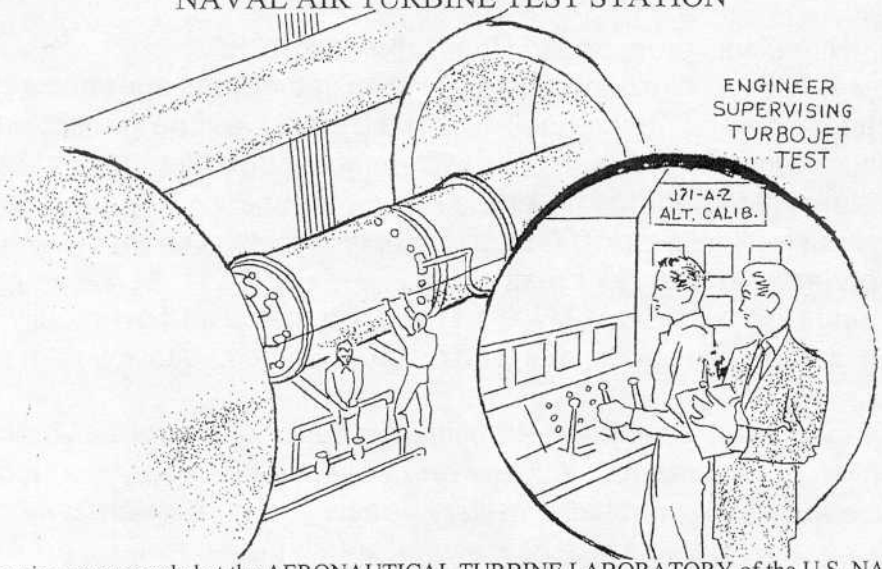
NAVAL AIR TURBINE TEST STATION



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

and beginning the work for which it was intended. Fortunately, the Navy, always a leader in supporting research and development, had a good in-house capability for airbreathing propulsion already in place at AEL to draw upon. In addition, senior engineers were recruited from the National Aeronautics and Space Administration (NASA) and the aerospace industry. By 1960, a strong capable organization, with significant experience in engine testing, was in place and "real work" had begun.

The following is a chronology of events that were significant in the history of the Center.

1956

- The first full scale engine testing began at the Center with a Westinghouse turbojet engine. Following that test program, NATTS expanded in capability to accommodate new technologies and provided qualification and problem-investigation testing for every aircraft engine in the Navy inventory.
- CAPT W. E. Kenna, USN, assumed command on 1 July.
- Former CO Dodson was promoted to Rear Admiral in late July.

1957

- Officers of the French Air Ministry visited NATTS for ideas relative to building a facility for the same purpose in France.
- P&W's J75 turbojet passed all its tests for speed and altitude, without afterburner, and was approved for use on the Navy's Martin P6B Seamaster, the Air Force's Republic F-105 and the Convair F-106 fighters.
- Contracts were awarded in December to Malan Construction Corp. and Dean Construction Co., Inc., of New York City, for the extension of the Blower Wing (Ram Blower #4) and a new altitude test chamber (3E); bid price was $5,140, 000.

1958

- CDR J. R. Wood, USN, relieved CDR C. L. Bardwell, USN, as Executive Officer in October.
- Ground breaking for construction of 3E and the blower Wing extension took place on 23 January.

NOTE: During the period from 1956 through 1958, test programs for the General Electric J79 series and several models of the Pratt & Whitney J57 engines were accomplished.

1959

- CAPT J. K. Leydon, USN, assumed command on 13 November.

1961

- CAPT N. O. Wittman, USN, assumed command in May.
- Testing of the Wright engine used in the FJ-3 and FJ-4 aircraft identified causes for fleet engine turbine failures at high altitude, and contractor changes eliminated the problem.
- Testing of the Allison J71 engine established that contractor changes had not corrected the problems with operation in heavy rainfall and icing environment, and additional testing led to modifications that corrected the problems.
- NATTS sponsored and held the first of 11 Annual National Environmental Conferences for Aircraft Propulsion Systems

- The Pratt & Whitney J52 engine was tested for application in the Douglas A-4E Skyhawk and the Grumman A-6 Intruder; testing of J79-GE-2 engine demonstrated successful fixes for anti-icing deficiencies identified in earlier testing (engine was used in F-4H Phantom and A-5J Vigilante carrier based aircraft).
- Initial studies were completed to determine costs and benefits of consolidating AEL, Philadelphia, with NATTS, Trenton. The study indicated that the costs would be too high.

