I. Facility Designation

Altitude Wind Tunnel -(Test Section 20' diameter)

Construction started 1942 - Operation February 1944

II. Purpose

A. To investigate (under simulated altitude conditions)

1. Engines - turbojet, turboprop, ramjet, reciprocating - piston
2. Engine controls
3. Afterburners
4. Inlet ducts
5. Exhaust nozzles
6. Complete engine-propeller, propulsion-unit installations

B. Information gained

1. Operating characteristics of engines at simulated altitude conditions-stability of output, thrust, fuel consumption, temperatures.
2. Reliability and effectiveness of controls.
3. Flow characteristics of ducts and nozzles
4. Aerodynamic qualities of engine - nacelle and other configurations

III. Structures and Equipment

A. Identification

Structure No.	Name
7	Altitude Wind Tunnel (offices, shop, control room)
8	Exhauster Building
9	Refrigeration Building
10	Cooling Tower No. 1
18	Air Dryer No. 1

B. Description

The Altitude Wind Tunnel group of structures occupies an area that is approximately 560' x 200' exclusive of the cooling tower.

1. Altitude Wind Tunnel (for test capacities see figures following. The AWT is a closed-circuit, steel-shell (1/2" to 15/16" thick, of "Yolloy" copper-nickel steel) tunnel with a test section that is 20 feet in diameter and 40 feet long. An air space, 1 ft. to 2 ft. in depth, separates 4 inches of glass wool insulation from the tunnel

shell. The outer covering is a 1/8-inch steel "weather-skin" which is sealed to prevent the entrance of moisture. The upper half of the test section is hinged longitudionally and can be opened in about 10 minutes by means of a hoist. Models are carried over the test section and lowered into place by a 10-ton hoist. Models are mounted in the test section by attaching them to trunnion plates at the sides of the tunnel test section. Frequently, additional support is obtained by using a strut extending upward from the tunnel floor. The model attachment plates at the sides of the tunnel and the support pad for the strut are independent of the tunnel shell but are integral with a balance frame which encompasses the lower half of the test section. The balance frame is supported and restrained by a lever and scale system which is potentially capable of measuring all forces and moments acting on the model. At present, scale heads are installed for measuring thrust (or drag), lift, and pitching moment only. The force scale readings are printed on paper tape when an operator pushes a control button, which he does only when a light indicates that the scale is in balance.

2. Tunnel Drive

Fan dia. - 31 feet
No. of blades - 18
Construction - laminated aircraft quality spruce wood
Drive Motor 18,000 hp.
Fan speed 10 to 410 rpm.
Air velocity - 425 mph. from 30,000 ft. up, varying to 250 mph. down to 1,000 ft.
Minimum velocity 30 to 40 mph.
Velocity control, infinitely variable.
Mach number range -

Mach No.		Pressure
0 to 0.23	at	13.8 psia (max.)
0 to 0.63	at	1.72 psia (min.)

Stagnation pressures-
Minimum (approx.) 0.1 atmos.
Maximum (approx.) 1 atmos.
Stagnation temperatures-
Minimum -40°F.
Maximum +50°F.

3. Air and exhaust gas removal

No. of pumping units - 7 total
Type - reciprocating piston

Total connected load 10,150 KW
Gas cooler - water spray - 935 KW pumps
Exhaust through mufflers to prevent noise nuisance
Original installation - Four, Worthington, four cylinder, double-acting reciprocating-piston vacuum pumps
- Bore - 60 inches
- Stroke - 30 inches
- Horsepower per unit - 1,750
- Motor voltage - 2,300
- Speed - 133 1/3 rpm
- Displacement - 50,000 cfm/each 4-cylinder machine

Additional equipment installed 1951 - Three, Ingersoll-Rand Eight-cylinder, double-acting reciprocating-piston vacuum pumps
- Bore - 39½ inches
- Stroke - 14 inches
- Horsepower per unit - 2,000
- Motor voltage - 2,300
- Speed - 327 rpm
- Displacement - 50,000 cfm/each 8-cylinder machine

Simulated altitude - 55,000 feet (nominal)
Note: - By means of 6-foot diameter piping, these exhausters can also augment the exhaust capacities of the Engine Research Building and the Propulsion Systems Laboratory.

