I. Facility Designation

Propulsion Systems Laboratory

Construction Started	1950
Operation started	1952

II. Purpose

A. To investigate:

1. Full scale turbojet engines
2. Ramjet engines

B. Information gained - Engines are tested under simulated altitude conditions, with controlled temperature and pressure, to determine such characteristics as:

1. Thrust
2. Fuel consumption
3. Air flow
4. Stall limits
5. Blow-out limits
6. Operating temperatures
7. Acceleration characteristics
8. Vibration
9. Starting characteristics

III. Structures and Equipment

A. Identification. Structures having the following numbers and names comprise the PSL group:

Structure No.	Name
60	PSL Operations Building
64	PSL Equipment Building
65	PSL Altitude Chambers (2)
66	PSL Access Building
67	PSL Primary Coolers (2)
68	PSL Secondary Cooler
69	PSL Tie Line
70	PSL Cooling Tower
71	PSL Fuel Storage
72	PSL Low-Pressure Fuel Pumping Station
73	PSL High-Pressure Fuel Pumping Station
74	PSL Circulating-Water Pumping Station
75	PSL Substation "U"
76	PSL Combustion-Air Heater
79	PSL Cooling-Water Deaerators

B. Description Most of the structures of the PSL facility occupy a part-approximately 250 feet by 600 feet - of the area bounded by Durand, Walcott, Westover and Moffett roads. This area is to be reserved for future prime research facilities, as test stands or process equipment etc.

1. Test Chambers The testing of engines is accomplished in two closed chambers (structure No. 65) in which conditions of pressure and temperature corresponding to those at altitude can be simulated. These chambers have test sections 14-feet in diameter and 24-feet long and have exhaust sections 12-feet in diameter and 37-feet long which serve as extensions of the test sections.

   The altitude test chambers are supplied with combustion air and altitude exhaust services by compressors and exhausters located in the equipment building (structure No. 64).

2. Air Compressors The three 45 psig combustion air compressor units are centrifugal machines having three wheels in each of three casings. They have two casings in the first stage and one casing in the second stage. Each compressor is driven by a 16,500 horsepower motor and furnishes 112 pounds of air per second at a pressure of 45 psig. The maximum available quantity of combustion air is about 336 pounds per second. A booster compressor will supply 183 pounds of air per second at a pressure of 150 psig.

3. Air Heaters Three gas fired heaters, which operate in parallel can be used to heat the combustion air. Each heater will heat 125 pounds of air per second from 40°F. to 600°F. and in doing so uses natural gas at the approximate rate of 100,000 cubic feet per hour. The combustion air passes through the inside of vertical tubes which absorb heat by radiation from the luminous natural gas flame.

   45 psig. 700°F 119 pps.

4. Air Dehydrators Two parallel contact type dehydrator units can reduce the moisture content of 125 pounds of air per second, at 45 psig, to 9 grains per pound. The air is passed upward through a vertical tank and over cascade trays providing intimate contact with the liquid cooling medium. The first stage of air cooling uses cooling tower water which cools the air from 120°F to 90°F. The second stage of air cooling uses water which has been chilled to 35°F in a flooded type Freon cooler served by two centrifugal Freon compressors. This refrigerating equipment serves both dehydrators. The air leaves at a temperature of 40°F and at the 45 psig pressure, contains only 9 grains of water per pound of dry air.

The moisture content of some of the air can be further reduced in a desicant type dryer described as follows:

Drying agent, activated alumina, approx. 190,000 pounds
Air capacity, 115 pounds per second
Inlet air temperature, 40°F.
Inlet air moisture content, 9 grains/pound of dry air
Outlet air, moisture content, less than 1 grain/pound of dry air
Air drying time, 9 hours
Reactivation time, 6 hours (4 hours heating, 2 hours cooling)

5. Air Refrigeration Turbine A maximum of 112 pounds of air per second can be passed through an expansion turbine which can reduce the air temperature by approximately 100°F.