1962

- Dr. J. S. di Rende assumed the position of Technical Director in June.

1963

- Lester G. Tilton passed away on 6 May.
- CAPT R. E. Sorensen, USN, assumed command on 27 June.

1964

- CAPT R. E. Sorensen passed away on 11 January from a heart attack.
- CAPT J. M. Richards, USN, assumed command on 12 March.
- A fire erupted in the insulation on the 3E test cell several hours after a high temperature test run, destroying most of the instrumentation and electrical wiring above the test chamber.
- Designed and constructed a wind tunnel for simulating the climb corridor for transport aircraft and utilized it to successfully achieve test objectives over a period of intensive testing of a Boeing 720B Commercial Transport aircraft power plant nacelle and JT-3D engine.

1965

- CAPT J. C. Snodgrass, Jr, USN, assumed command in April.
- CAPT J. S. Marrow, USN, assumed command on 31 August.
- The first Pratt & Whitney TF30 prototype engine was tested for possible use in the proposed TFX Air Superiority Fighter (the TF30 was the first turbofan fighter engine with an afterburner and it evolved into the TF30-P-3 for the Air Force F-111 Superiority Fighter — the TF30-P-408, without afterburner, became the power plant for the Navy A-7 Corsair II — and the TF30-P-412 became the power plant for the Grumman F-14A Tomcat fighter).
- All weather testing of the J52-P-6A (power plant for the A-4E Skyhawk and A-6A Intruder) was successfully completed, demonstrating acceptable operation of the engine in rainfall and icing environments.
- Testing of large gas turbine engines using the AEL developed synthetic lube oil MIL-L-23699 was successfully completed and the oil has been in continuous use in Navy engines since that time.

1966

- CDR R. E. Dimmitt, USN, relieved CDR J. M. Wolff, USN, as Executive Officer in June.

1967

- On 1 July, per Naval Aviation History chronology, the *"Naval Air Propulsion Test Center, with headquarters at Trenton, N.J., was established by merger of the Naval Air Turbine Station, Trenton, and the Aeronautical Engine Laboratory of NAEC Philadelphia."* The mission of the Naval Air Propulsion Test Center (NAPTC) was to test and evaluate aircraft propulsion systems, their components and accessories, and fuels and lubricants; and perform applied

research and development leading to correction of design deficiencies and service problems. NAPTC was organized into two departments, the Aeronautical Turbine Department (ATD) and the Aeronautical Engine Department (ATD).

NOTE: The following are synopses of the two merged organizations at that point in time:

***ATD** - The Aeronautical Turbine Department at Trenton had been testing aircraft gas turbine engines since 1954, and had facilities capable of supplying complete environmental simulation on experimental and production turbojet and turbofan engines. This included the ability to simulate air speed, altitude, temperature, humidity, water ingestion, icing, missile exhaust gas ingestion, and inlet pressure distortion. Fast response air flow control systems enabled engine transient operation throughout the entire flight regime.*

ATD facilities were located on a 66-acre tract of land adjacent to the Mercer County Airport, with the test area contained in three major groups of buildings: the ram air blower wing, the test wing, and the exhauster wing.

The blower wing could provide air flows up to 550 pounds per second, pressures up to two atmospheres, and air temperatures ranging from -65 to +650 degrees F.

The test wing housed six major test areas: three chambers capable of altitude simulation; two sea level cells; and a ten-foot diameter subsonic wind tunnel. To accommodate the largest engines, the entire supply of conditioned air could be directed to one cell. In other areas, the air could be supplied concurrently to more that one cell.

The exhauster wing contained 14 vacuum pumps capable of creating altitude cell pressures corresponding to 80,000 feet.

Engines currently under test were the General Electric J79 used in the McDonnell F-4 and the North American A-5 aircraft; the Pratt and Whitney TF30 used in the Ling-Temco-Vought A-7 and the General Dynamics F-111; the Pratt and Whitney J52 used in the Douglas A-4 and Grumman A-6; and the Continental J69 used in the Ryan BQM-34 target drone. The F-4, A-4, A-5, and A-6 were the Navy's first line aircraft in operation in Viet Nam.

