Altitude Wind Tunnel (AWT)

HISTORY

Anne Power

NASA Glenn Research Center has been at the forefront of jet and rocket engine studies in general, particularly under altitude conditions. The Altitude Wind Tunnel and the Propulsions Systems Laboratory were primary components of the center's research. The ability to test full-size engines instead of just a single cylinder, as was previously done, resulted in a more rapid transition from design to flight testing.

The Altitude Wind Tunnel, which first began operation in 1944, was the first wind tunnel in the country capable of testing full-scale engines under simulated altitude conditions. The facility was converted from a wind tunnel to a vacuum chamber in 1962 and was renamed the Space Power Chamber. The new Space Power Chamber was utilized through the early 1970s for Centaur system testing and separation tests.

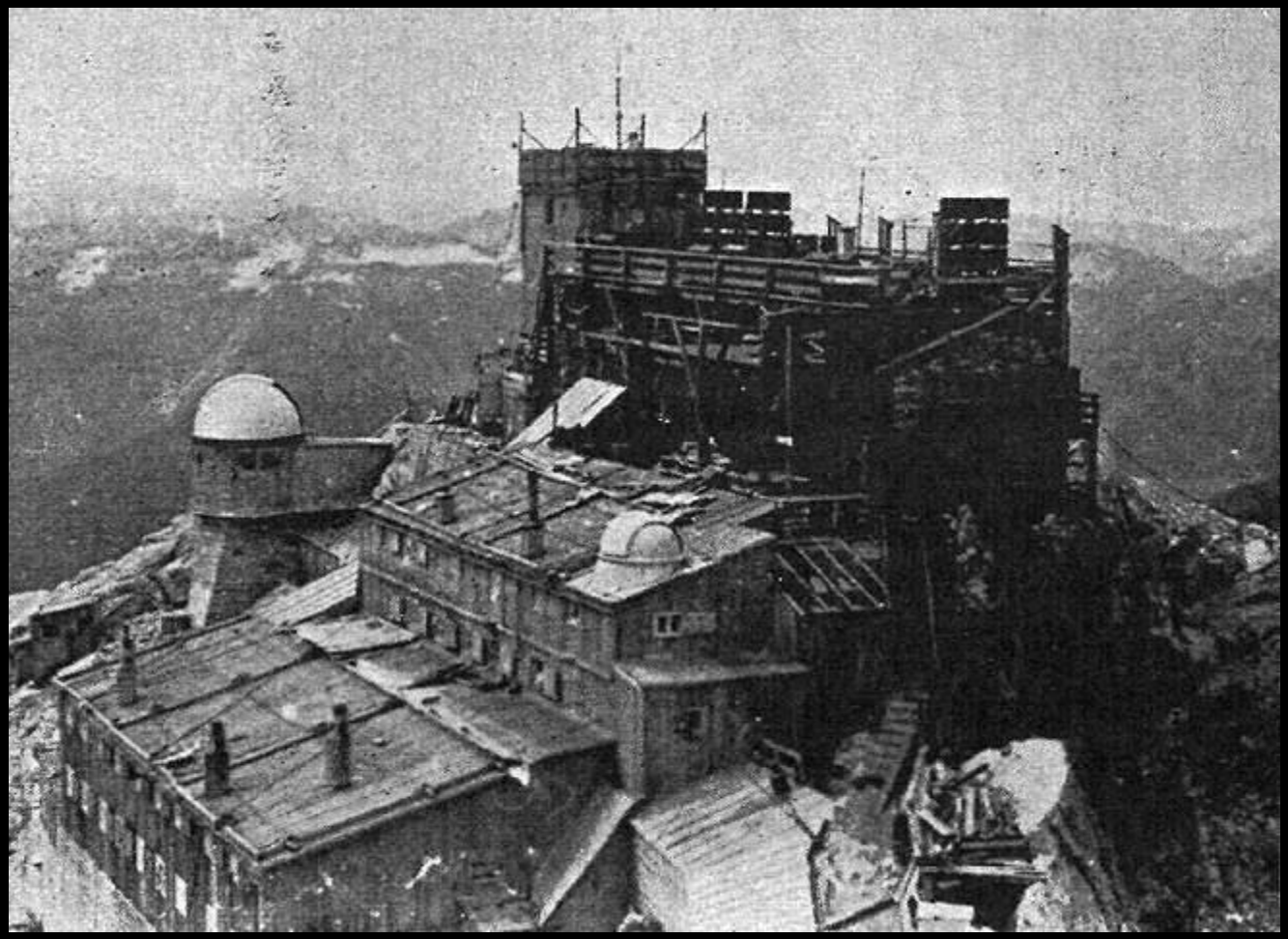
Altitude Wind Tunnel

Space Power Chamber (SPC)

