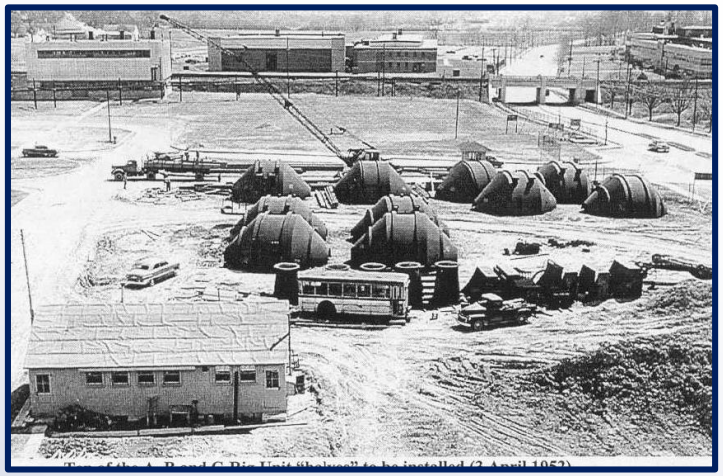
Clad in parkas, men work in mist and wind testing prototype jet engines for Navy and Air Force fighters and bombers. Sub-zero temperatures simulate conditions that effect jet engines when a plane makes its landing approach. During this "let-down" phase of flight is when critical icing conditions take place.

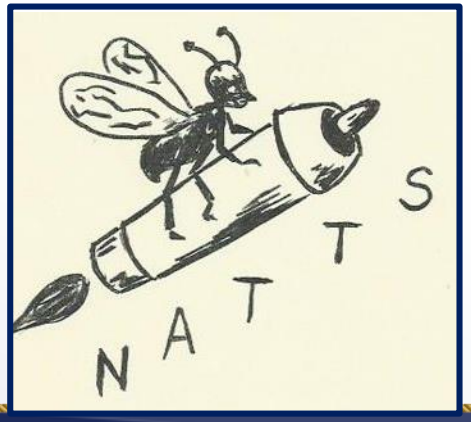
New anti-icing improvements are developed on Mt. Washington, in addition to showing the maximum operating condition of the planes' power plants.

Lodi News Sentinel
June 27, 1953

# Test Center History – The Build

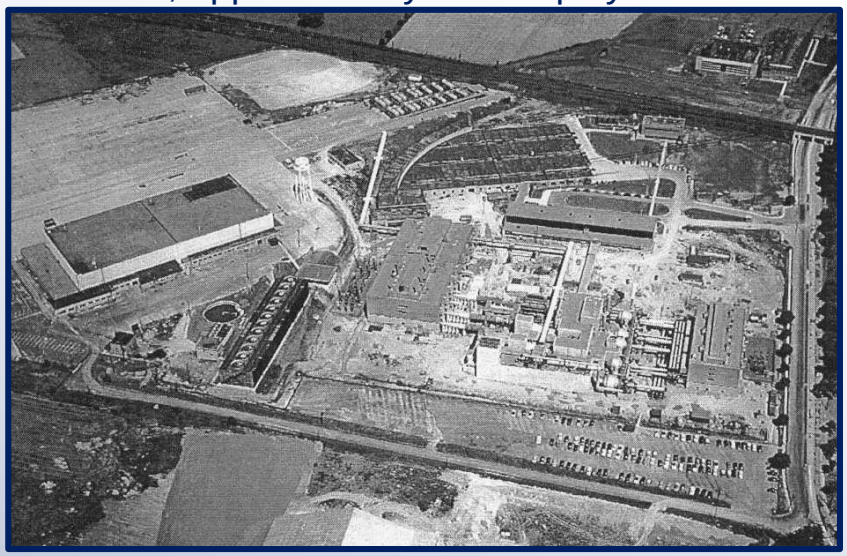
- Turbine engine development advancing rapidly – 1947 decision to increase airflow from 100 pps to 300 pps, cost increase of $24M
- Utilities Required
  - Cooling Water: Built pumping station on shore of Delaware River – 3 mile pipe run
  - 10 mile high tension electric power supply by Public Service Electric and Gas Co at 132,000 volts.
- Original test cells, altitude 1E and 2E, Sea Level Ram 1W and 2W and Turboprop 3W
- Commissioned Naval Air Turbine Test Station (NATTS) in July1, 1951, activated 1955. Full scale engine testing started in 1956
- Total spent from 1948 to 1956 was $41M