4. Refrigeration Equipment

A refrigeration plant, adjacent to the tunnel structure, serves to reduce the temperature of the air circulating in the tunnel (by means of a heat exchanger in the tunnel air stream) and that of separately supplied combustion air, to that existing in the atmosphere at any altitude which it is desired to simulate, down to a minimum temperature of -48°F. Exhaust gases are removed through a scoop and cooler without entering the tunnel air stream. Make-up air, to replace that removed, can be dried and cooled.

a. Tunnel Air Stream Cooling

Number of Carrier compressors - 14 in parallel
Type - Centrifugal
Horsepower per unit - 1,500
Refrigerant - Freon-12
Total capacity - 7, 000 tons
Total charge - 60,000 pounds

Use - principally for cooling air circulating in the tunnel but can also assist in cooling make-up air for large flows or very low temperatures.

b. Make-up Air Drying and Cooling

Number of York Compressors - 12
Type - reciprocating
Horsepower per unit - 150
Refrigerant - Freon 12

Primary refrigeration coils reduce temperature of air at atmospheric pressure from 85°F dry bulb and 73°F. wet bulb to 41°F. saturated.

Activated alumina beds further dry air by adsorption (reactivation by steam heating)

Secondary refrigeration coils further reduce the temperature of the dried air to -41°F. This air can be taken into the tunnel air stream or piped directly to an engine intake.

c. Water Cooling Tower

In the operation of the refrigeration equipment, heat is dissipated to the atmosphere by means of a cooling tower in which cooling water is exposed to the air.

Pump capacity - 63,000 gpm
Basin capacity - 600,000 gallons
On tower temperature - 93°F
Off tower temperature - 83°F
Condition for above cooling - 73°F wet bulb
Number of cells - 18

This cooling tower is also used by the Engine Research Building.

5. Pressurized Combustion Air Supply - Cooling and Heating

a. Pipe lines from air compressors in the Engine Research Building and the Propulsion Systems Laboratory can supply combustion air for connected inlet tests of jet engines in the AWT test chamber under the following conditions:

Engine inlet pressure from 0.1 atm. to 4 atm.
Engine inlet temperature from -100°F to 350°F.

b. Combustion Air Cooling

A turbo expander, is installed to refrigerate combustion air supplied to the test chamber. The name plate design conditions for this turbo expander are:

Inlet Press. 55.0 PSIA Temp. 35.0°F.
Exhaust Press. 13.5 PSIA Temp. -97.5°F.
Gas-Air
Capacity 405,000 lb./hr. Speed 6,500 rpm.
Max. operating speed 6,500 rpm.

c. Combustion Air, heating

An indirect, gas-fired, combustion-air heater has the following design capacity for air at 44 psig:

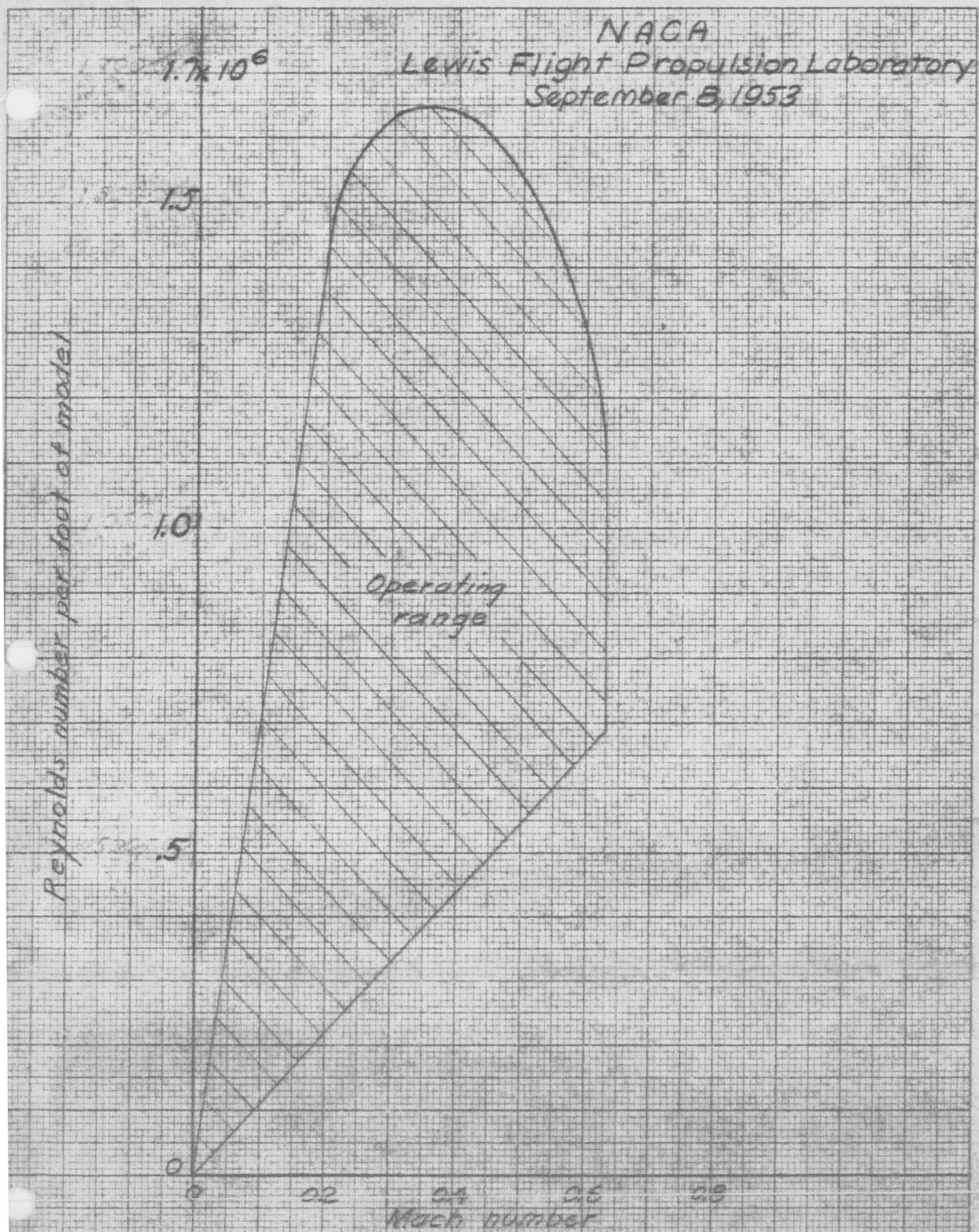
Inlet temp. °F.	Outlet temp. °F.	
	250 lbs/sec.	100 lbs/sec.
225	295	395
120	190	290
40	110	210