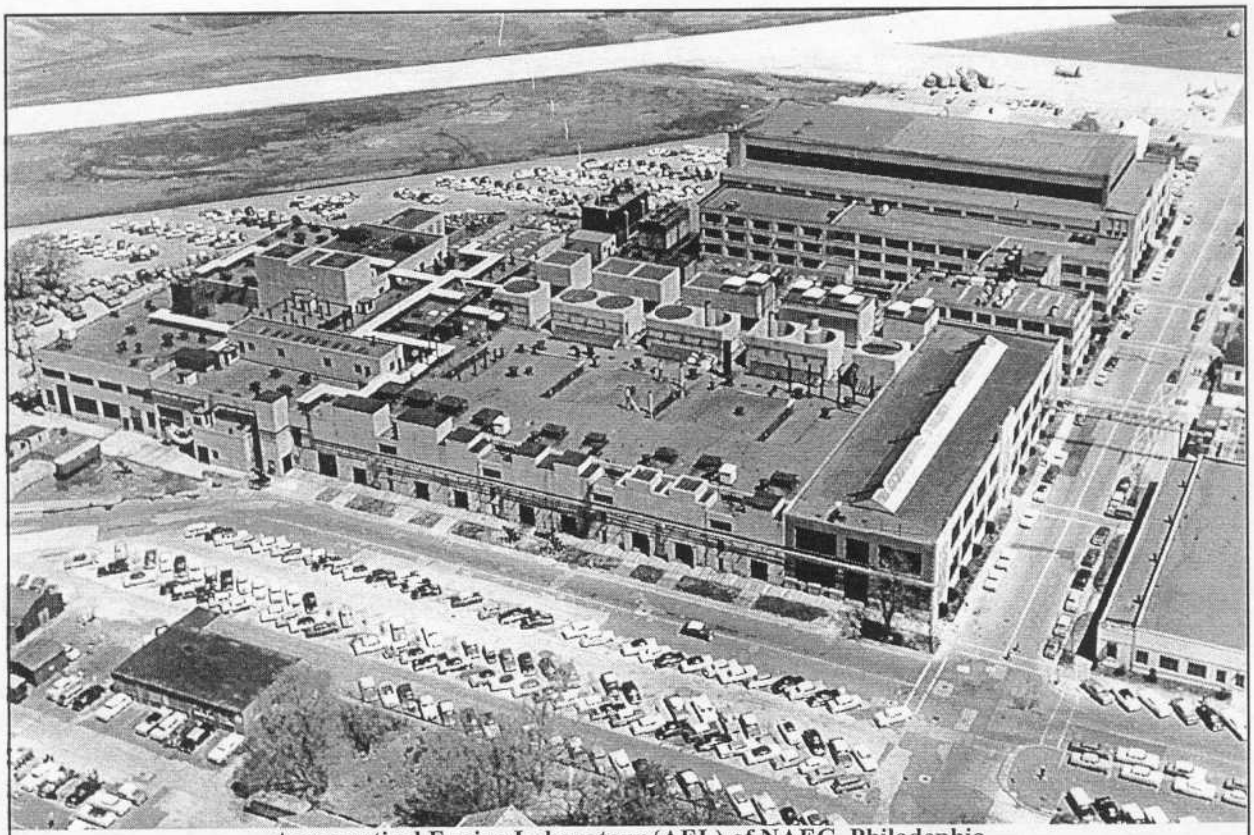
Development projects underway at that time at ATD included evaluation of variable area transpiration-cooled turbines and management of the Navy's field evaluation of an engine sonic analyzer. Another area of prime interest to industry and the military departments were ATD's studies and reports on state-of-the-art for compressors, turbines, infrared suppression, thrust augmentation systems, and engine monitoring instrumentation.