6. Exhausters The three exhauster units are centrifugal machines each having two first stage castings, one second stage casing, one third stage casing, and one fourth stage casing (nominal pressure ratio, 2). A 10,000 horsepower motor drives the two first-stage rotors and a 16,500 horsepower motor drives the second, third, and fourth stage rotors. The total exhaust-gas handling capacity of these exhausters is 166 pounds per second at a test chamber altitude of 50,000 feet or 384 pounds per second at a test chamber altitude of 32,000 feet. Greater amounts of exhaust gas can be handled at lower altitudes with fewer than four stages. The total inlet volume of these machines is 1,650,000 cu. ft. of gas per minute.

7. Motor Horsepower The drive motors for the compressors and exhausters have a total capacity of 147,000 horsepower.

8. Interconnecting Pipe Lines Pipe lines between the PSL equipment and other facilities extend the services of the PSL equipment. These lines are:

   a. A 24-inch diameter underground, 150 psig, combustion-air pipe connects PSL to HEFL, EPRB, JPSTL and 10'x10' U. SWT.

   b. A 72-inch diameter exhaust pipe connects PSL to the Engine Research Building and to the Altitude Wind Tunnel.

III. Structures and Equipment (continued)

c. A 30-inch diameter, combustion-air pipe line, from PSL designed for 150 psig at 450°F. connects with other pipe lines at the Engine Research Building to supply the Engine Research Building, the Altitude Wind Tunel through a 35-inch pipe line and the Icing Research Tunnel through a 12-inch pipe line.

IV. Operation

1. The engine to be tested is attached to a suitable mount which is bolted to a bedplate in the test section of the altitude test chamber. The entire bedplate and engine are supported by a scale system which measures thrust or drag force. The combustion air supply can be piped directly to the engine inlet or it can be discharged through a supersonic nozzle directed toward an air duct inlet simulating one to be used in flight.

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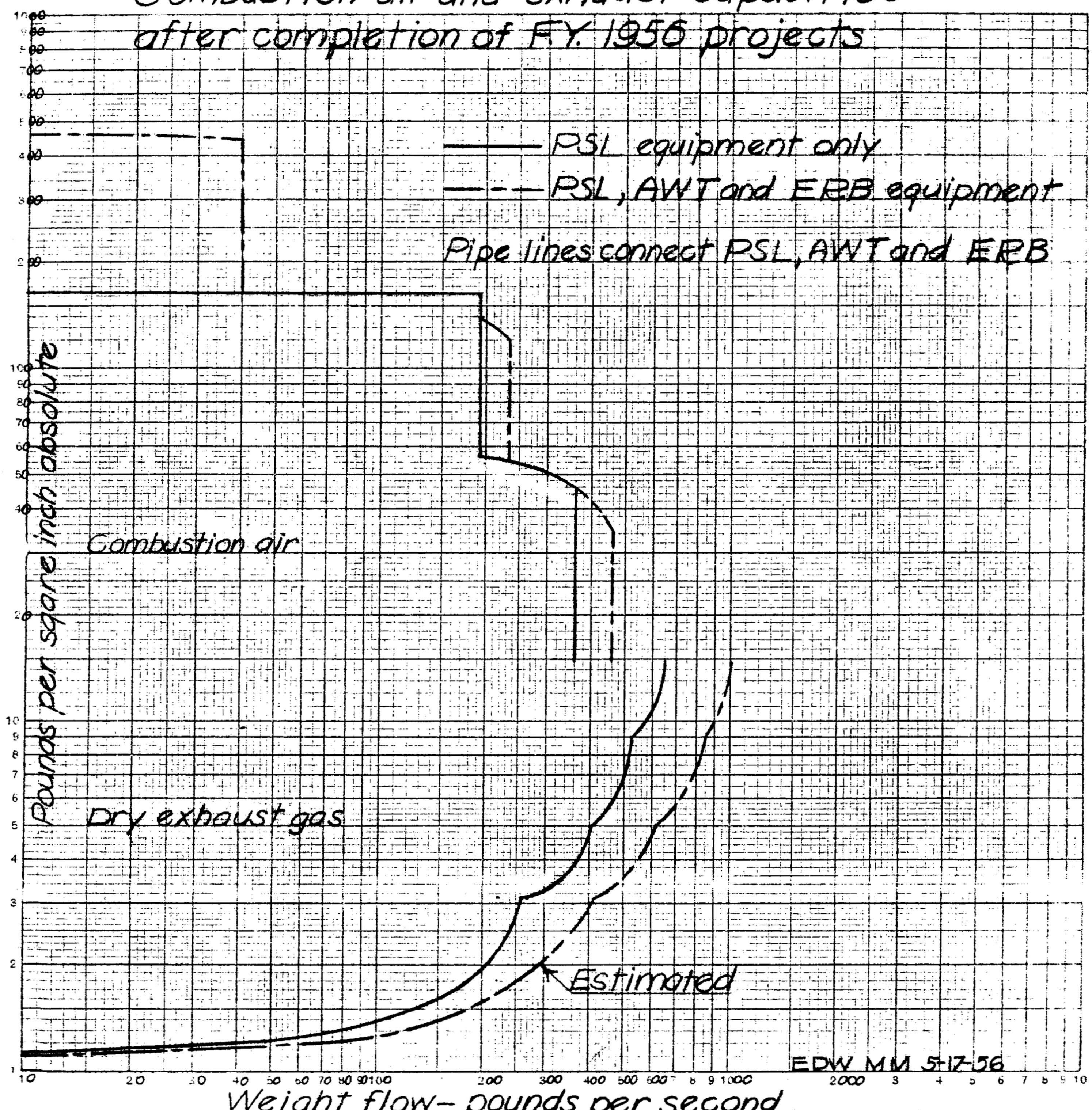
Propulsion Systems Laboratory Altitude Engine-Test Chambers Combustion air and exhaust capacities after completion of FY 1956 projects