AERL & AWT Construction

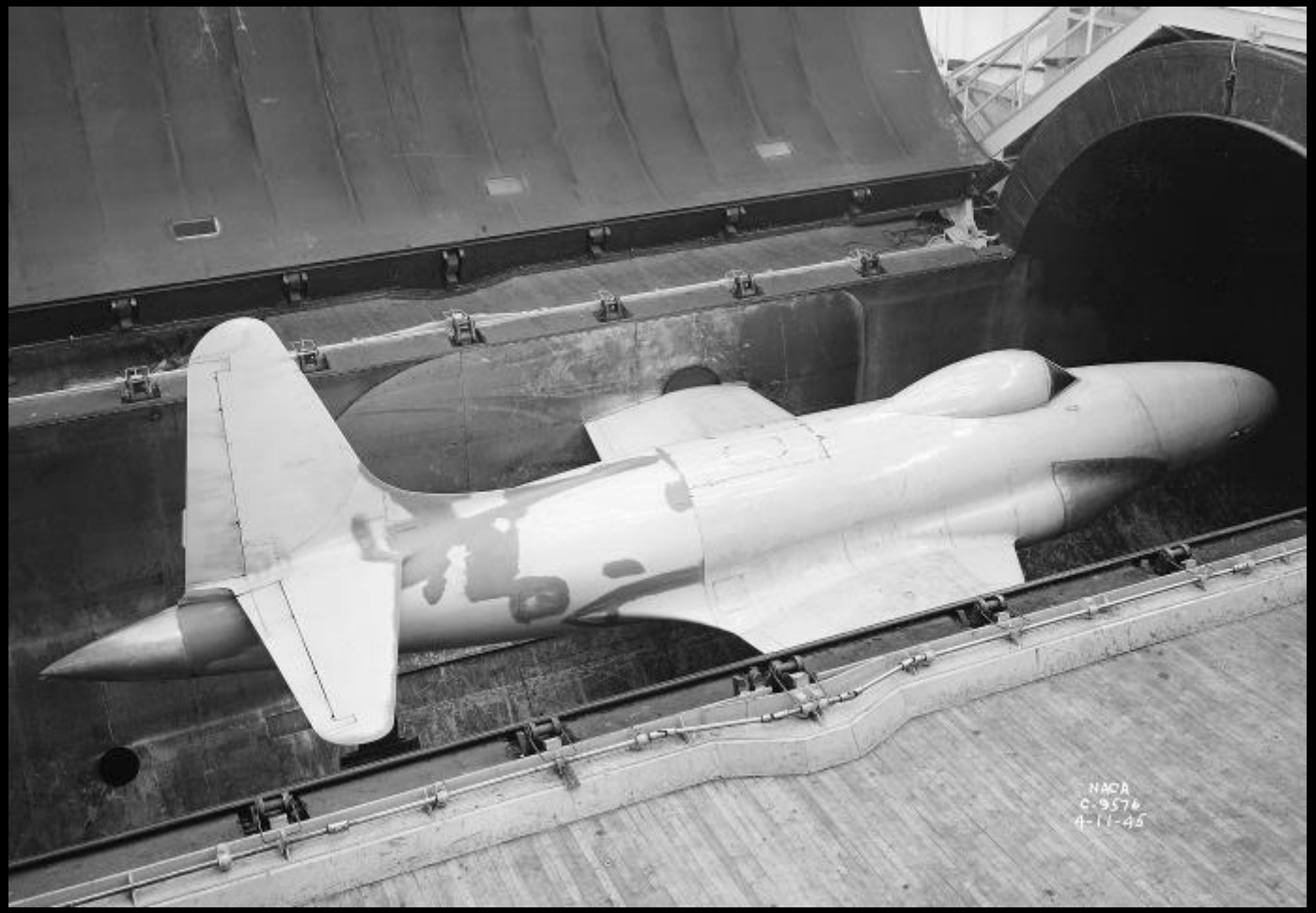
After the Wright Brothers' 1903 flight, American aeronautical research was quickly superseded by the Germans and British. As a result the US began the National Advisory Committee for Aeronautics in 1915 to perform general aeronautical research for the American aviation industry. The Europeans continued to dominate the field, though. In 1939, with another world war eminent, the NACA sought to create two new laboratories, one specifically to study aircraft engines.

This new Aircraft Engine Research Facility was located in Cleveland, Ohio and is now the NASA Glenn Research Facility. The centerpiece for the new engine lab would be the Altitude Wind Tunnel [AWT]. The new facility was the nation's first wind tunnel capable of testing full-scale engines in simulated altitudes. Engine power, speed, drag, vibration, and cooling could all be analyzed in altitude conditions. The massive exhauster system and refrigeration system could simulate altitudes up 50,000 feet and produce speeds of 500mph. The tunnel's support buildings and systems were also used to operate another Glenn facility, the Icing Research Tunnel.