AED *- The Aeronautical Engine Department was a recognized authority in the fields of turboprop and small turboshaft engines, aircraft engine accessories, and fuels and lubricants. At that time. AED had gradually shifted from reciprocating engine work to turboshaft and turbo prop engine work until small turbine engines and their associated projects comprised about 95 percent of the Department's efforts.*

AED had 62 test areas housed in 250,000 sq. ft. of laboratory space. Some of the department's unique testing facilities were used to evaluate engine accessories, lubricating oils, special lubricants, auxiliary power units, fuel controls, in-flight refueling nozzles, fuel filters, and detectors for fuel contaminated with solids or water.

Other unique facilities that evolved to handle AED's needs were: a variable attitude engine test stand intended for use in VTOL engine testing; a variable attitude test stand with temperature simulation to 350 degrees F for evaluating engine starters; an accessory test area capable of altitude simulation and with a temperature range of -67 to +200 degrees F; a fuel control test area with temperature capabilities up to 410 degrees F; two spin pits to study turbine disc burst phenomena; a Foreign Object Damage (FOD) rig to test FOD separators without hazarding an engine to possible damage; a site for measuring engine sound profiles; and a rig to simulate atmospheric icing conditions encountered in flight so anti-icing characteristics of shaft engines could be determined.

Research and development was also carried out in problem areas common to most engines where performance improvement was desired, such as noise, combustion, corro-



Aeronautical Engine Laboratory (AEL) of NAEC, Philadephia

sion, and smoke.

To enable the project engineer to monitor testing programs, a real time data system was used. This system took a reading on all the engine instrumentation instantaneously and upon request of the project engineer. In 75 seconds, a typeout and plots of these readings were available to the project engineer.

- AEL retained its full capability, including testing of small gas turbine engines, auxiliary power units, engine starters, propellers, gearboxes and transmissions, and a major RDT&E effort in Fuels and Lubricants, while the extensive effort of relocating the AEL facilities to the Trenton site was accomplished. This major effort was planned and carried out by the combined expertise of NATTS and AEL "in-house" personnel with outstanding quality at minimum cost and no impact to the test workload, and when the final physical consolidation was completed in 1975, the facilities at Trenton were far superior to those in Philadelphia. The Navy accomplished its goal to consolidate the aeronautical propulsion test and evaluation facilities at one site, the Naval Air Propulsion Test Center (NAPTC). With the merger, a unique capability was established, improving administrative, operational and technical response to assigned tasks and reducing the cost of operation.

1968

- CAPT R. V. Hayes, USN, assumed command on 17 July.
- Operational testing of a J79-GE-10 engine solved a compressor stall flameout problem that was occurring in the F-4 Phantom, and three of the fixes evaluated were incorporated in all the engines.
- Designed Missile Exhaust Gas Ingestion rig to simulate missile firing and performed the first analytical testing in an altitude test cell to define engine inlet transients due to aircraft missile firing.
- Established gas turbine engine exhaust emission standards for Navy aircraft and developed the equipment and methodology for measuring the emissions.
- Participated with Navy Laboratories in the first Navy Technological Forecast covering current and future propulsion systems and related technology effort.
- Initiated testing to demonstrate a methodology for defining gas turbine engine sensitivity to sea salt atmosphere and the resulting corrosion problems that plague fleet operation.

1969

- Performed anti-icing tests on a TF41 engine for the Navy A-7E aircraft to demonstrate the reduced sensitivity to engine ice buildup. This was the first Navy turbofan without inlet guide vanes and used a rotating fan spinner in lieu of a stationary inlet bullet nose.

1970

- Executive Officer CDR R. E. Dimmitt, USN, separated from the Navy in June.
- Initial base engine Infrared Signature testing was successfully completed at an outdoor test site for turboprop/turboshaft engines to provide data for design of infrared suppression systems.
- A Research and Technology office is established at the Center to integrate and expand exploratory and advanced development engineering efforts.
- Completed initial engineering development testing on the YTF30-P-412 to qualify the en-

gine for use in the F-14A.
- As part of the AEL/NATTS consolidation, the 3W turboprop cell was gutted and the first altitude test cell in the new Small Engine Test Area (SETA) became operational.

