UNITES STATES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

LEWIS PROPULSION RESEARCH LABORATORY

CLEVELAND AIRPORT

CLEVELAND 11, OHIO

# SPECIFICATIONS
FOR
ALTITUDE TEST CHAMBERS
FOR
THE PROPULSION SCIENCES LABORATORY

PROJECT NO. 794

LOCATED

AT THE

LEWIS PROPULSION RESEARCH LABORATORY

CLEVELAND AIRPORT, CLEVELAND 11, OHIO

SPECIFICATION C-361-B

OCTOBER 8, 1948

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## SECTION I

1-01. General Description:

(a) The work covered by this specification consists of architect-engineer services for the detail design of the altitude test chamber in general accordance with Specification No. C-361, Part II, dated August 5, 1948. The requirements set forth in these specifications are intended to clarify and extend the requirements set forth in Part II, Section 2-07 of Specification No. C-361 and in no way alter or supersede any of the requirements set forth therein.

(b) The altitude test chamber consists essentially of a pressure vessel inside of which a full-scale thermal jet engine may be operated. Properly conditioned air to simulate the conditions of flight at various speeds and altitudes is admitted at one end of the test chamber, caused to flow through the jet engine, and evacuated from the other end of the chamber by an exhaust system. All equipment necessary for the proper installation, maintenance, and control of the engine, as further described herein, is considered as part of the test chamber.

(c) The general arrangement and overall dimensions of the equipment which comprises the test chamber shall be as shown in drawing SKS-52-1. The engine under test is mounted on a thrust platform in the test section of the chamber. The thrust platform is flexibly supported and connected to suitable devices for measurement of the engine thrust. All air admitted to the inlet end of the test chamber is guided into the engine through an inlet nozzle mounted on the pressure diaphragm installed in the chamber. A movable water-cooled bulkhead is installed in the chamber in the region of the engine

exhaust pipe to prevent radiation and circulation of the engine exhaust gases around the engine. An equipment hatch, access doors, utility opening, windows, cooling jackets, manholes, and other items necessary to the proper functioning of the test chamber are to be provided in general accordance with drawing SK-52-1 and as described in further detail in subsequent sections of this specification.

1-02. Temperature and Pressure Conditions in Test Chamber:

(a) The entire test chamber shall be designed for a minimum internal pressure of zero absolute. In addition, the test chamber between stations 0 and 6 on drawing number SKS-52-1 shall be designed for a maximum internal pressure of 180 pounds per square inch, absolute.

(b) The altitude test chamber shall be designed for internal air temperatures from minus 70 degrees Fahrenheit to plus 650 degrees Fahrenheit between stations 0 and 6 and from 40 degrees Fahrenheit to 3500 degrees Fahrenheit between stations 6 and 10.

(c) The exterior of that portion of the test chamber which is outside of the access building, shall be of such construction and materials that will be suitable for exposure to weather characteristic of the site.

1-03. Detail Design Features:

(a) A 24-inch diameter manhole, fitted with a blind flange, shall be provided between stations 0 and 1.

(b) A suitable screen shall be installed at station 1 to provide equal pressure distributing in the air before it reaches the honeycomb section. The screen shall be of corrosion resistant material and shall be supported sufficiently to prevent tearing under loads created by minor debris in the air and the pressure drop created across the screen.

(c) A honeycomb section to straighten the flow of inlet air shall be provided at station 2. The honeycomb shall be so constructed that it may be removed from the chamber through the access door. The honeycomb shall be approximately 2 feet long and shall have free air passage spaces of not more than 10 square-inch units. Corrosion-resistant material shall be used.

(d) Seven utility openings, each of 10 inches diameter and each fitted with a blind flange, shall be provided at the approximate locations shown on drawing SKS-52-1.

(e) Two access doors shall be provided for access into the test chamber, one between stations 2 and 3 and one between stations 7 and 8, as shown in SKS-52-1. These access doors shall have quick opening cam lock fasteners and shall be provided with an airtight seal to prevent gas leakage. The door between stations 2 and 3 shall be insulated in the same manner as the adjacent surface of the test chamber and the door between stations 7 and 8 shall be water cooled. A safety device which will prevent opening of the doors when the pressure in the test chamber is higher than the ambient pressure shall be provided for each access door.

(f) The altitude test chamber between stations 0 and 4, shall be insulated sufficiently to reduce the external surface temperature to a maximum temperature of 175 degrees Fahrenheit.