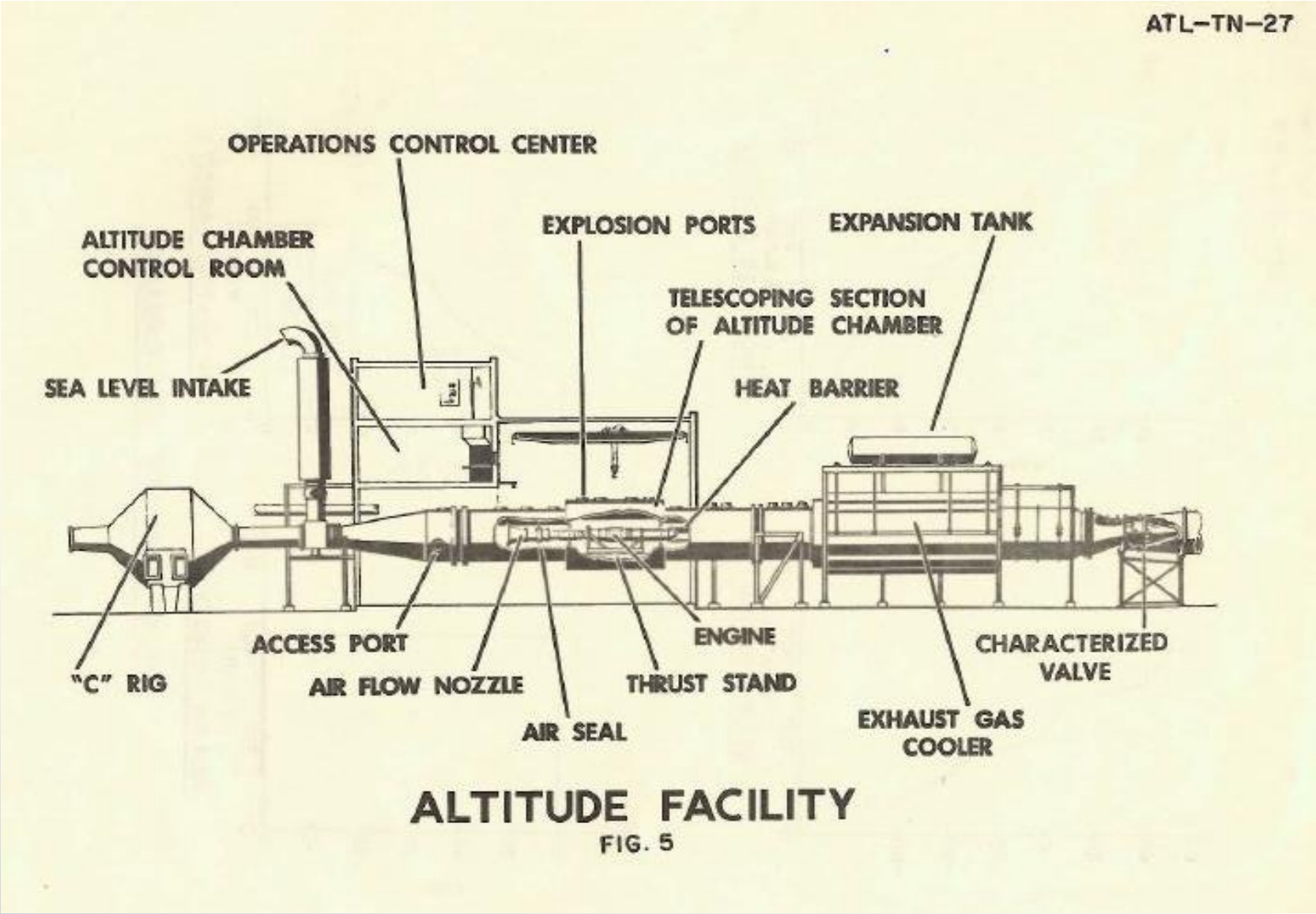


# 1950s – Testing Begins

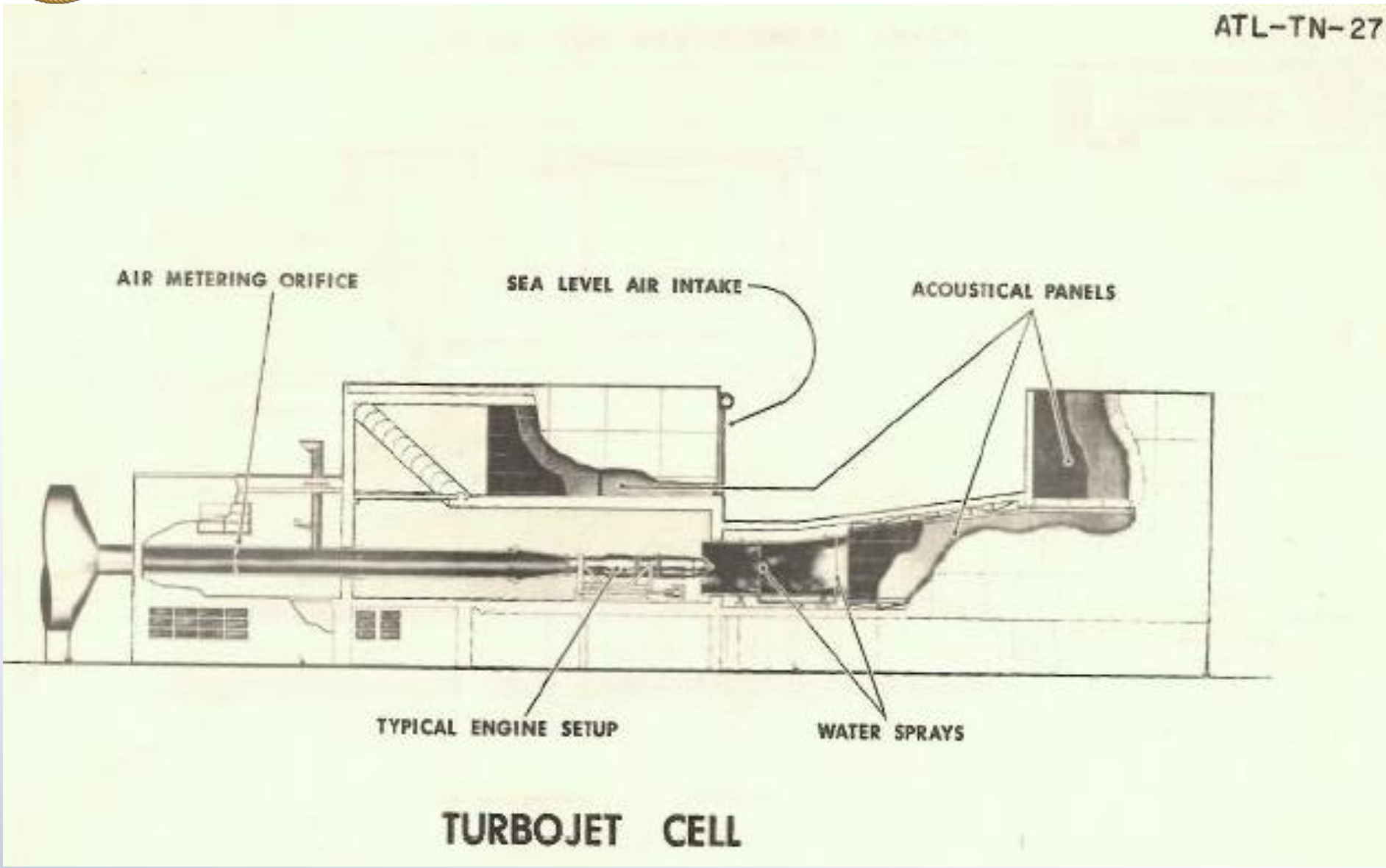
- Mr. Walter A. Paulson was considered the person most responsible for the technical quality of the Center and known as “The Father of NATTS”.
- Five Test Cells, 2 Altitude, 2 Sea Level, 1 Turboprop
- Commissioned Naval Air Turbine Test Station (NATTS) in July1, 1951, activated 1955. Full scale engine testing started in 1956
- Official dedication Ceremony, 4 Nov 55, 650 guests
- 1954 data system “sensing and storage system that would read and remember 300 data variables”, delivered 1957, could not meet requirements, new one in 1959
- 1955 used Characterized Valves for inlet and exhaust control
- 1958 Detonation Suppression system in the exhaust section of altitude chambers for afterburner operation
- 1959, Approximately 500 employees