1971
- CAPT A. D. Williams, USN, assumed command and CDR J. H. Cover, USN, reported on board as Executive Officer in May.
- Full scale testing of the YTF34-GE-2, a high bypass ratio turbofan engine, began in May. This engine program progressed successfully through all the development and qualification testing and was accepted by the Naval Air Systems Command for production go-ahead in August 1972 for use in the Lockheed S-3A carrier based anti-submarine aircraft.
- A major program to develop the Pratt & Whitney F401 engine to replace the interim TF30-P-412 in the Grumman F-14B was initiated. This development program was terminated in 1973 and emphasis was placed back on the TF30-P-412 program.
- A major increase in scientific digital computer capability was activated, permitting dual test cell real time testing.

1972
- Reorganization of NAPTC was initiated to integrate the former AEL and ATL Engineering and Operations functions. A new Operations and Plant Engineering Department (OPED), Measurements and Information Systems Department (MISD), and Project Engineering Department (PED) were formed.
- As a result of the physical consolidation of AEL facilities to Trenton, initial test capability for turboprop and turboshaft engines was established. Testing effort was resumed for six engines already in operational use by the Navy and the U.S. Army to demonstrate acceptability of engineering changes for the improvement of performance and air starting capabilities. At least half of the testing was for Army applications.

1973
- CDR J. A. Miller, USN, reported on board as Executive Officer.
- Using a TF30-P-408 engine as a test vehicle, Center engineers demonstrated an "in-house" developed digital computer based Diagnostics System for monitoring engine mechanical performance, oil system parameters, and hot section faults.
- A six year program was initiated for evaluation of methods to produce synthetic JP-5 from coal.
- High severity mission endurance testing was initiated with a new production J52-P-408 engine as the beginning of Simulated Mission Endurance Testing (SMET) for new Navy engines to identify premature failure modes prior to significant fleet usage.

1974
- CAPT W. C. Bentley, USN, assumed command in June.
- As part of an Advanced Development program, a procurement was initiated for a Full Authority Digital Electronic Control (FADEC) for applications to future Navy engines.
- An altitude performance program was successfully completed for the Swedish RM-8B augmented turbofan engine for the JA-37 Viggen fighter aircraft.

1975

- Physical consolidation of AEL facilities and functions into NAPTC was completed.
- A major Joint Navy/Air Force Technology Demonstrator Engine (JTDE) program was initiated under Advanced Development funding to provide suitable test vehicles for advanced technology engine components under development.
- Preparation was initiated for testing the turbofan sustainer engines for Sea Launched Cruise Missile (SLCM) application. This effort evolved into a major program for technical and testing support to the Navy Tomahawk Missile System and the Air Force Air Launched Cruise Missile (ALCM). The engines were variants of the William's Research F107 turbofan engine, and testing and support was projected into the 1990's (and it happened).

1976

- CDR E. G. Himes, USN, reported on board as Executive Officer in March.
- A fire of undetermined origin slightly damaged the redwood cooling tower.
- A thrust vectoring propulsion nozzle developed by GE under a Center managed contract was successfully demonstrated by full scale testing on an augmented YJ101 engine.
- An Executive Review Group, staffed in part by Center personnel, was convened to review problems with the operational use of the TF30-P-412A engine in the F-14A aircraft. This was one of many such groups that was supported by Center technical expertise, demonstrating the Center's expanded role in the propulsion arena.

The NAPC sign that was installed in front of Bldg. 1. At the Base is a replica of the Meritorious Unit Commendation Medal awarded to NAPC in 1981

1977

- CDR R. L. Stoddart, USN, reported on board as Executive Officer in March.
- In October, the Center name was changed to Naval Air Propulsion Center (NAPC) to reflect an expanded role in the development and support to Navy Propulsion Systems, namely, "to provide complete technical and engineering support for air breathing propulsion systems, components, accessories, fuels and lubricants."

