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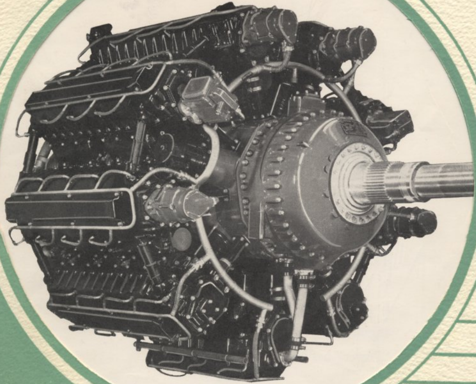
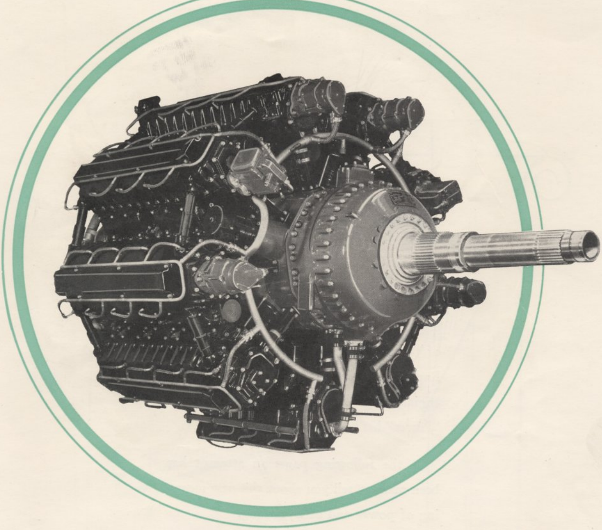


LYCOMING

XR-7755 AIRCRAFT ENGINE
and
ENGINEERING LABORATORIES



Introducing . . .

LYCOMING XR-7755
The World's Largest
. . RECIPROCATING . .
AIRCRAFT ENGINE

LYCOMING DIVISION
THE AVIATION CORPORATION
WILLIAMSPORT, PA.

INTRODUCTION

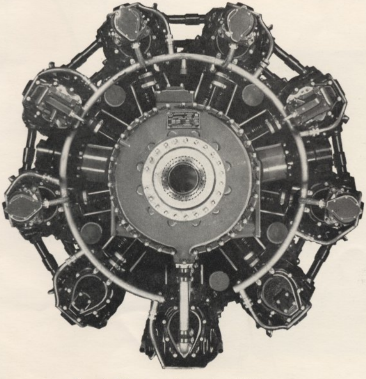
To those in the aircraft industry, the terms "Power" and "Lycoming" have long been synonymous; and with the completion of the two projects: The new Lycoming Experimental Laboratory and the XR-7755 engine, a wholly new conception of the word "Power" has been introduced.

In the following pages an attempt has been made to tell you about this new meaning of power and of Lycoming.

DESCRIPTION

The Lycoming model XR-7755 aircraft engine is the most powerful reciprocating aircraft powerplant in the world today. It develops 5000 H. P. at 2600 R. P. M. for take-off and 4000 H. P. at 2300 R. P. M. for continuous operation. In construction, the engine is a 36 cylinder, single crankshaft, liquid cooled, radial type with cylinders arranged in four rows of nine each and having a total piston displacement of 7755 cubic inches. A few of the accessories are mounted conventionally at the rear of the engine, but others, including starters (two required), tachometers, and propeller governor, as well as the low tension magnetos and distributors, are located ahead of the front row of cylinders.

As you view the World's Largest Aircraft Engine, it is probably very difficult to imagine the tremendous powers and capabilities that lie momentarily dormant within its relatively small body. Let us compare some of its component parts, as well as the complete unit, with more familiar items. This engine, slightly over 10 feet long and 5 feet in diameter, weighing 6050 pounds, produces more power than the average railway locomotive. A modern steam locomotive of equivalent power is a huge juggernaut 90 feet long, 15 feet high, weighing 670,000 pounds.