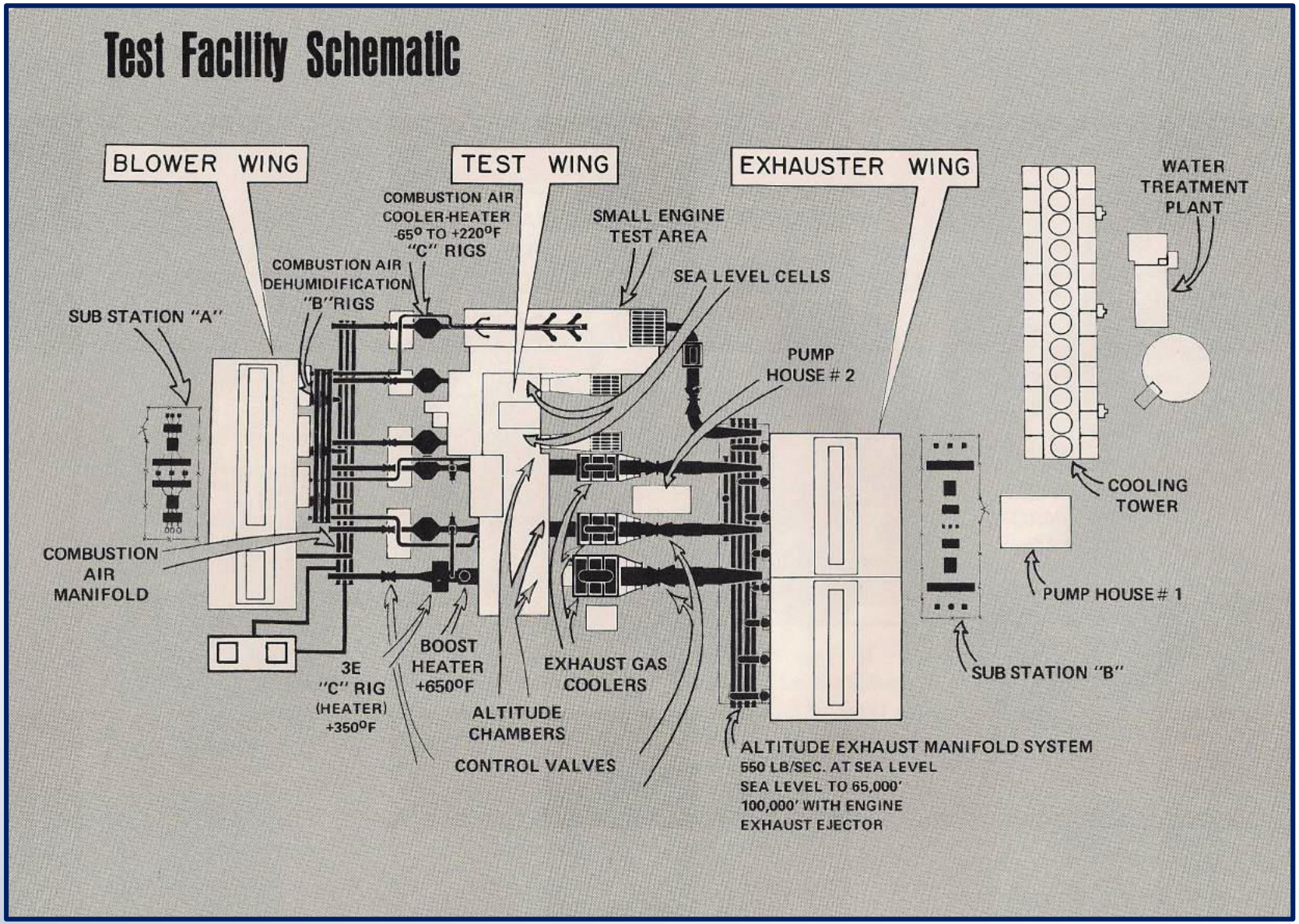
# Altitude Test Cell (1E & 2E)



# Sea Level Environmental (1W & 2W)

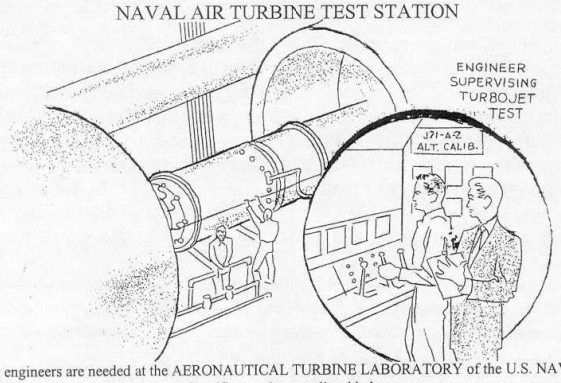


# Airflow Schematic 1951-1975



# Recruiting Add – Mid 1950s

NAVAL AIR TURBINE TEST STATION




Civilian engineers are needed at the AERONAUTICAL TURBINE LABORATORY of the U.S. NAVAL AIR TURBINE TEST STATION in West Trenton, New Jersey. Specific openings are listed below.

This ultramodern laboratory, finest of its kind in the East, performs test, research, and development on turbojet and turboprop aircraft engines for the U.S. Navy Bureau of Aeronautics. Its facilities include:

Five test cells -- Two altitude cells, two sealevel cells, one turboprop cell.

Air handling system -- 1,000,000cfm, through three 6,000-hp blowers and fourteen 3,000-hp to 4,500-hp exhausters.

Air refrigeration system -- 5,000-ton F12 plant which can cool air to -67F for delivery (at speed of sound) to engines under test.