6. Other Equipment

Fuel supply system

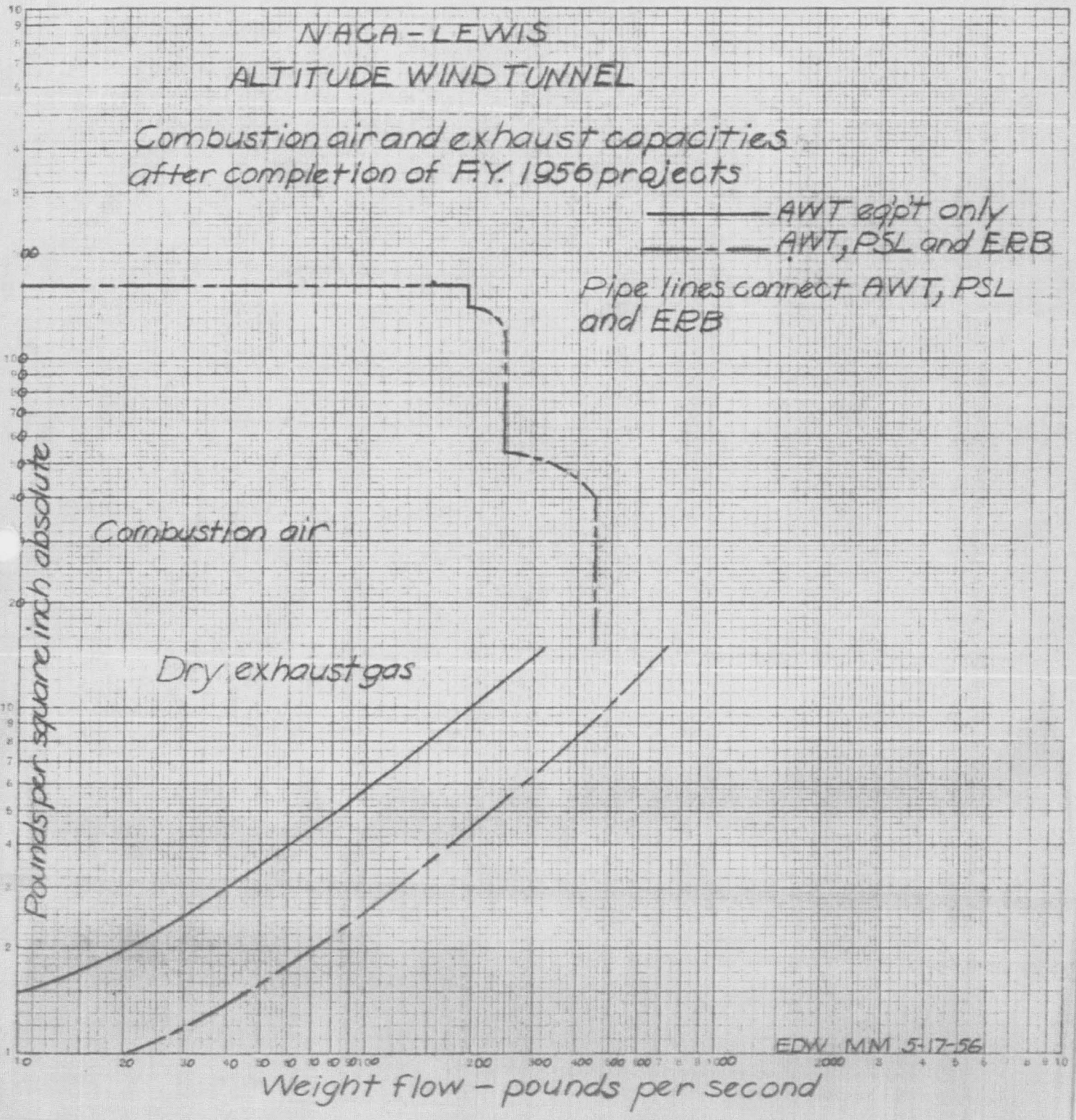
Manometer system for measuring and recording pressures

Temperature measuring and recording equipment.



Reynolds number vs. Mach number for altitude wind tunnel.