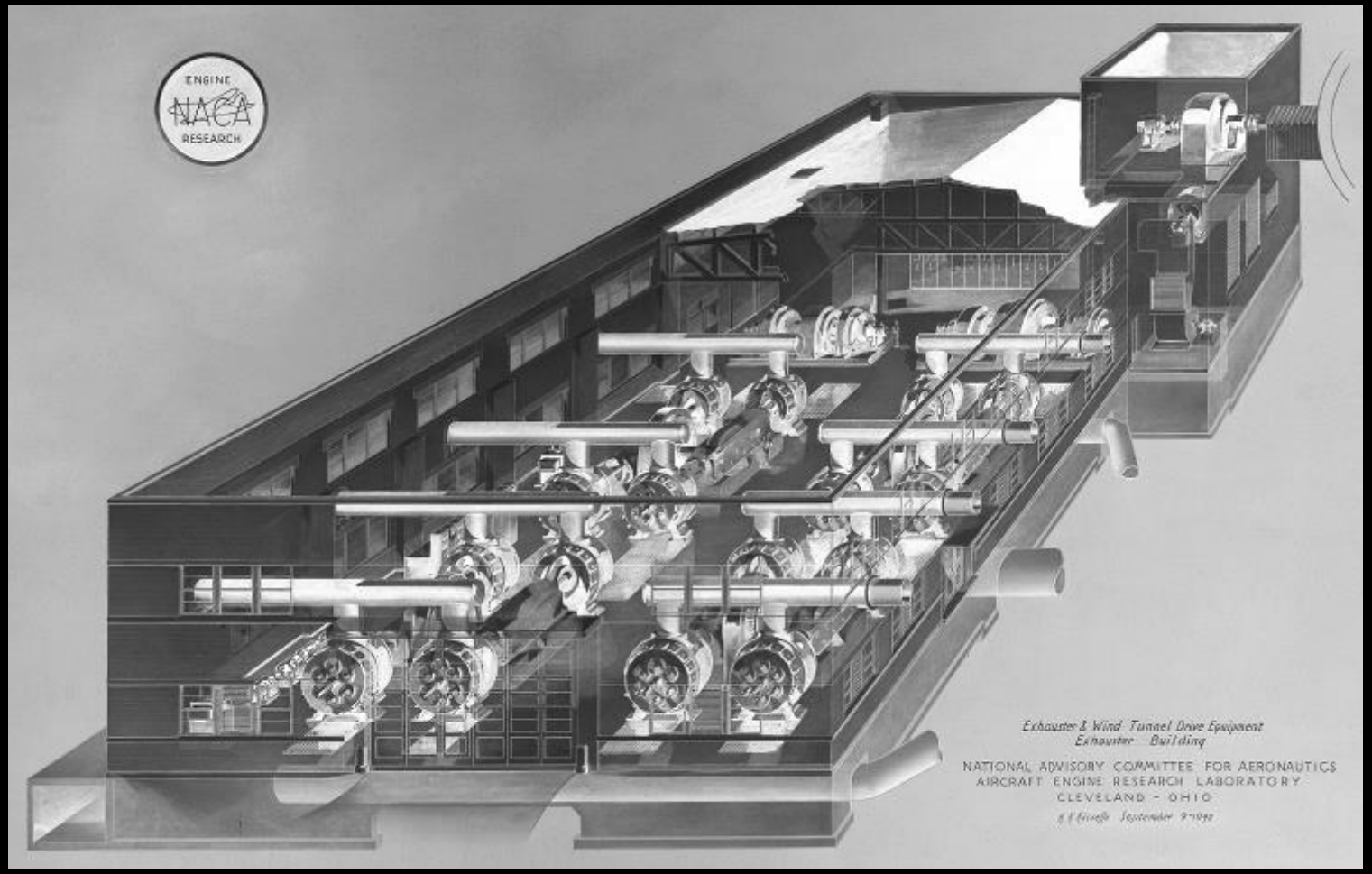


High-Frequency Research Station in Germany

Aircraft Engine Research Laboratory construction



AWT test section



AWT exhausters and drive motor

AERL & AWT Construction

In the rush to assist in the war effort, construction of the AERL was completed ahead of schedule, but at twice the original cost. The design of the massive Altitude Wind Tunnel was a tremendous engineering challenge. It was announced early in the process that the building of the AWT would require more engineering man-hours than the Boulder Dam. Design of the tunnel began in early 1941, its foundations were installed the following spring, and the first test was on February 4, 1944.