Front View — Lycoming XR-7755

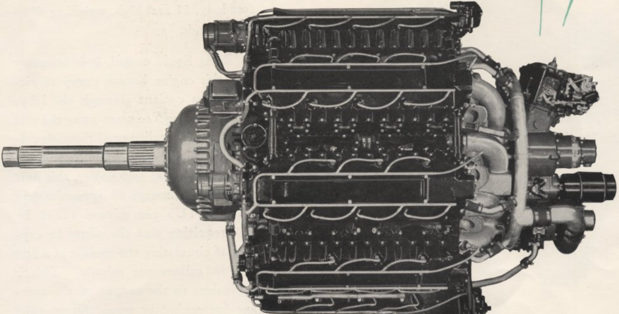
Being liquid cooled, it is necessary that this engine have a pump to circulate the coolant through the labyrinth of passages to carry away the vast amount of heat dissipated through cylinder heads and walls. While operating at take-off speed and power, this heat dissipation amounts to approximately 95,600 BTU's per minute (2250 H. P.), requiring that the pump be capable of circulating the coolant at a rate of 750 gallons per minute. This is equivalent to the output of the average fire engine, or would fill an 8000 gallon tank car in approximately 10½ minutes.

In order that oil may be supplied to the many parts needing lubrication, and in sufficient quantities, the oil pressure pump has a capacity of 500 pounds per minute which is equal to 71 gallons per minute at an outlet pressure of over 100 pounds per square inch.

Heat generated by friction and part of the heat rejected from the combustion process is absorbed by this oil and carried away from the engine to the oil cooler. At the maximum power of the engine, this heat rejection is at the rate of 25,500 BTU's per minute (600 H. P.) or enough to heat a large hotel or apartment building.

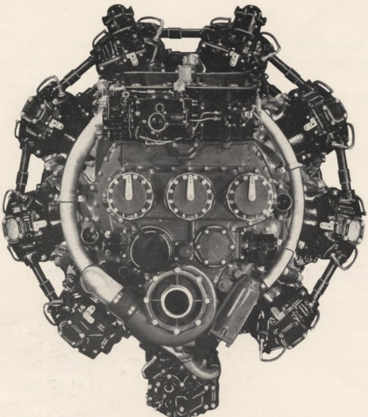
Another pump located in the reduction gear unit increases the pressure from 100 pounds per square inch to 300 pounds per square inch for the operation of the hydraulic shifting mechanism.

When operating at maximum speed and power, this engine will consume gasoline at a rate of approximately 580 gallons per hour. If this rate of consumption were maintained for an hour, the same amount of gasoline would operate the average automobile for a period of one year, or over 10,000 miles.



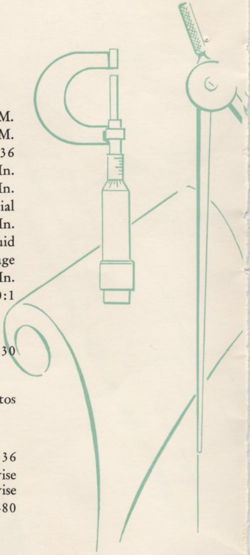
Side View — Lycoming XR-7755

Since economy of operation was one of the primary objectives, the design of this engine incorporates several unique features. The propeller drive is through a two speed dual rotation reduction gear, either ratio of which can be used at the pilot's discretion to obtain maximum propeller efficiency. The shifting is accomplished hydraulically and provides a direct drive to each of the two propeller shafts without the use of a friction clutch. Another feature is the use of camshafts, with two seperate sets of cams which can be shifted to change the valve timing for maximum power or cruising economy. In conjunction with this feature, the ignition timing is also adjustable and is operated by the same mechanism that shifts the camshafts. These innovations make it possible to secure a fuel consumption at cruising conditions considerably lower than that of contemporary engines at equivalent power.