F.Y. 56


NACA-LEWIS
ALTITUDE WIND TUNNEL
Combustion air and exhaust capacities after completion of F.Y. 1956 projects
AWT eq'pt only
AWT, PSL and ERB
Pipe lines connect AWT, PSL and ERB
Combustion air
Dry exhaust gas
Pounds per square inch absolute
Weight flow - pounds per second
EDW MM 5-17-56

F.Y. 57

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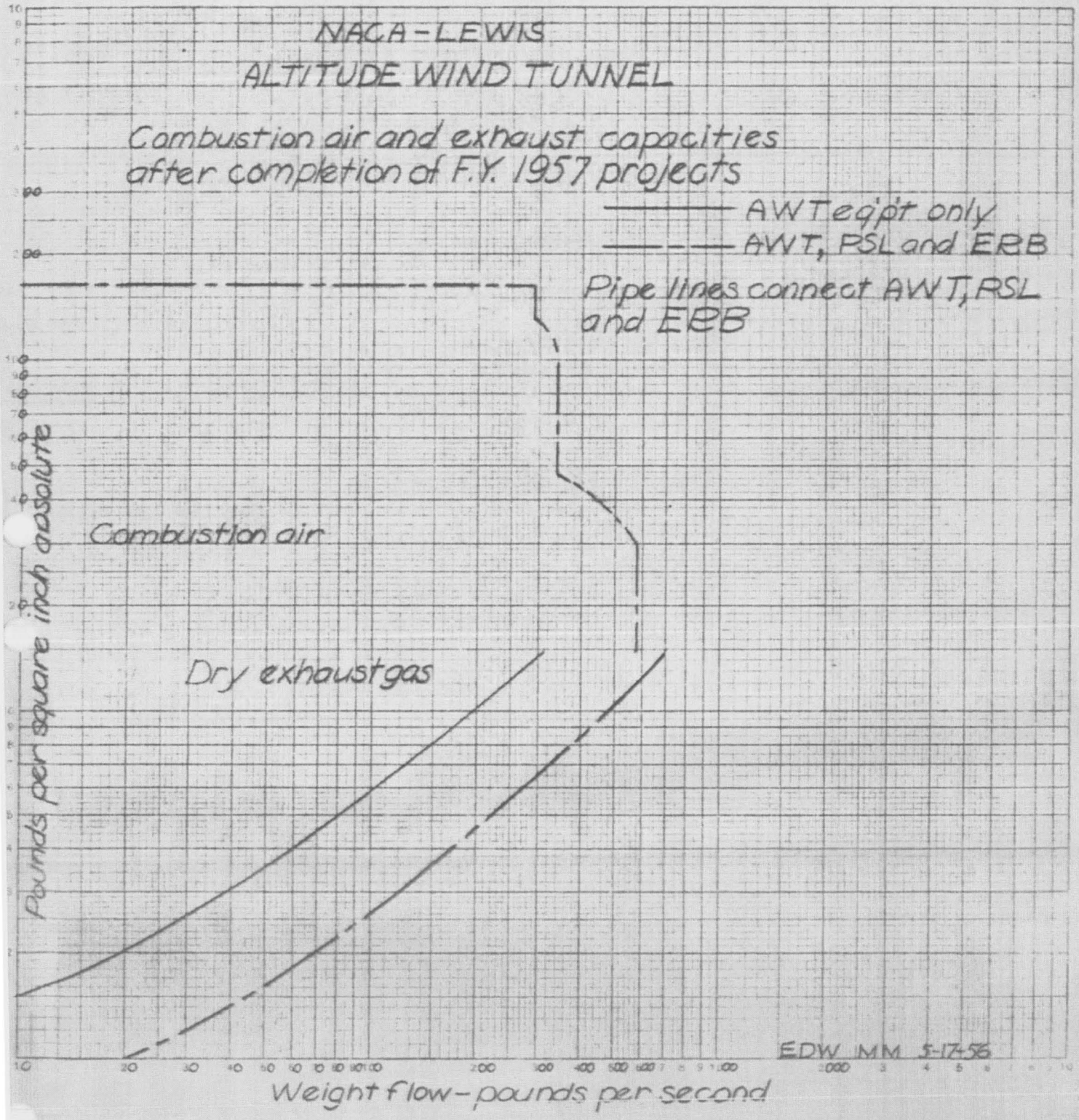

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