Interior of AWT during construction

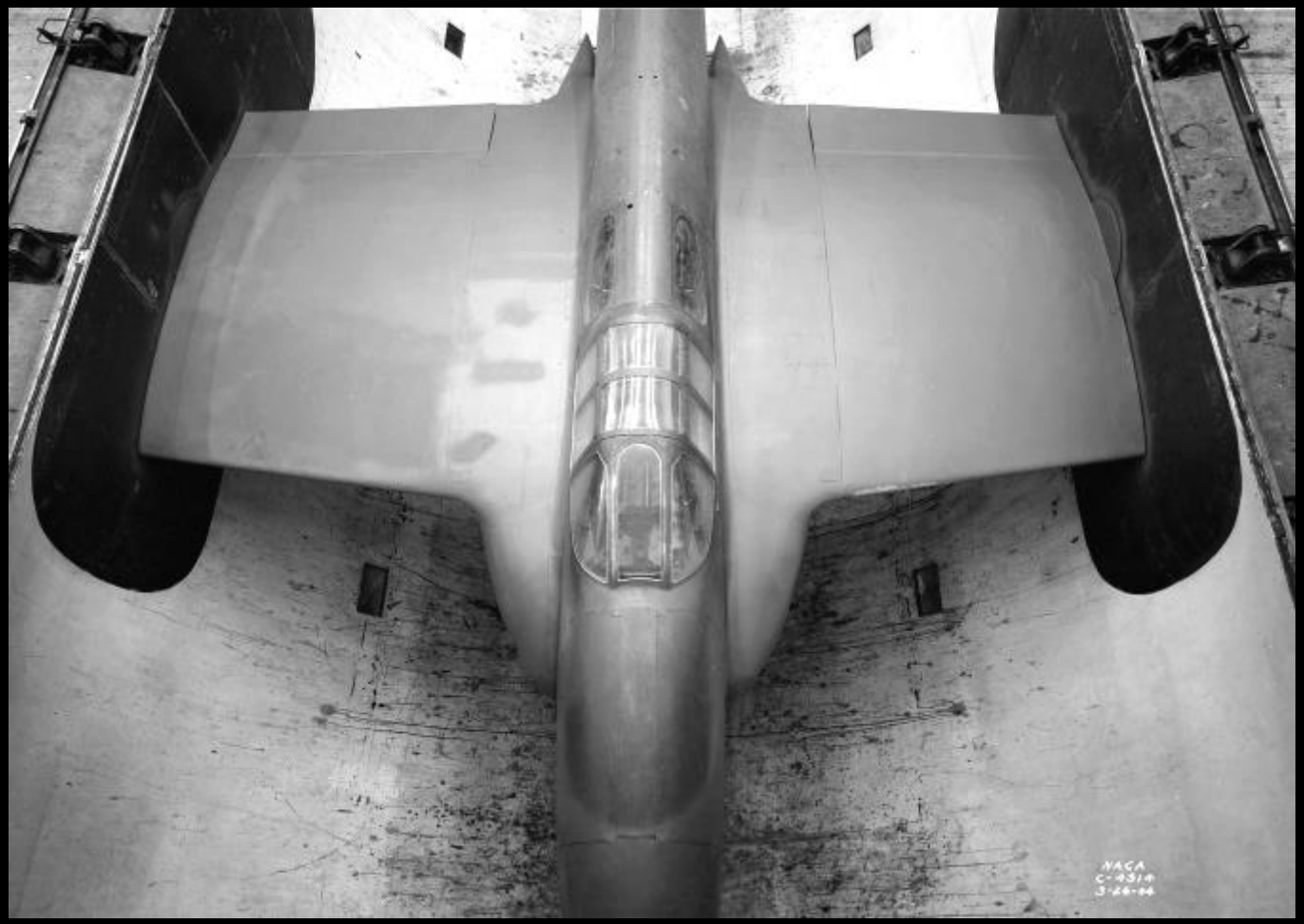
Exterior of AWT

AWT turning vanes

Wartime Research

Almost all of the NACA's research during the war concentrated on improving existing military aircraft. A notable exception was the Altitude Wind Tunnel's very first test, the Bell YP-59A Airacomet. The Airacomet was powered by the GE I-16, which was the first turbojet engine in the United States. The I-16 was based on a Whittle jet engine, which was secretly brought from Britain to the United States in 1941. Despite the enhancements made in the Altitude Wind Tunnel, the Airacomet remained too problematic and inefficient to be used for World War II combat.

Much of the center's efforts during the war were concentrated on solving cooling problems for the new Boeing B-29 bomber's Wright R-3350 engines. The aircraft had been rushed through production for the war, but the R-3350s often burned up or failed at higher altitudes. The engines underwent a series of investigations over the course of six months in 1944. NACA researchers were able to resolve the cooling problem and increase fuel efficiency by 18%. These improvements were not integrated into the engine design until after the war. US Strategic Bombing Commander, Curtis LeMay, opted to forsake the high-altitude precision bombing for low-altitude incendiary bombing which caused more casualties but would not strain the B-29's engines.