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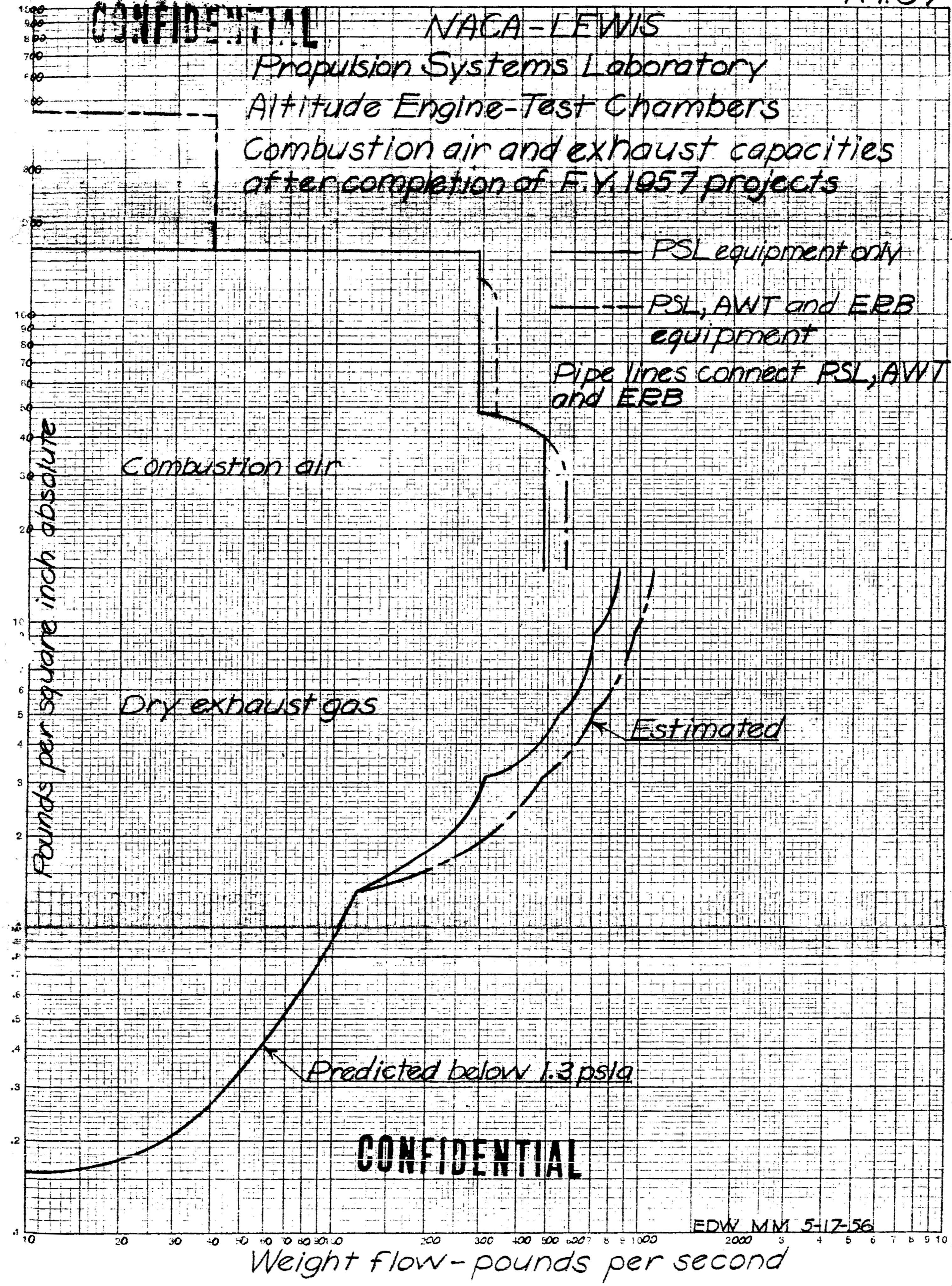
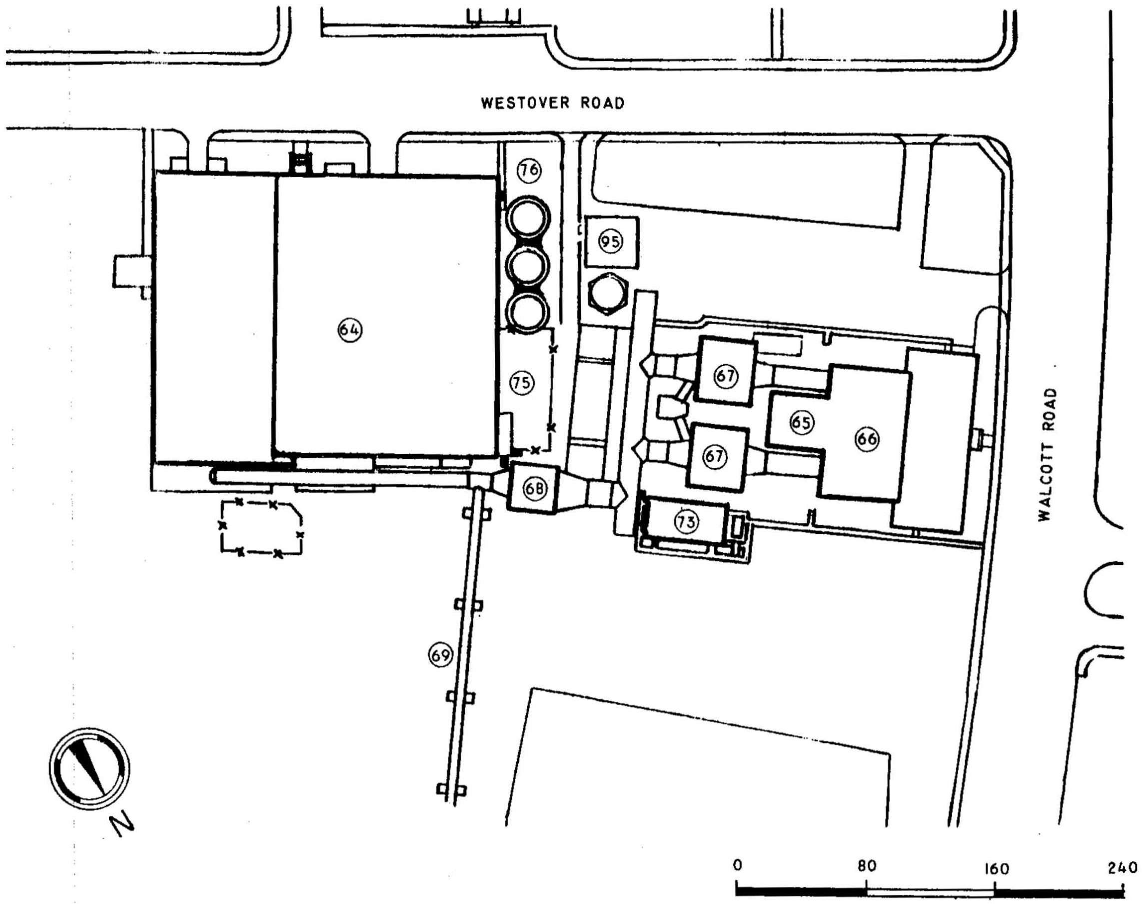