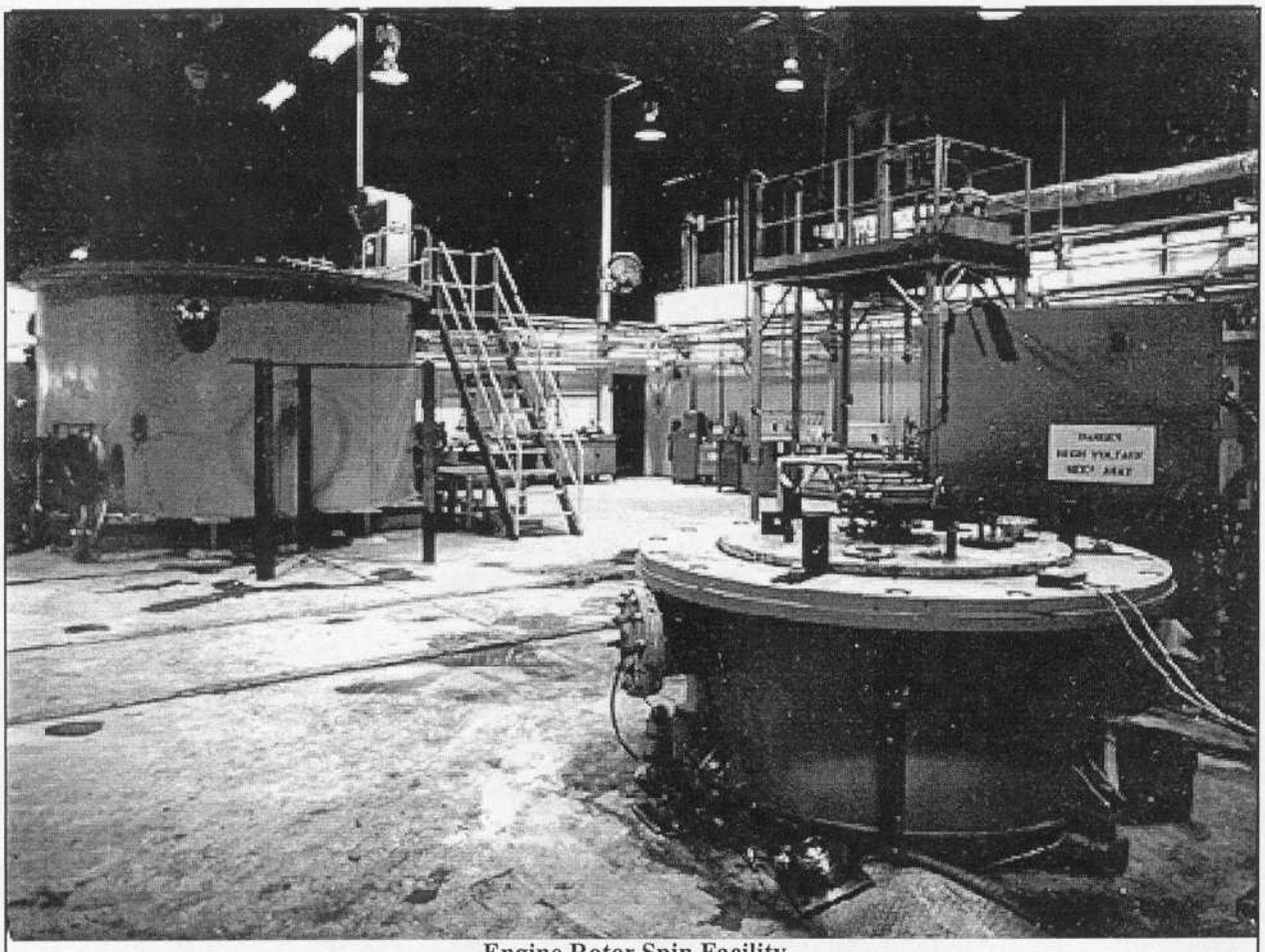
1978

- CAPT B. T. Alligood, Jr., USN, assumed command on 7 July.

1979

- Continued development of synthetic JP-5 fuel from oil shale with full scale engine testing and laboratory testing and analysis.
- The Pratt & Whitney FADEC, developed under a contract with the Center, was successfully tested on an advanced technology engine in August.

- Successfully completed F404-GE-400 engine altitude and qualification tests on schedule. GE commended the Center for its outstanding support of this major Navy program in several letters of appreciation.
- Completed tests on several models of the F107 Cruise Missile Engine prior to engine qualification testing. The engine contractor, Williams Research Corporation, expressed appreciation for the excellent support and assistance during the development of the engines for use in Boeing and General Dynamics Cruise Missile Systems.
- The Center was tasked by the Joint Cruise Missiles Project Office to make provisions for an independent, dual test cell capability in the Small Engine Test Area (SETA) to support long-term testing of expendable gas turbine engines.