Bell YP–59A Airacomet—first jet engine in the United States

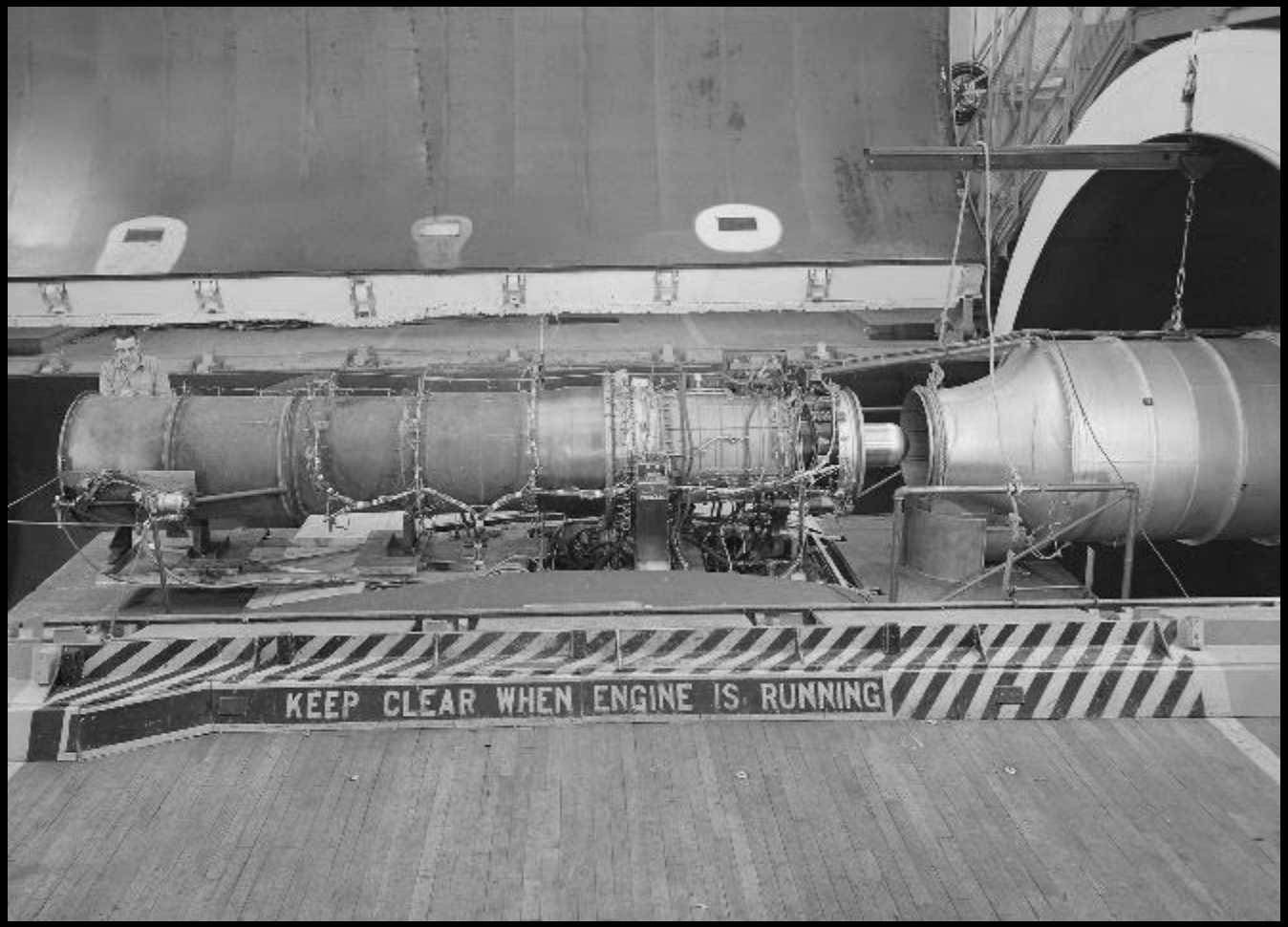
B29’s Wright R–3350 engine in AWT

B29 on the hangar apron

Early turbojets

Following the war, the NACA was finally able to delve into new research, particularly with turbojet and ramjet engines. Turbojet studies actually began in late 1944 with studies on the Westinghouse 19B and 19XB engines, the GE TG-180 engine and afterburner, and the Lockheed YP-80A Shooting Star, which was the first jet aircraft entirely manufactured in the United States. Air distribution, windmilling, and basic operating problems with the Shooting Star's GE I-40 engine were improved. The YP-80A evolved into the F-80 and was used extensively in the Korean War.

The Altitude Wind Tunnel underwent several upgrades in the late 1940s and early 1950s to increase the tunnel's speed and altitude capabilities. This included reducing the size of the test section. Originally entire fuselages could be inserted, but even with the smaller size test section, entire engines and nacelles could be used. Testing continued on ramjets, turbojets, and the jet-powered turboprops.