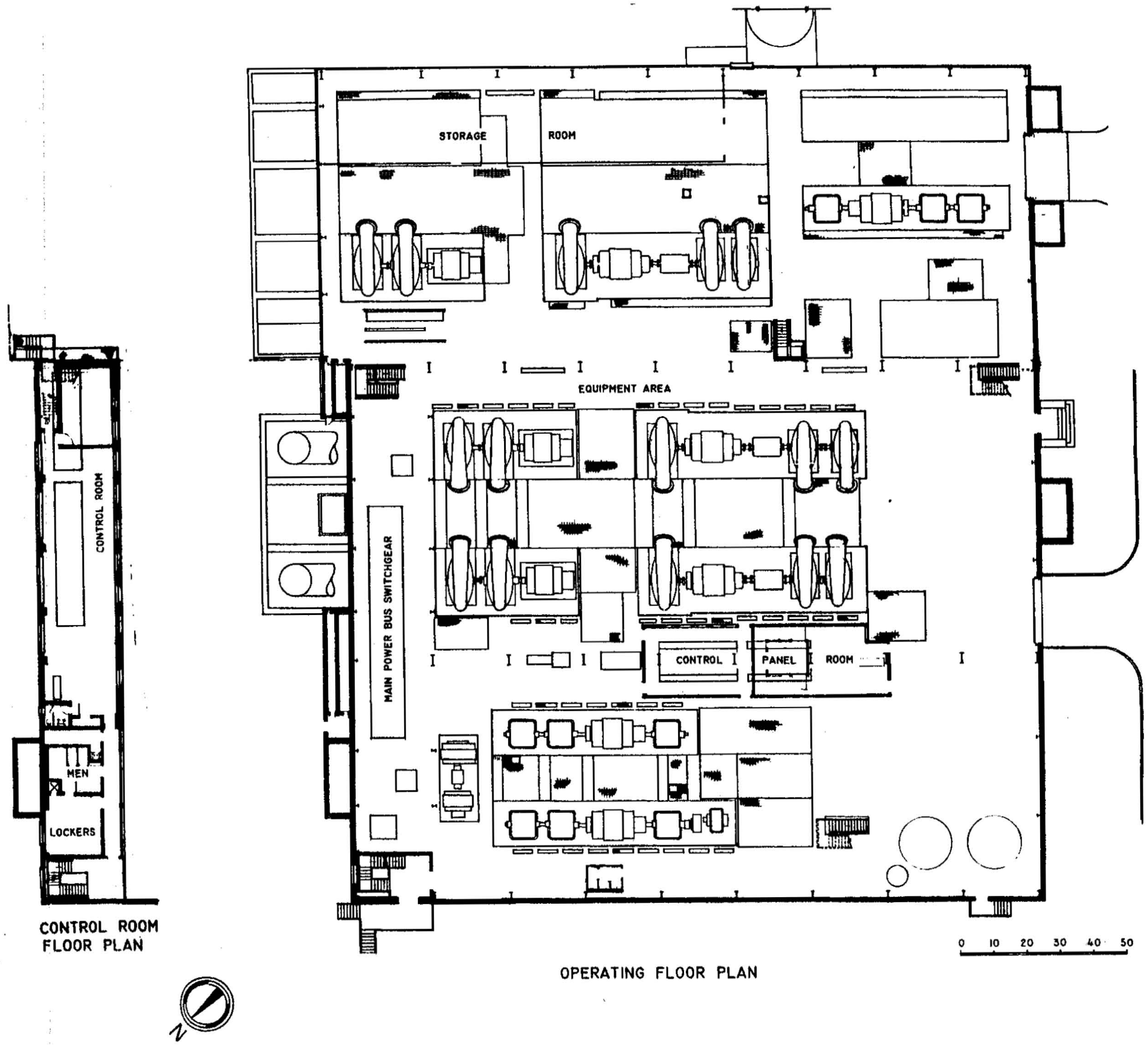