Engine Rotor Spin Facility

NOTE: During the 1970's and 1980's, the Center improved its testing capabilities by adding facilities at Trenton and the Naval Air Engineering Center (NAEC), Lakehurst. Two significant improvements were expansion to the rotor spin facilities that were relocated from AEL, Philadelphia, and construction of an Outdoor Test Site (OTS) at Lakehurst.

Improvements and additional capability were added to the Rotor Spin Facility (RSF) at

Trenton. This facility is used to verify engine component lives, certify turbine blade containment hardware and evaluate new materials and designs. Both large and small-scale rotor

Outdoor Test Site

disks and accessories can be spun at speeds up to 100,000 rpm. The spin chambers are built to withstand the ballistic forces generated by bursting test articles and the resulting fragments. A high-speed photographic systems records test events and provides detailed pictures for in-depth analysis.

OTS was constructed on a 21-acre site at NAEC, Lakehurst. The facility provides open-air testing of jet engines and associated hardware, and includes a Gyroscopic Moment Test Facility (Gyro Test Stand), a Variable Attitude Test Stand (VATS), and a Multi-Purpose (rotatable) Test Stand (Turntable Stand).

The Gyro Test Stand is used to induce loading on the structural members of an operating engine that are similar to those it sees in high "G" maneuvers. The loading is induced by rotating the operating engine at up to 3.6 radians/second (34 rpm) about the "yaw' axis. Engines with thrust levels up to 50,000 pounds can be tested on this stand.

The VATS, designed and built for the V-22 tilt-rotor aircraft, can also simulate aircraft maneuvers on an operating engine. This unique test apparatus can subject a full-scale,

operating engine, gearbox and rotor system (up to 22 feet) to a wide variety of pitch and roll attitudes to evaluate maneuvering effects on bearing and lubrication systems. Pitch capability ranges from 60 degrees nose down to 115 degrees nose up. Roll ranges from zero degrees to 50 degrees clockwise or counter-clockwise.

The Turntable Stand can be rotated from zero to 200 degrees making it ideally suited for measurement of engine noise levels, infrared radiation signatures and exhaust smoke or emissions. Highly accurate measurements of engine sea-level performance can also be accomplished using this test stand due to the absence of test cell effects.

1980

- CDR D. G. Parry, USN, reported on board as the Executive Office in June.
- Completed initial tests on two of four engines developed under the JTDE program. The testing demonstrated the advanced technology engine concepts.
- Completed qualification testing of the F107 Cruise Missile Engines for the Navy Tomahawk and Air Force ALCM applications.

1981

- CAPT E. J. Sturm, USN, assumed command in June.
- Center received a Meritorious Unit Commendation from the Secretary of the Navy for meritorious service from 1 October 1979 to 1 April 1981. The commendation stated that during this period, "the personnel of Naval Air Propulsion achieved myriad significant developments associated with air breathing propulsion systems which advanced to capability of naval and other armed services aviation, and greatly enhanced the posture of the national defense."
- Successfully completed testing of the GE F101 Demonstration Flight Engine throughout its operating envelop. The engine was delivered to Grumman on schedule for follow-on flight tests in the F-14B Super Tomcat. Center personnel involved in the program were recognized for their outstanding support.
- Facility modifications were completed to provide the Center with vertical and horizontal thrust vector measuring capability required to fully test the F402-RR-402 V/STOL engine. No other facility outside of England had that capability.
- Completed 9000 hours of testing on two contractor furnished FADEC units.
- Completed program for evaluation of creating synthetic JP-5 from oil shale crude stock.
- Initiated testing of a Center developed corrosion inhibiting MIL-L-23699 transmission oil.

1982

- Completed altitude testing of the F404-GE-400 engine.
- Tested the uprated F107 engine for cruise missiles during various phases of its development.
- Reviewed and analyzed an E-2 aircraft engine bog-down problem and identified inadequate surge margin as the cause of the problem.
- Testing revealed the cause of failures with an aerial refueling type MA-2 coupling and a design change was recommended to the vendor, resulting in minimal impact on the delivery schedule.

1983-84

- CDR R. S. Bondi, USN, relieved CDR D. G. Parry as Executive Officer in June 1983.