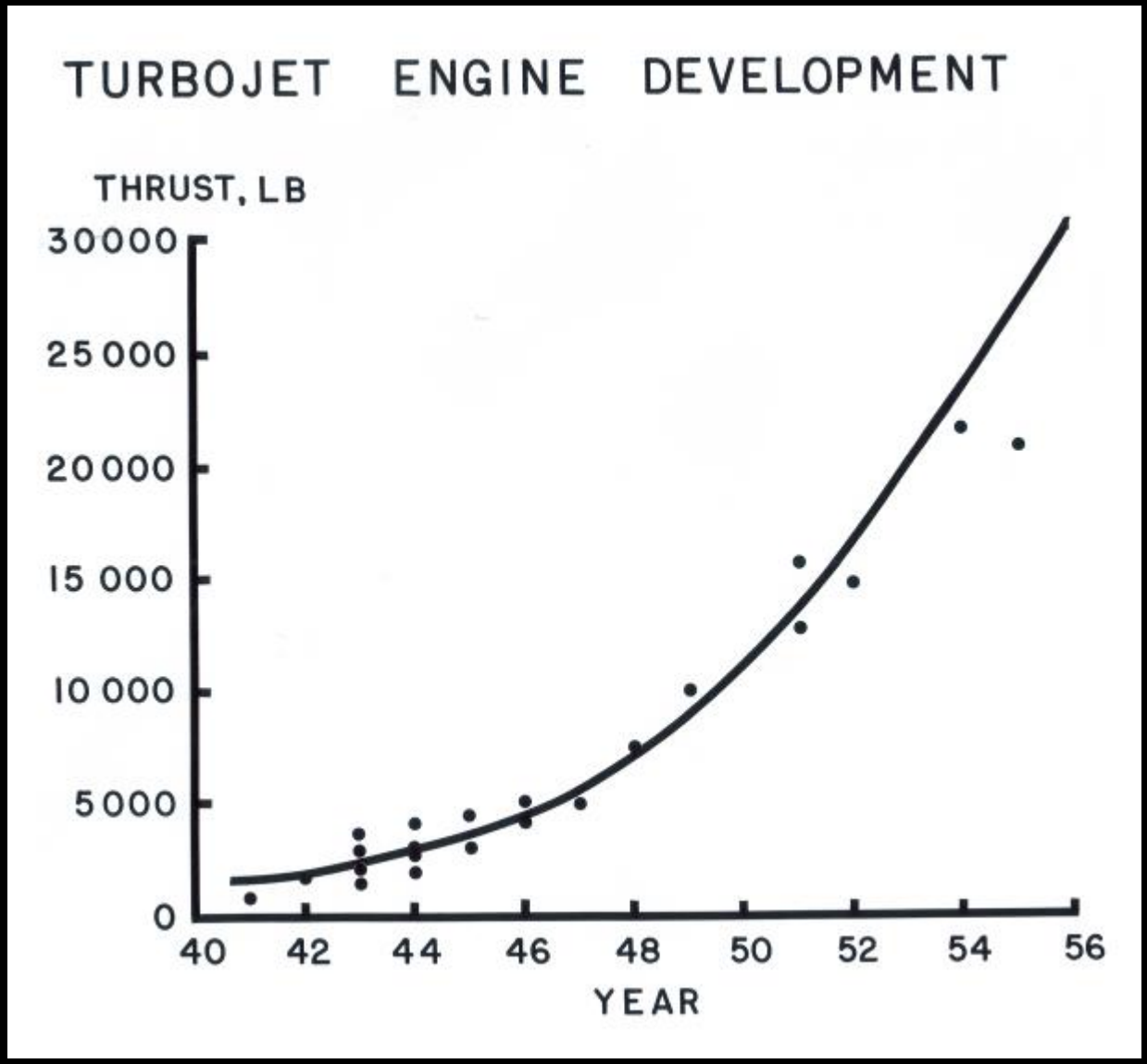


Westinghouse 24C turbojet engine

Lockheed YP–80A Shooting Star—first U.S.-built jet engine


ALTITUDE WIND
RAM-JET
NACA
RAM-JET
ENGINE
MODEL
TURBO-PROPELLER

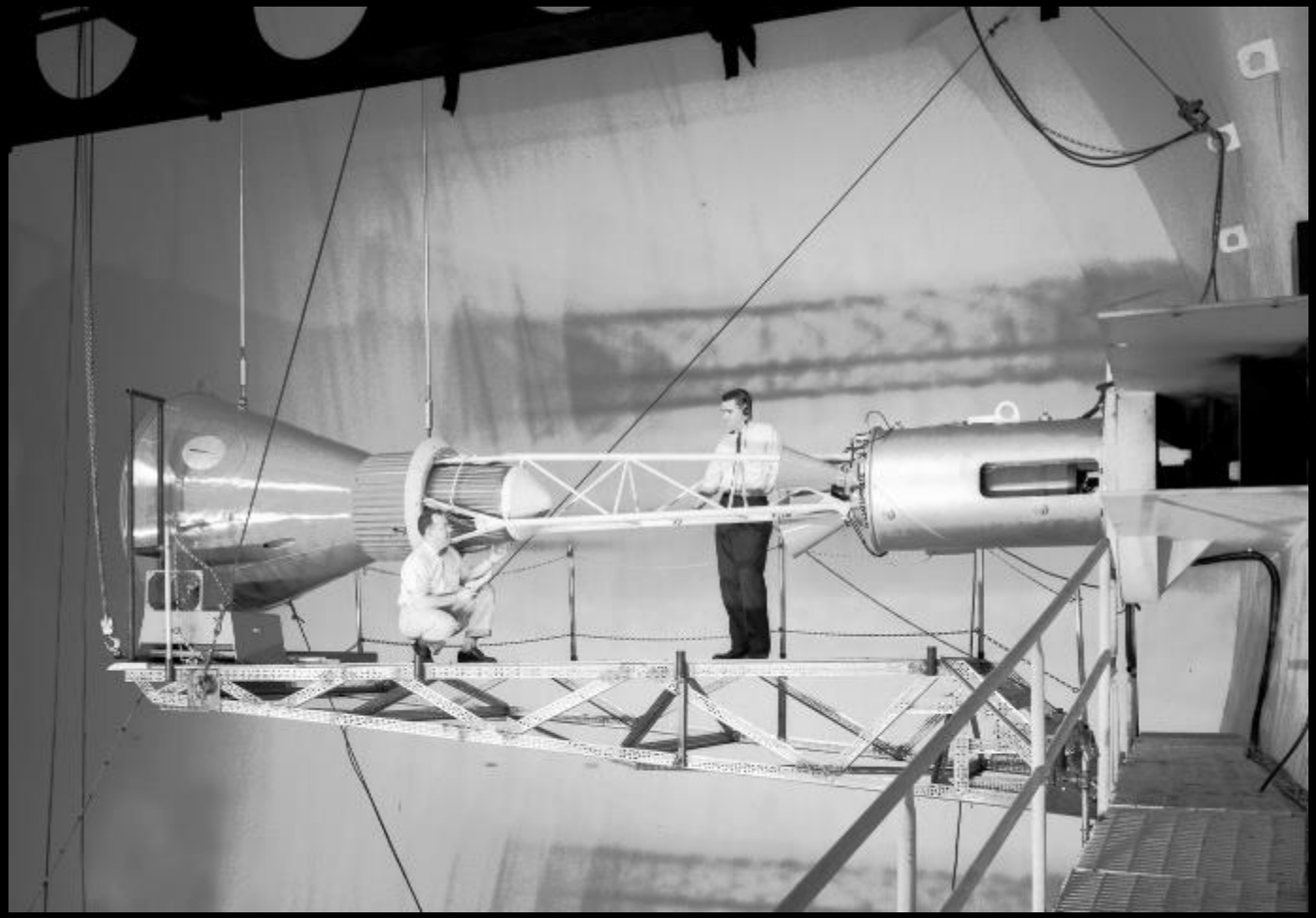
J–65 jet engine in AWT


TURBOJET ENGINE DEVELOPMENT
THRUST, LB
30000
25 000
20 000
15 000
10 000
5000
0
40
42
44
46
48
50
52
54
56
YEAR

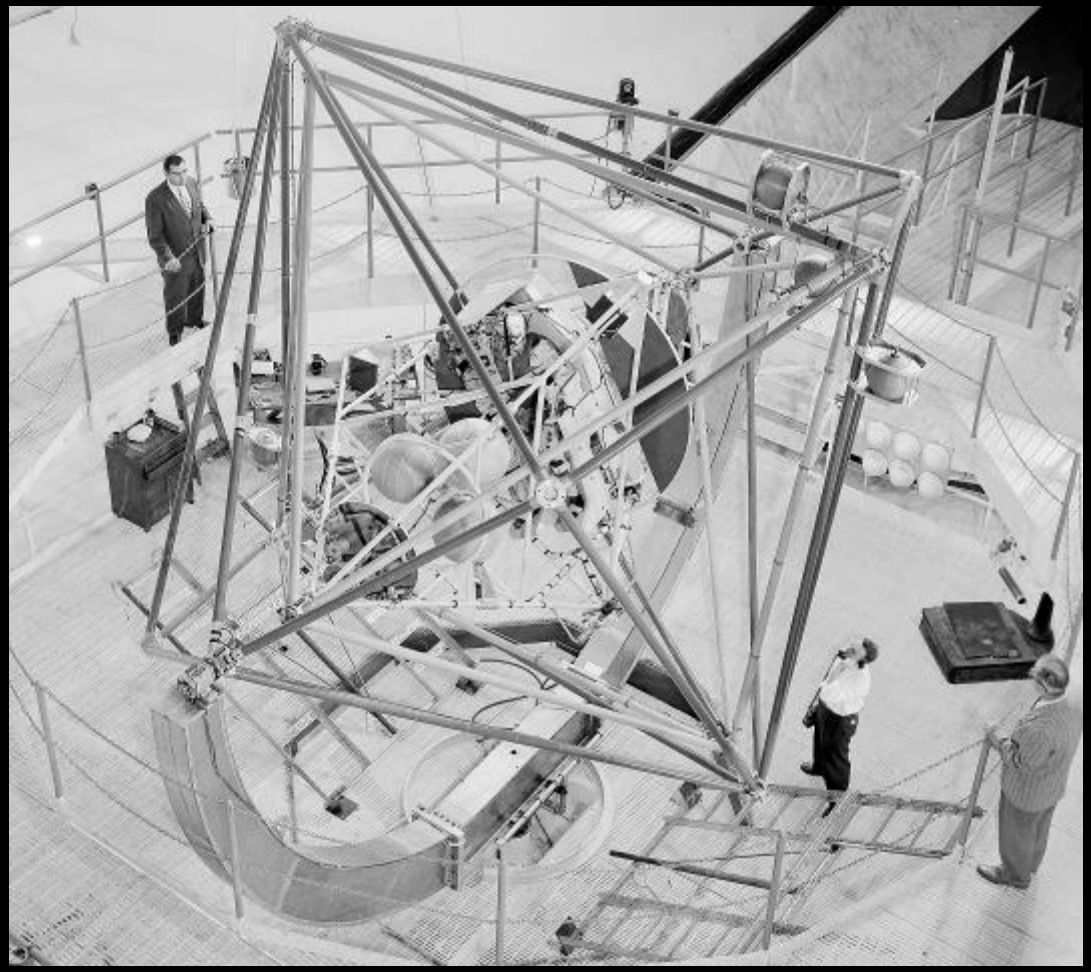
Mercury Program

By the late 1950s, though, other more advanced facilities, including the new Propulsion Systems Laboratory, were relied on for more and more engine testing. As the space program emerged and the center became part of NASA, the facility began to be utilized for its cavernous space rather than its wind tunnel capabilities. Escape rocket tests for the Mercury capsule were performed inside the wide section of the tunnel. In 1959, the original astronaut corps traveled to Cleveland to be test their ability to bring a tumbling Mercury capsule under control in the Multi-Axis Spin-Test Inertia Facility Trainer apparatus which was also installed inside the Altitude Wind Tunnel.