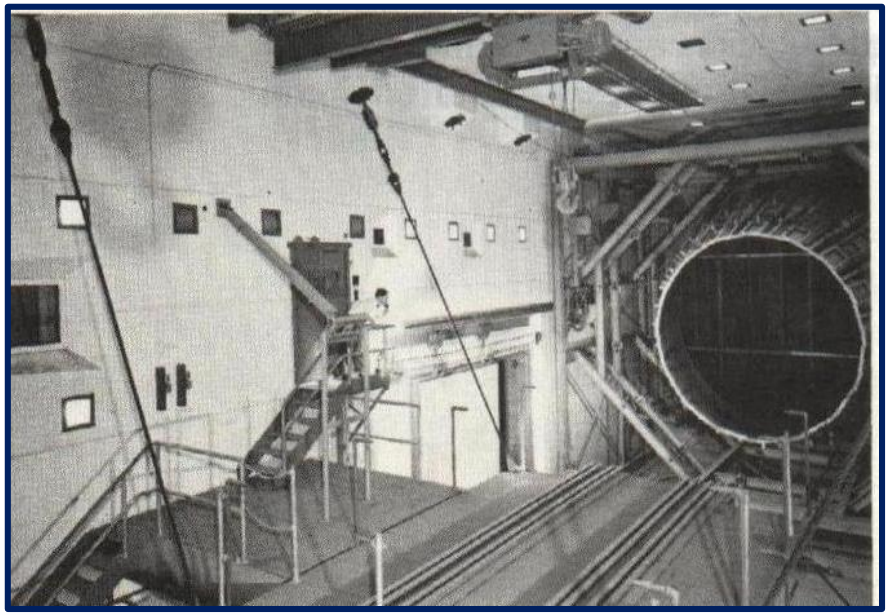
A word about the pleasant living conditions in this suburban-rural section of the Delaware Valley. Single or family housing is reasonable and plentiful within one to ten miles. Famous ocean resorts are 40 miles away; New York, 60 miles; Philadelphia, 35 miles. The Poconos and New Jersey's northern lakes are within one or two hours driving time.

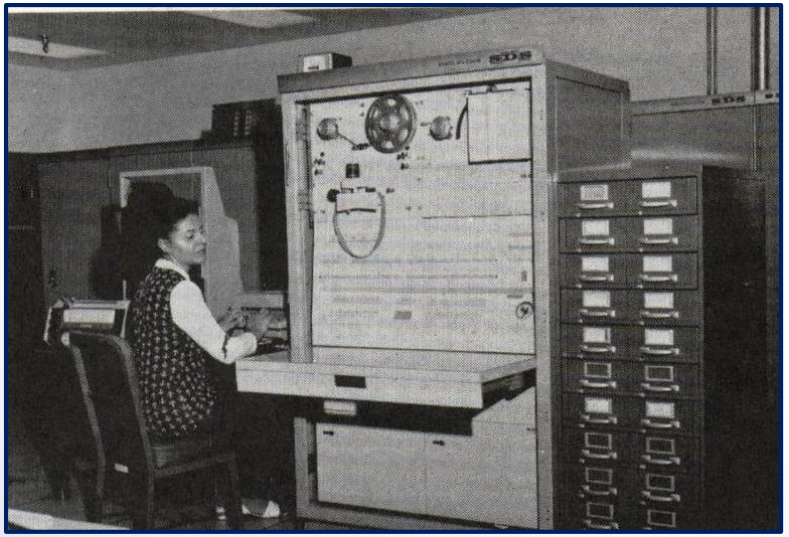
All in all -- a fine place to work, to develop professional experience, and to bring up a family. The following positions are now open:

| | | |
|---|---|---|
| 1 - Engineering Group Manager (SAPPRE) | GS-834-15 | $12,690 |
| 1 - Operations Group Manager (Supv Gen Eng) | GS-801-14 | $10,320 |
| 1 - Head, Accessories Br, Engine C & A Div ( SAPPRE) | GS-834-13 | $10,065 |
| 1 - Chief, Plant Operations Div (Supv Gen Eng) | GS-801-13 | $ 8,990 |
| 1 - Chief, Test Operations Div (SAPPTE) | GS-834-13 | $ 8,990 |
| 4 - Project Engineer (APPRE) | GS-834-12 | $ 8,645 |
| 1 - Research Eng (Aero Instrumentation) | GS-801-12 | $ 8,645 |
| 1 - Electronics Scientist (Instrumentation) | GS-1312-12 | $ 7,570 |
| 1 - Head, Test Operations Eng Branch (SAPPTE) | GS-834-12 | $ 7,570 |
| 1 - Head, Plant Operations Eng Branch (Supv Gen Eng) | GS-801-12 | $ 7,570 |
| 5 - Project Engineer (APPRE) | GS-834-11 | $ 7,465 |
| 1 - Research Eng (Aero Instrumentation) | GS-801-11 | $ 7,465 |
| 1 - Electrical Engineer, Engineering Design | GS-850-11 | $ 7,035 |
| 1 - Electrical Engineer, Plant Operations | GS-850-11 | $ 7,035 |
| 1 - Aero Power Plant Test Eng | GS-834-11 | $ 7,035 |
| 4 - Aero Power Plant Research Eng | GS-834-9 | $ 6,250 |
| 1 - Research Eng (Aero Instrumentation) | GS-801-9 | $ 6,250 |
| 3 - Mechanical Engineer | GS-830-9 | $ 6,115 |

Send Form #57 to: IRO, NATTS, Box 1719, Trenton, N.J.

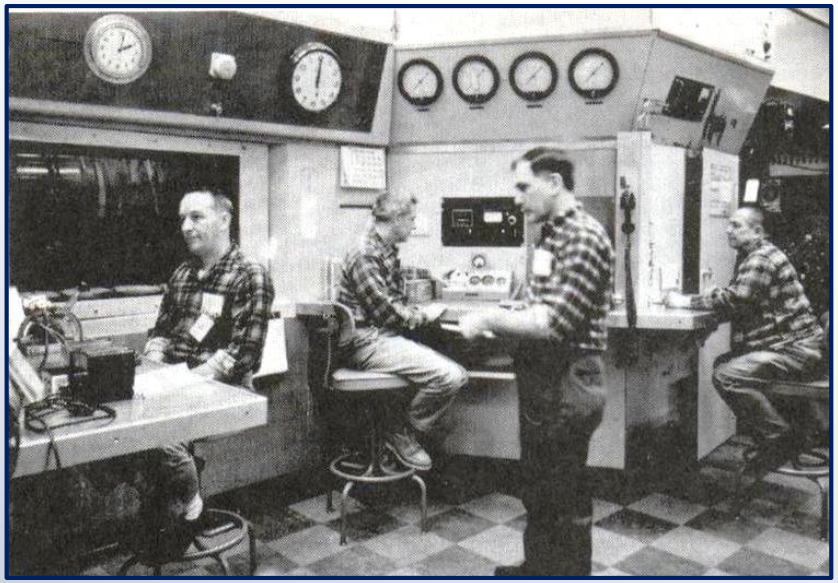
**A vacancy announcement from the Mid - 1950s**

