National Aeronautics and Space Administration

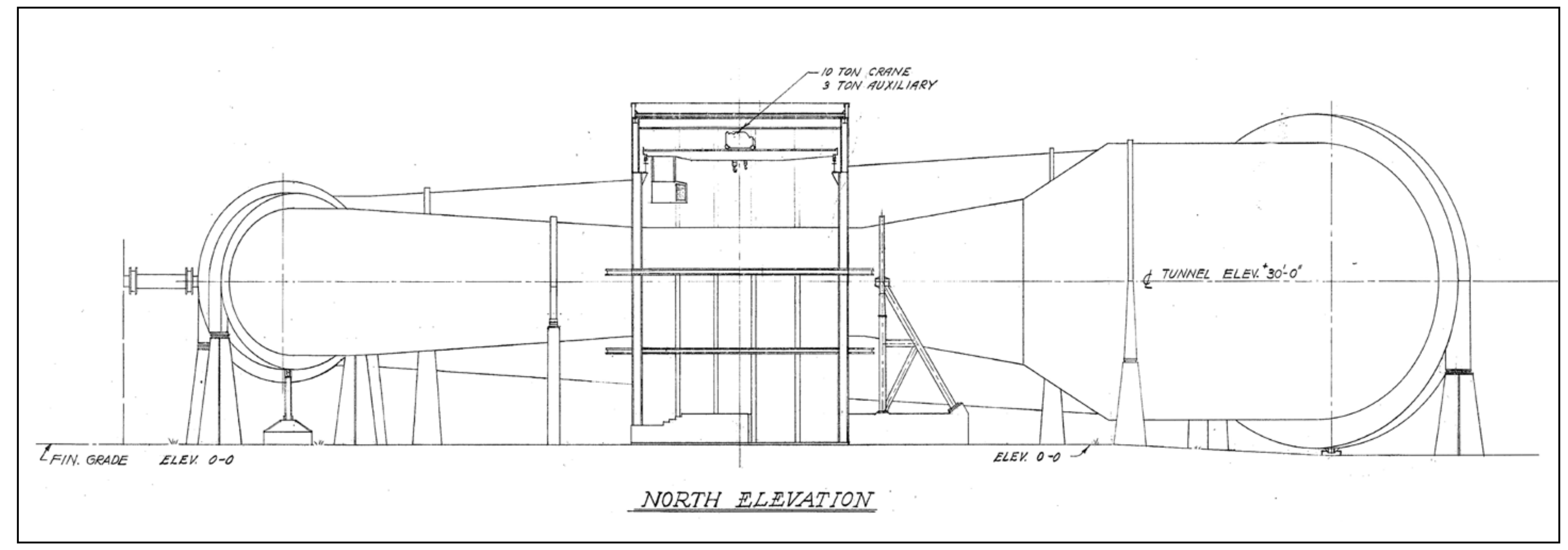
Altitude Wind Tunnel—Operation

When constructed in the early 1940s, the Altitude Wind Tunnel (AWT) was the nation's first and only wind tunnel capable of studying full-scale engines under realistic flight conditions. It played a significant role in the development of the first U.S. jet engines as well as technologies such as the afterburner and variable-area nozzle.

In order to simulate flight conditions, both the pressure and temperature associated with high altitudes had to be created using a large volume of air. The exhaust from engines undergoing tests had to be removed to avoid contamination of the tunnel environment. Thus, the airstream had to be constantly replenished with clean air. The tunnel operators had to not only control the conditions in the tunnel, but also remotely run the engine over a range of engine speeds. This required an elaborate control room and extensive test section equipment.

The tunnel shell had to withstand the simultaneous temperature and pressure decreases. The shell consisted of two steel layers with a blanket of insulation between. The 1-inch-thick inner steel shell could withstand external pressure when the tunnel was evacuated to high altitude pressure levels. A chromium, copper steel alloy with the strength of normal carbon steel was used so that the shell could endure the low temperatures of the high altitudes without becoming brittle. A 4-inch-thick layer of insulation was installed with steel mesh over the inner tunnel shell to retain the tunnel's low temperatures. The outer 1/8-inch steel shell was then constructed over this to protect from the environment.

The exhaust system was used to reduce the tunnel's air pressure to simulate the atmosphere at high altitudes. The Exhauster Building directly to the east of the tunnel housed four 1750-horsepower exhausters. These pumped the air out of the tunnel and expelled it into the atmosphere. The original configuration could simulate pressure altitudes up to 50,000 feet, but the capacity was increased over the years to 100,000 feet. In 1951, the Exhauster Building was expanded and more powerful compressors were added.