Vast interior of AWT



Mercury capsule in AWT for escape rocket jettison test



Mercury astronaut in the MASTIF

Space Power Chamber

Between 1958 and 1960, the lab refocused its efforts almost completely towards the space program. Although the AWT had already played a prominent role with the Mercury Program, its continued use was in question. Unwilling to let this historically significant facility fall into obsolescence, NASA Lewis administrators decided to convert the tunnel into vacuum chamber.

During this conversion process, two massive bulkheads were installed inside the tunnel, creating two vacuum chambers. It also included rewelding the tunnel's joints, installing a new vacuum pump house, and creating a dome that could be removed to insert test equipment. On September 12, 1962 the Altitude Wind Tunnel was officially renamed the Space Power Chamber or SPC.

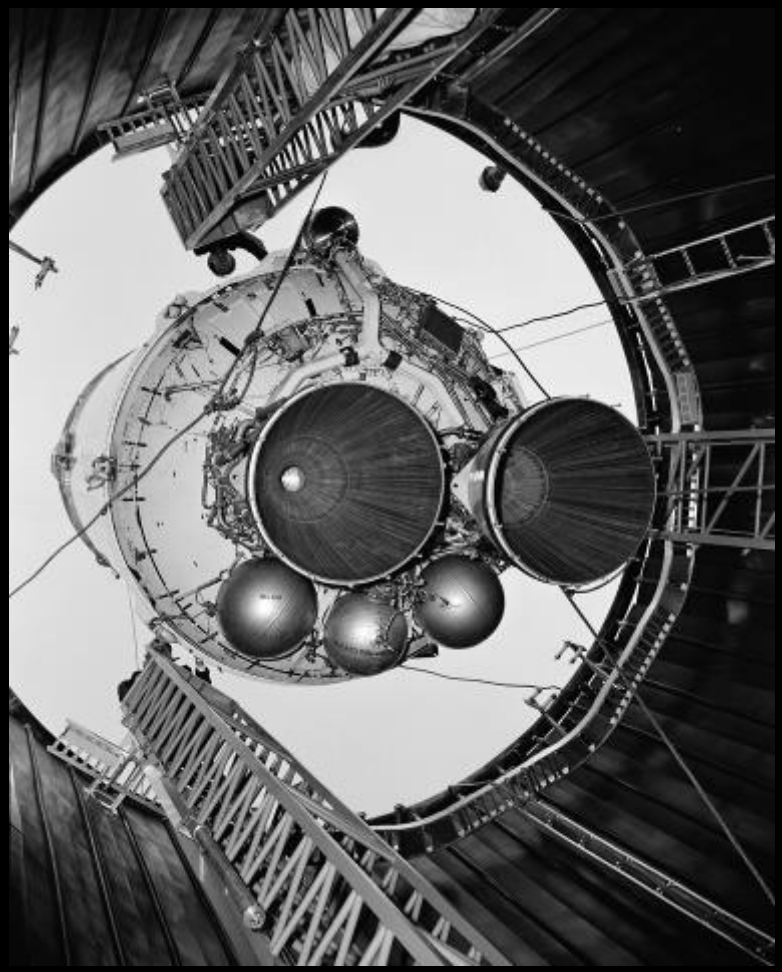
Conversion of AWT to SPC

Bulkhead installed inside AWT

Vacuum pumps installed in SPC

Centaur

In 1961, Center Director Abe Silverstein convinced NASA to transfer the Centaur Program from Marshall Space Flight Center to NASA Lewis. A mock-up Centaur rocket was installed in the Space Power Chamber to study entire systems tests in a space environment. The other end of the tunnel was used for shroud separation tests. These tests contributed to the Surveyor, Orbiting Astronomical Observatory, and many other Centaur missions.



Centaur rocket installed in SPC

Orbiting Astronomical Observatory nose faring test

Rehab

By the mid-1970s fewer tests were conducted in the Space Power Chamber and it fell into obsolescence. There was a proposal in the early 1980s to overhaul the facility and convert it back into a wind tunnel for icing research tests. After several years of preliminary studies, the $150 million renovation was scrapped and the facility has remained unused.

SPC interior today

AWT today