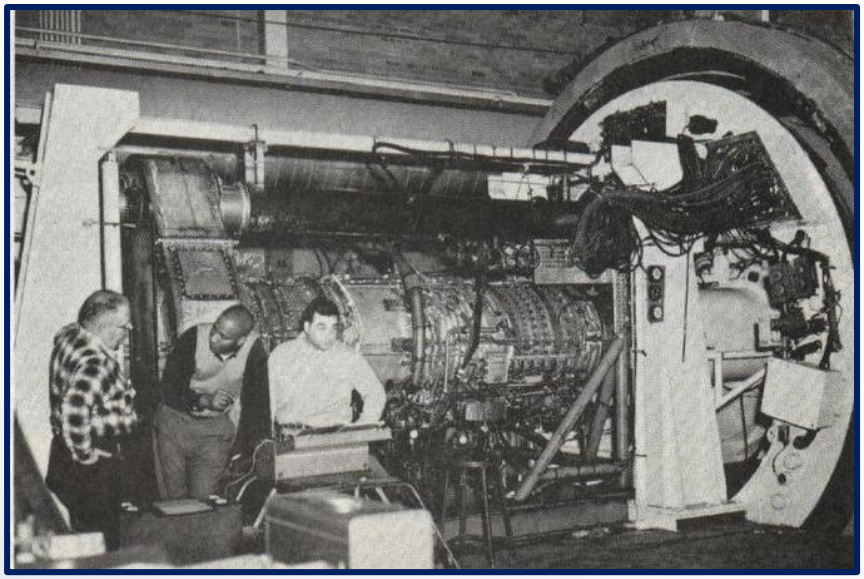




# Testing 1950-1969

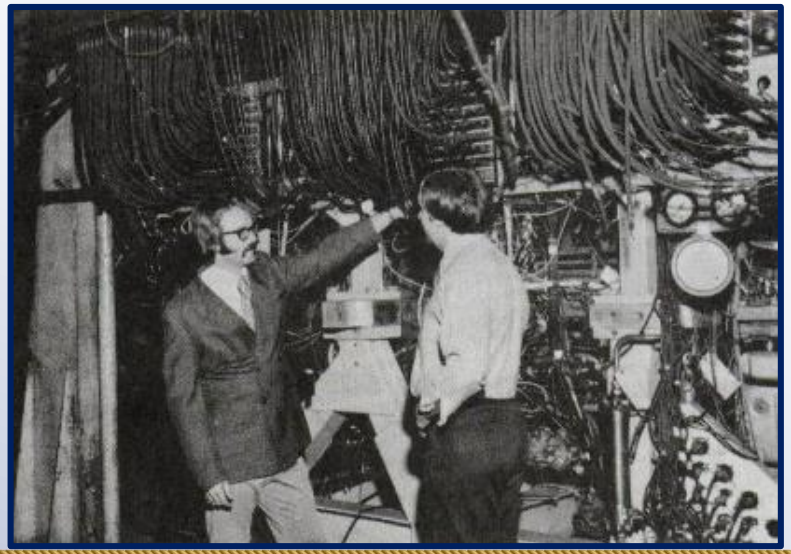
- First engine to test, Westinghouse J40-WE-8 in 1E altitude cell, November 1954
- First Turboprop test, Allison T40-A-6, July 1955
- First Sea Level Test, August 1955 on a Westinghouse J40
- 1957 P&W J75 turbojet passes all tests for speed and altitude
- 1957 Contracts awarded for 3E test chamber and Ram Blower #4 (500 pps, Mach 3.0)
- 1958 J79 and J57 testing dominated test schedule
- 1960 Wright J60 testing identified causes for Fleet turbine failures at high altitude
- 1960 testing of Allison J71 confirmed contractor changes to the engine did not solve the problems of operating in heavy rain and icing environment
- 1961 initial studies of consolidating AEL (Philly) and NATTS (Trenton)





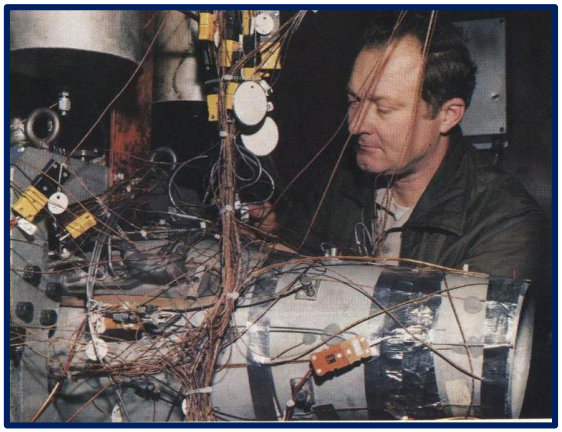
# Testing 1950-1969

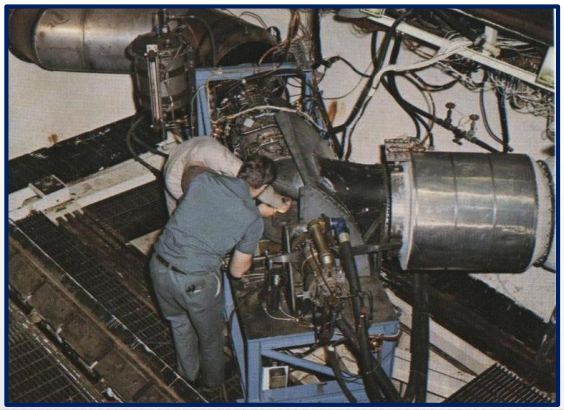
- 1964 3E test cell checkouts, fire erupted in the insulation after several hours of high temperature testing, destroying most of the instrumentation and electrical wiring above the chamber
- Navy decided to consolidate AEL and NATTS in the Mid 1960s
- 1965 First TF30 Testing, first augmented turbofan engine
- 1965 testing completed of engines using MIL-L-23699 developed by AEL, still in use today
- 1 July 1967 Naval Air Propulsion Test Center created merging NATTS and AEL
- 1968 Designed missile exhaust gas ingestion rig.
- Initiated testing to demonstrate a methodology for defining gas turbine engine sensitivity to sea salt
- 1969 Icing of TF41, first Navy engine without inlet guide vanes and had a rotating spinner.