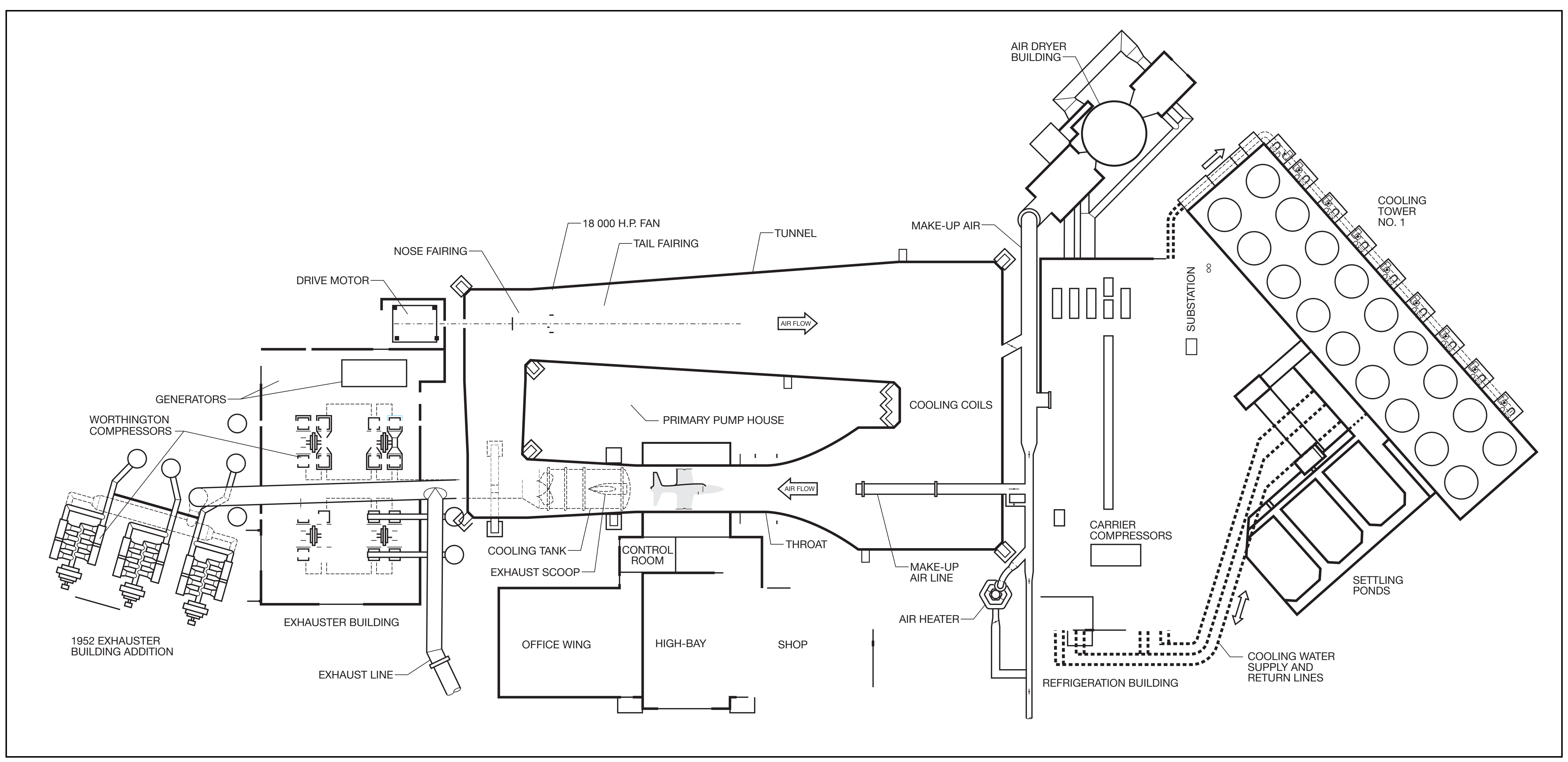


The AWT's cooling system, designed by the Carrier Corporation, was the largest refrigeration system in the world. It could lower the temperature of the tunnel's massive airflow to –47 °F. The system was powered by 14 Carrier chillers, which were housed in the Refrigeration Building to the west of the tunnel. Freon 12 was then pumped into the eight identical banks of cooling coils inside the tunnel's return leg. These banks were a collection of 260 copper-plated coils arranged in a zigzag design that covered a 51 foot width of the tunnel. The Freon absorbed heat and was then pumped back through the Refrigeration Building. Heat was removed from the refrigerant in heat exchangers. The water was routed to the cooling tower where the heat was dissipated into the atmosphere. At its original capacity, 20,000 gallons of cooling water were required for the system every minute.

A 16-bladed wooden fan near the southeast corner could generate wind speeds up to 500 miles per hour through the test section at the standard operating altitude of 30,000 feet. The average speed at lower altitudes was 345 miles per hour. Elliptical panels of turning vanes were installed in each corner to guide through the tunnel and even the airstream. The tunnel contracted from a diameter of 51 feet to just 20 feet as it approached the test section to accelerate the air as it passed through the test section and around the engine being studied.

The contamination from the engine exhaust was removed with an air scoop downstream from the test section. The exhauster equipment would suck the engine's contaminants out the scoop. A large cooler was installed under the air scoop in 1951 to cool the temperature of the exhaust.

The engine was installed inside the 20-foot-diameter test section on a wingspan that was attached to the sides of the tunnel. The engine was connected to six component balances that measured thrust. A number of supply and instrumentation lines were hooked up to the engine. Operators in the soundproof control room controlled the tunnel's atmosphere and ran the engine. Two sets of pneumatic levers operated the different facets of the engine.



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