CONFIDENTIAL
NACA-LEWIS
Propulsion Systems Laboratory
Altitude Engine-Test Chambers
Combustion air and exhaust capacities
after completion of F.Y. 1957 projects
PSL equipment only
PSL, AWT and ERB equipment
Pipe lines connect PSL, AWT and ERB
Combustion air
Dry exhaust gas
Estimated
Predicted below 1.3 psia
Pounds per square inch absolute
Weight flow - pounds per second
EDW MM 5-17-56
CONFIDENTIAL



(64) EQUIPMENT BUILDING
(65) ALTITUDE CHAMBERS
(66) ACCESS BUILDING
(67) PRIMARY COOLERS
(68) SECONDARY COOLER
(69) TIE LINE
(73) H.P. PUMPING STATION
(75) SUB STATION J
(76) COMBUSTION AIR HEATERS
(95) DESICCANT AIR DRYER

PLOT PLAN

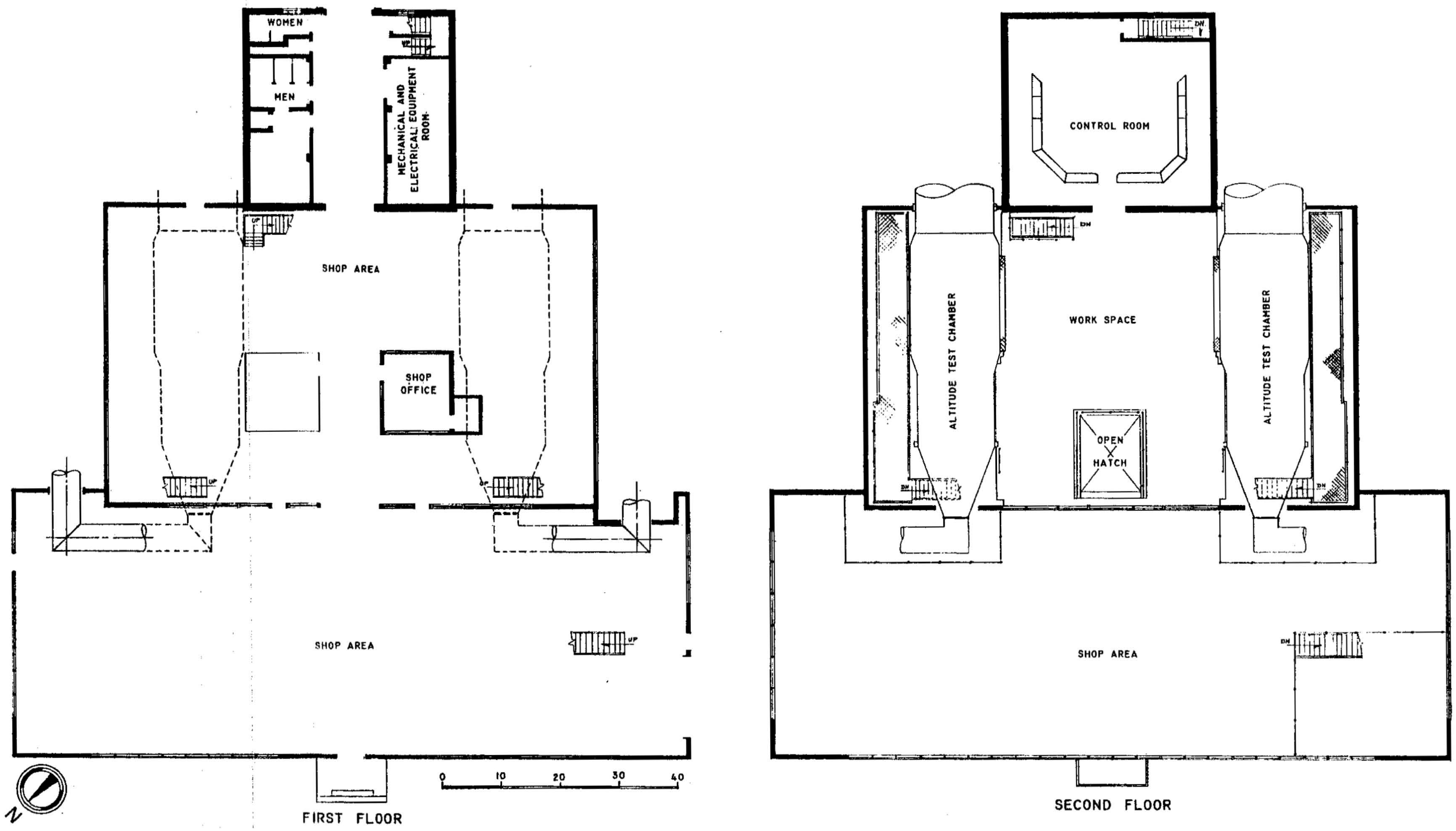
PROPULSION SYSTEMS LABORATORY GROUP



PROPULSION SYSTEMS LABORATORY EQUIPMENT BUILDING

Structure No.

64



PROPULSION SYSTEMS LABORATORY ACCESS BUILDING

Structure No.

66

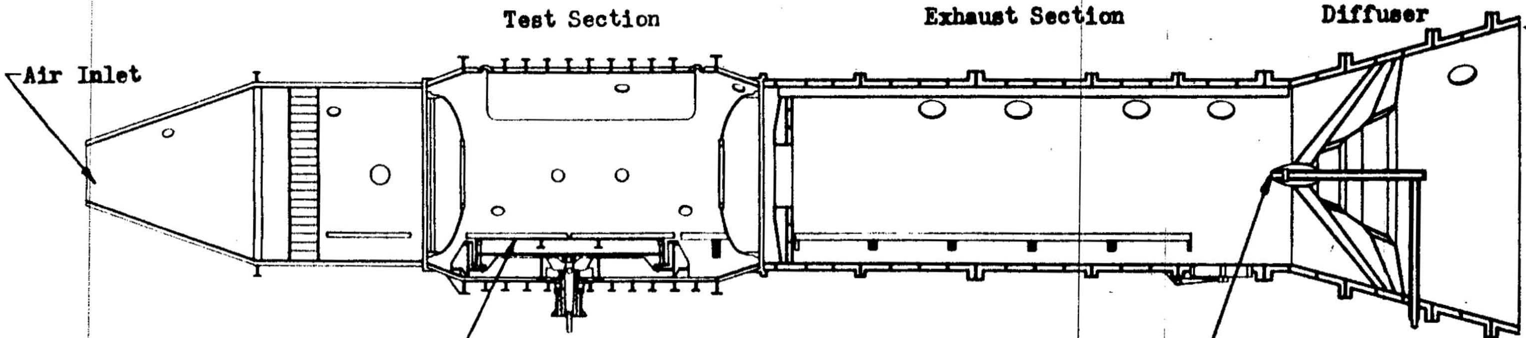


Fig. 45 Diagram of Propulsion Sciences Laboratory Altitude Test Chamber

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