(g) The entire surface of the test chamber, including hatch, access doors, and other appurtenances between stations 4 and 10 shall be cooled by a water jacket. The water jacket shall be designed to permit continuous operation with internal gas temperature of 3500 degrees Fahrenheit, including luminous radiation from solid particles at this temperature, without undue thermal stresses in any part of the test chamber or the formation of steam in the cooling jacket. The thickness of the water jacket walls shall include 1/16 inch for corrosion allowance. Cooling water will be supplied to the chamber at 80 degrees Fahrenheit and 40 pounds per square inch gage.

(h) A catwalk shall be provided on each side of the chamber between stations 2 and 10 and shall be so constructed that the catwalk and supporting structures may be removed in sections from the chamber through the two access doors or hatch. The catwalk shall be on the same level as the top of the thrust platform and shall have a nonskid surface to insure good footing.

(i) A 15 foot long hatch, operated by an overhead electric motor and cable system, shall be provided between stations 4 and 5. The hatch shall open as shown on SKS-52-1 and shall be provided with an airtight seal to prevent air leakage into or out of the chamber.

Quick opening cam locks shall be provided to secure the hatch in the closed position. An automatic safety catch with manual release shall be provided to secure the hatch in the open position. The entire hatch shall be water-cooled.

(j) An 8 by 15 foot engine platform shall be installed in the test chamber beneath the 15 foot hatch as shown in SKS-52-1. The platform shall be supported in a manner that will permit free movement in a longitudinal direction as required for measurement of the engine thrust as specified herein in paragraph (k), and be suitably guided and restrained from movement in a transverse or vertical direction. The supporting system of the platform shall be designed so as to keep friction forces to a minimum and be adequately protected against damage, entry of dirt, or other factors that may occur during normal operation and maintenance of equipment in the chamber that may adversely affect the accuracy of thrust measurement. The platform supporting system shall also be designed so that thermal expansion of the engine platform or other test chamber temperature effects shall not affect the alignment of the engine or thrust members sufficiently to alter the thrust measurement within the limits of the required accuracy. The engine platform shall be capable of supporting a dead load of 10,000 pounds and of transmitting a horizontal thrust load of 45,000 pounds to the thrust measuring mechanism if mechanism is connected below engine centerline. The tee-slots in the platform shall be spaced approximately 6 inches apart and parallel to the longitudinal centerline.

(k) The engine platform shall be connected to a thrust measuring system that will provide an indication of engine thrust in a control room located on a mezzanine floor above the inlet end of the test chamber. The entire system shall be capable of resisting a thrust load of 45,000 pounds and momentary shock loads of two times the thrust load. The system shall be capable of measuring thrust loads of 30,000 pounds initially with provisions for eventual increase to loads of 45,000 pounds. The accuracy of thrust measurement shall be plus or minus one percent of the total thrust load for a range of thrust loads from 500 to 30,000 pounds. The thrust measuring system shall be of the "null" type or of such design that prevents movement of the engine platform in the longitudinal direction with changing thrust load. Any part of the thrust measuring system that extends through the wall of the test chamber shall be enclosed in a pressure-sealed

fitting capable of operating over the range of temperature and pressure conditions specified in section 2 of this specification. The thrust measuring system shall be of such design that its calibration will be independent of pressure and temperature conditions inside the test section of the chamber. All transmission shafts, thrust yokes, platform supporting members or other parts of the platform supporting and thrust measuring systems shall be located between stations 4 and 5 of the test chamber and either below the level of the engine platform or in such locations that will not interfere with installation and maintenance of the test engine and instrumentation. Provisions shall be incorporated into the thrust system that will accommodate preloading the system in increments of at least 500 pounds up to a total of 7,500 pounds.

(l) A thrust calibrating device that will enable a dead weight calibration of the complete thrust measuring system shall be provided. The calibrating load shall be transmitted by rods or cables as shown in SKS-52-1 which will permit connection of the calibration load to the test engine or the trunnion supports of an engine stand which is bolted to the engine platform. The rods or pulleys of the thrust calibrating device shall be capable of convenient installation and removal through the access doors or hatch of the test chamber. Removable plugs shall be provided in the diaphragm at station 4 and in the wall of the test chamber as required for passage of the necessary rods or cables. Connection of the calibrating rods or cables to engine thrust stands varying in widths from 4 feet to 8 feet is required. The weight pan shall be located so that it may be conveniently loaded manually outside of the test chamber. The calibrating device shall be capable of imposing calibration loads up to 30,000 pounds on the engine stand in maximum increments of 200 pounds. A suitable lever or force multiplying system that will permit the maximum calibration load of 30,000 pounds to be imposed with a maximum dead weight on the scale pan of 3000 pounds shall be provided. The complete calibration device shall be designed for an accuracy of plus or minus one-half percent for imposed calibration loads from 500 to 30,000 pounds.