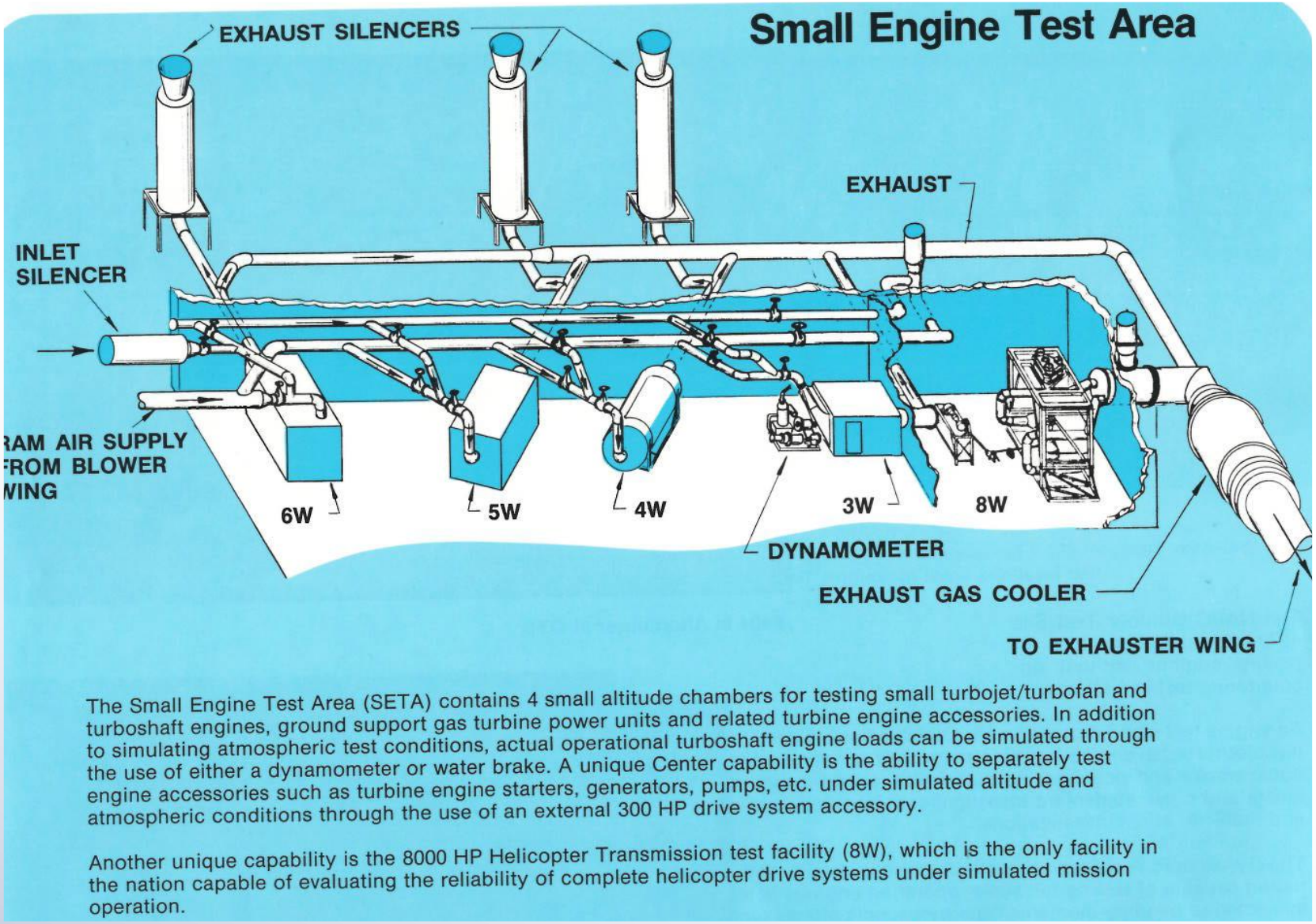
# Capability Growth 1970-1985

- Merger began in 1971 moving AEL systems, rigs and people to NATPC
- Disassembled 3W turboprop test cell and began building Small Engine Test Area (SETA: 3W, 4W, 5W, 6W and 8W)
- AEL capabilities moved: Containment Evaluation Facility (RSF), small gas turbine facilities, auxiliary power units, engine starters, propellers, gearboxes, transmissions and fuel and lubricant analysis laboratories.
- Move completed in 1975
- Name changed to Naval Air Propulsion Center (NAPC) in 1979
- 1970-1980s added Gyroscopic testing, multi purpose turntable and Variable Attitude Test Stand, all at the Outdoor Test Site in Lakehurst NJ, about 50 miles from Trenton.
- 1980s added UAV testing, developed accelerated engine duty cycles from aircraft mission profiles and mission mix



# Converstion of 3W to SETA

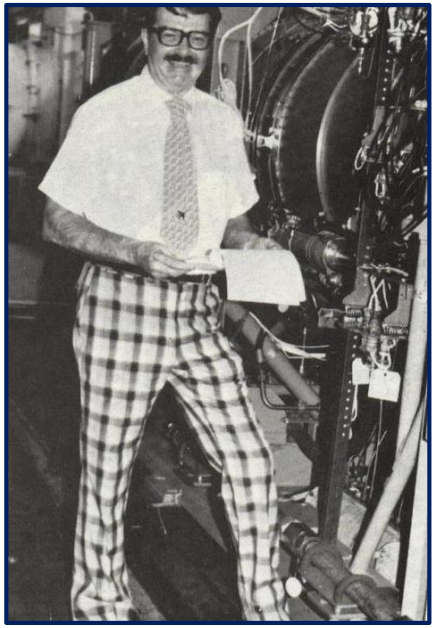


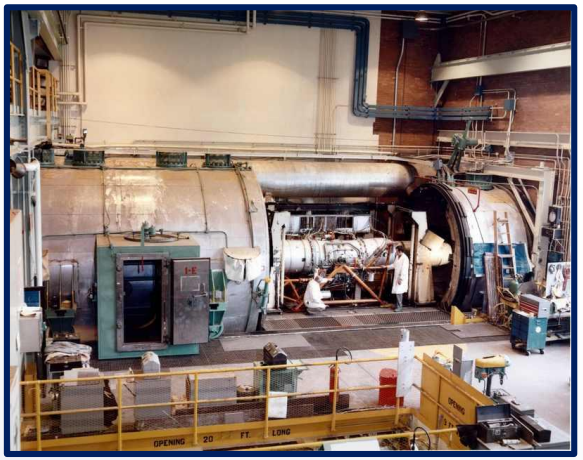

The Small Engine Test Area (SETA) contains 4 small altitude chambers for testing small turbojet/turbofan and turboshaft engines, ground support gas turbine power units and related turbine engine accessories. In addition to simulating atmospheric test conditions, actual operational turboshaft engine loads can be simulated through the use of either a dynamometer or water brake. A unique Center capability is the ability to separately test engine accessories such as turbine engine starters, generators, pumps, etc. under simulated altitude and atmospheric conditions through the use of an external 300 HP drive system accessory.

Another unique capability is the 8000 HP Helicopter Transmission test facility (8W), which is the only facility in the nation capable of evaluating the reliability of complete helicopter drive systems under simulated mission operation.

# Testing 1970s

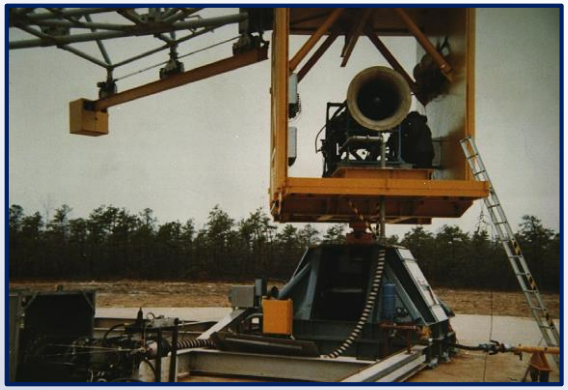
- 1970 Conducted first testing of TF30-P412 for F-14.
- May 1971 – Aug 1972 all TF34 qualification testing was completed.
- 1971 Development of F401 engine begun for F-14 program
  - Terminated in 1973 for technical reasons
- 1972 First testing of small turbines for both Navy and Army
- 1973 Began 6 year effort to develop synthetic JP-5 Fuel from Coal
- 1973 First High Severity Simulated Mission Endurance Test (SMET) conducted
- 1974 First test for the Sweden JA-37 Viggen engine
- 1975 Began preparations for testing the Sea Launched Cruise Missile (SLCM) application, later designated the F107 turbofan engine
- Redwood cooling tower damaged by fire
- Center was renamed the Naval Air Propulsion Center (NAPC)
- 1979 Full scale engine test began on Synthetic JP-5 made from oil shale
- 1979 Completed qualification testing of the F404 engine
- 1979 Center allocated 2 small altitude test cells for Cruise Missile testing





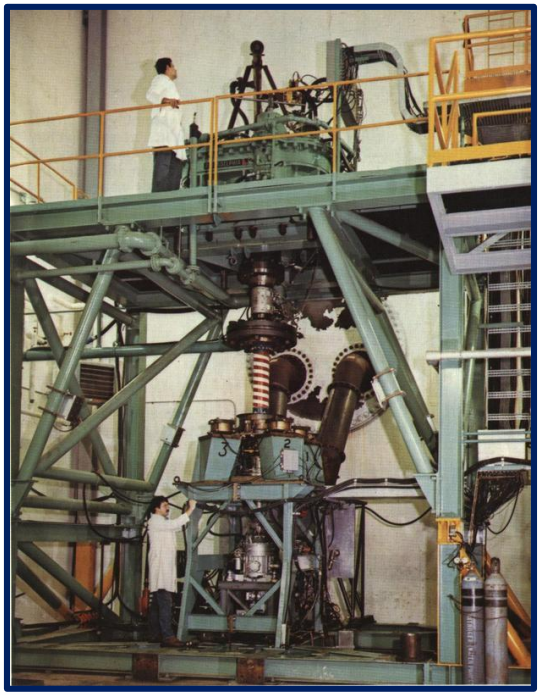
# Outdoor Test Site

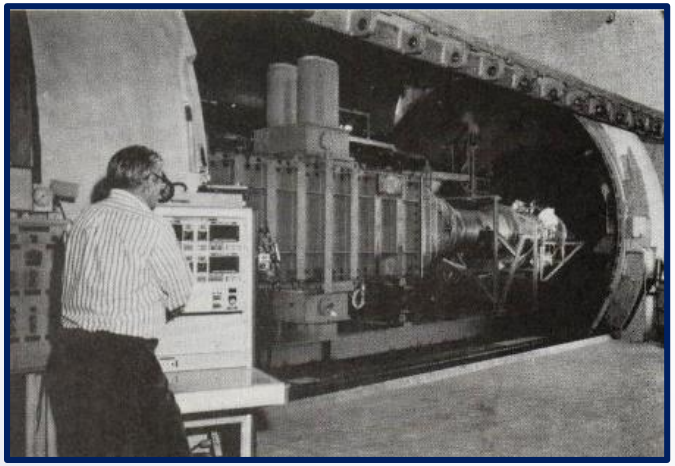
Outdoor Thrust Stand – Turntable
Variable Attitude Test Stand – VATS
Gyroscopic Test Stand - Gyro