(m) An airtight diaphragm shall be provided in the test chamber at station 4. The diaphragm shall have a concentric 4 foot diameter opening with an adjacent 2 inch wide machined face on the downstream side in a plane normal to the axis of the chamber suitable for drilling and attachment of

sealing devices on the test engine. The diaphragm may be conical or dished in shape (except for the machined flange) and if necessary may be supported by braces to the test chamber on the upstream side. The entire diaphragm shall be of such design that will permit its convenient removal and alternate installation at station 5. The diaphragm shall be designed to resist a pressure difference of 180 pounds per square inch (higher pressure on upstream side) at gas temperatures of 650 degrees Fahrenheit.

(n) A water-cooled bulkhead shall be provided at station 6 with a 4 foot diameter concentric opening. The water-cooled bulkhead shall be designed to resist a gas pressure difference of 15 pounds per square inch and to operate with 3500 degrees Fahrenheit gas temperatures on the downstream side without excessive thermal stresses or steaming of the water. The entire diaphragm shall be of such design that will permit its convenient removal and relocation at any section of the chamber (within one foot) between stations 6 and 10. The bulkhead shall be so connected and/or supported by the inner skin of the chamber as to prevent excessive gas leakage.

(o) Four 3 inch by 12 inch quartz glass windows one inch thick shall be provided on each side of the test chamber at the approximate location shown on drawing SKS-52-1. The windows shall be designed to permit their convenient removal for cleaning from the outside of the chamber.

(p) An 18 inch diameter cooling-air pipe shall be provided in the test section between stations 4 and 5 as shown in drawing SKS-52-1. Standard pipe flanges shall be attached to both the inside and outside ends of this pipe with sufficient clearance for attachment of standard pipe elbows on both ends.

(q) A pressure relief valve or valves designed to open at 5 pounds per square inch gage shall be provided between stations 7 and 9. This valve or valves shall be capable of passing 100 pounds of exhaust gas per second at a temperature of 3500 degrees Fahrenheit. In addition to this valve, bursting discs or diaphragms having sufficient area to relieve any explosion which may occur shall be provided between stations 7 and 9. All the relief valves and bursting discs shall be suitable for continuous operation of the test chamber with gas temperatures up to 3500 degrees Fahrenheit, and shall be suitably vented to the outside of the building.

(r) A pressure tube bulkhead shall be installed inside the test chamber in the forward end of the test section and between 4 and 6 feet above the level of the engine platform. This pressure tube bulkhead shall provide for 300 pressure tubes spaced on a minimum center to center distance between tubes of one and one-half inches. Standard compression-type bulkhead fittings for 3/16 inch copper tubing shall be installed at the bulkhead for connection of tubing to the test engine on one side of the bulkhead and for permanent installation of pressure tubes between the test chamber and control room bulkheads on the other side.

(s) An automatic quick acting bleed valve approximately 36 inch diameter, shall be installed between station 9 and 10. This valve shall be used only when starting engines to eliminate pressure surges in the exhaust system. The valve shall be open to atmosphere at the beginning of engine starting operation and shall be actuated by the difference in engine inlet and exhaust pressures, shall close with sufficient speed to prevent the exhaust pressure from equalling or exeeding the inlet pressure.

(t) Sufficient flush internal lighting shall be furnished between stations 2 and 6 to illuminate both the top and bottom of the equipment installed in the test section.

(u) A monorail and a removable 1/2 ton chain fall shall be provided to permit material handling inside the chamber between stations 6 and 10. The monorail shall be so cooled or connected to the water-cooled wall of the chamber as to prevent any warpage which would interfere with the operation of the chain fall and any thermal stresses which would result in cracking or buckling of the test chamber wall. Provision shall be made to permit removal of the chain fall through the access door of the test chamber.

(v) Iron-constantan thermocouples spaced 6 feet apart and 4 on a circumference, located and installed in such a manner as to indicate inner tank wall temperature shall be provided between stations 6 and 10.

(w) Suitable provisions shall be made in the chamber supporting structure to permit thermal expansion.

(x) A flange shall be provided at the inlet end of the chamber (station 0) for connection to the inlet-air pipe.

(y) A flange shall be provided at the outlet end of the chamber (station 10) for connection to the exhaust-gas pipe.

(z) A sufficient number of two-inch diameter drain pipes shall be provided in the bottom of the chamber to prevent accumulation of liquids in the chamber. These drain lines shall be provided with standard pipe connections.