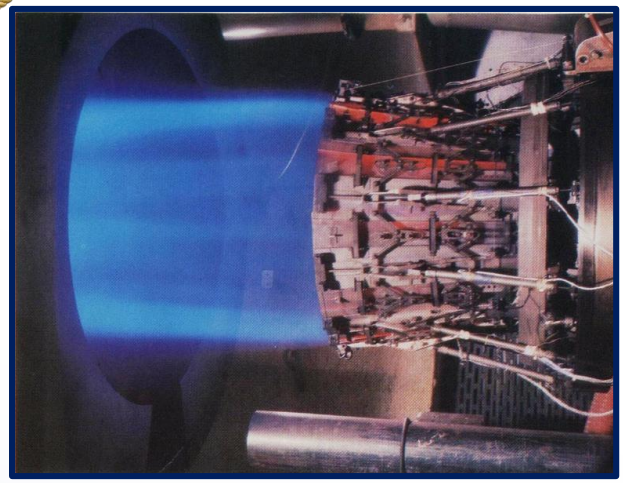
# Testing 1980s

- 1981 Completed testing of the GE F101 Demonstration Flight Engine, delivered to Grumman for F-14B Super Tomcat Flight Tests
- 1981 Completed facility modification to provide testing capabilities for F402-RR-402 VSTOL engine
- 1982 Completed altitude testing of the F404-GE-400 engine
- 1984 Major facility expansion was completed to provide dual SETA test cell operational capability
- New 3W test cell was commissioned utilizing the first digital control room at the Center
- 1985 Completed qualification testing of the alternate source F404 (PWA)
- 1985 Began qualification testing of the F110-GE-400 for the F-14D
- 1985 Completed testing of H-60 Transmission and Tail Rotor Couplings in Transmission Test Facility in the old 3W exhaust stack
- 1985 Completed first testing of the T56-A-427 utilizing the new low speed dyno simulating propeller load
- 1988 Qualification of the Hybrid F404 engine (parts from GE and Pratt)
- 1988 Completed Icing testing of the Allison T406 engine
- 1989 Completed qualification testing of the uprated Tomahawk F107-WR-402
- 1989 Completed 750 hour endurance test of the H-3 drive system
- 1989 Completed operational assessment of the Pioneer RPV
- 1989 Completed production verification of the Swedish F404/RM12
- 1989 Completed second source testing of the F107

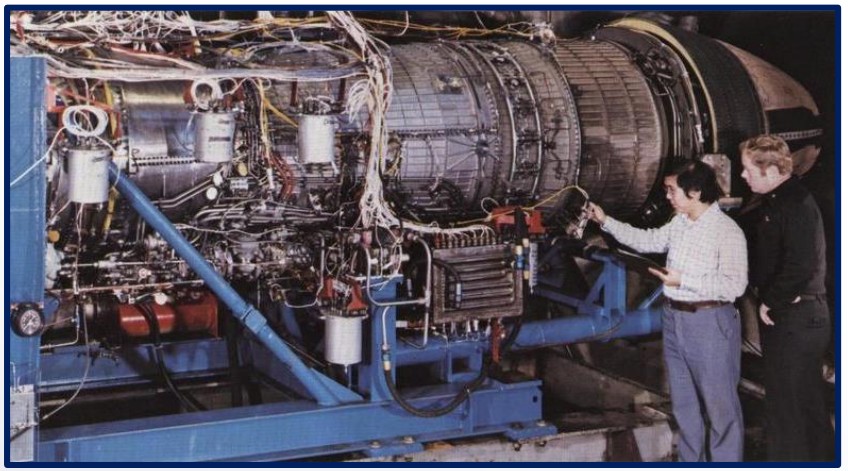




# Testing 1990 - Closure



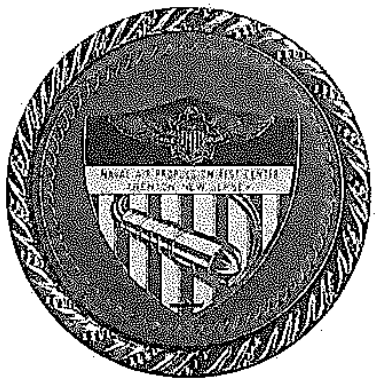
- 1990 Renovated the 3E test cell with new instrumentation and configured for the F412-GE-400, include multi axis thrust
- 1990 Added Harpoon engine testing capability to the Cruise Missile test cells
- 1991 Completed stall/overtemp testing of the TF-34-GE-400 engine
- 1991 Completed validation testing  of the Short Range UAV
- 1991 Completed altitude verification of the J52-PW-409 utilizing the Aircraft Tail Pipe and measured vectored thrust
- 40th Anniversary Celebration
- BRAC 91 and 93 set closure in motion, closure 1998.
- Last test completed in 1997



# Navy Propulsion at Trenton NJ

NATTS

*1 JULY 1951 - 1 JULY 1967*



NAPTC

*1 JULY 1967 - 1 OCTOBER 1977*

NAPC

*1 OCTOBER 1977 - 2 JANUARY 1992*


TRENTON

NAWCAD-TRN

*2 JANUARY 1992 - 15 OCTOBER 1998*

# Questions

# NAPC Review

- 67 Acres in West Trenton
- 11 test cells, large altitude (1E, 2E, 3E), four small altitude (3W-6W), two large SL test cells (1W, 2W), Helicopter Transmission Test Facility (8W)
- Sea Level Cells – Environmental Focus – liquid water, sand and dust, missile exhaust gas, salt spray, water vapor, icing Clouds to the inlet of the engine. Also can be direct connect to the test wing air supply for ram and temperature control.
- Helicopter Transmission Test Facility – provides realistic evaluation of total helicopter power drive system (excluding rotor and hub) under simulated flight loads.
- Additional test facilities – Rotor spin facility, fuels and lubricants test facilities, accessory test area (ATA), hot gas facility,
- RSF – 4 chambers, vacuum spin, LCF and Burst testing
- Fuels and Lubricants Test Facilities – Chemistry Lab, fuels/Lubes performance test, fuels handling
- Accessory Test Area – 5 test cells for sea level testing of air turbine starters, and starter accessory drives, starter control valves, Auxiliary power units
- Fuel system test facility – Fuel system component testing with conditioned/alternate fuel and effects of contamination
- High volume fuel system facility – Evaluation of aerial refueling nozzles and couplings, ground refueling devices and fuel tank components.
- Outdoor test site – turntable, Gyro and VATS
- IR Signature Assessment Facility – Mobile lab to conduct IR measurements and IR data processing facility
- 1991 became part of the Naval Air Warfare Center – Aircraft Division, Jan 1, 1992 became NAWCAD Trenton
- BRAC 93 announced closure, closure completed Dec 1998