Rear View — Lycoming XR-7755

SPECIFICATIONS



Normal Rated Power	4000 H. P. at 2300 R. P. M.
Take-off Horsepower	5000 H. P. at 2600 R. P. M.
Number of Cylinders	36
Bore	6.375 In.
Stroke	6.750 In.
Cylinder Arrangement	4 Row Radial
Displacement	7755 Cu. In.
Coolant Medium	Liquid
Supercharger	Single Speed-Single Stage
Impeller Diameter	14.4 In.
Impeller Ratio	6.0:1

Fuel Specification

Fuel	Grade 130

Engine Equipped for Either Carburetion or Fuel Injection

Ignition	2 Bendix DRN-7, Low Tension Magnetos

Propeller Drive

2 Speed Gear Reduction	High -.2460; Low -.3536
Dual Rotation Propeller Shaft	Inboard—Counterclockwise Outboard—Clockwise
Propeller Shaft Spline	60L-80

Accessories	*No. of Units*	*Ratio*	*Director of Rotation*
Starter	2	3.040:1	Counterclockwise
Generator	1	3.429:1	Clockwise
Power Take-off	1	3.429:1	Clockwise
Vacuum Pump	2	1.567:1	Clockwise
Fuel Pump	1	.937:1	Counterclockwise
Tachometer	2	.500:1	Counterclockwise
Propeller Governor	1	.986:1	Counterclockwise

Dimensions

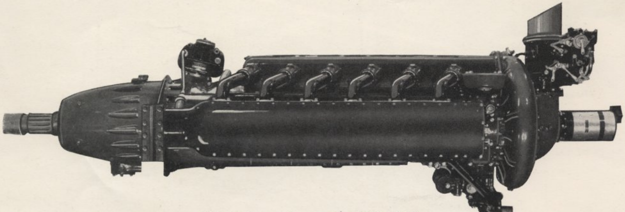
Length	121.35 In.
Width	60.50 In.
Height	66.25 In.
Diameter	61.00 In.

Total Dry Weight	6050 Lbs.

A BRIEF HISTORY

The development of an engine such as the XR-7755 is not accomplished in a few days or even a few months. This engine actually had its beginning in the fall of 1932. It was at that time that Lycoming began plans to study high powered liquid cooled engines. A new laboratory was proposed and work begun with the primary purpose of developing high output aircraft engine cylinders and the studies of allied research for cylinder development purposes. By February of 1934 a room had been added to the small building which then housed the automotive and aircraft experimental departments. A single cylinder test dynamometer with all necessary equipment had been installed and the first single cylinder liquid cooled engine was operating.

Single cylinder development continued and in May of 1936 a single cylinder engine completed a 50 hour endurance test. The progress of the multi-cylinder engine necessitated the building of another larger addition to the then existing experimental laboratory. This addition consisted of a teardown room, dynamometer room, analytical room and office space. The multi-cylinder engine was a twelve cylinder, horizontally opposed, liquid cooled engine of 1233.6



Side View — Lycoming XO-1230

LYCOMING XR-7755

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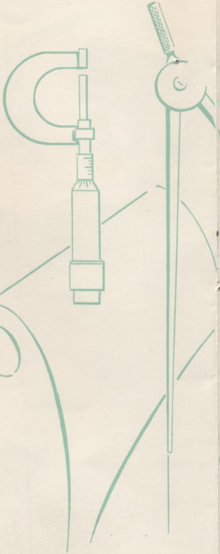
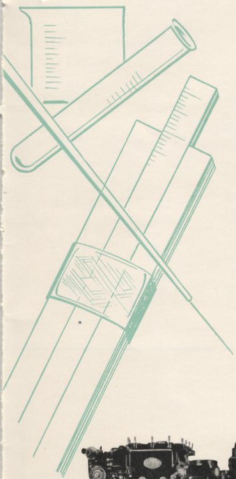
cubic inches displacement, rated at 1200 H. P. for take-off with a 1000 H. P. normal rating. This engine was ready for endurance testing in December of 1937.

After continued laboratory and flight tests, it was realized that more and more power was required from a single engine. With this thought in mind, the design of a much larger engine was started in the summer of 1939. As a result of the engineering data and experience gained through the past six years, much more rapid progress was made in the construction of the multi-cylinder engine. This engine was first operated in July of 1940. Known as the XH-2470, it was a 24 cylinder liquid cooled engine with the cylinders arranged in the form of an H. The two crankshafts were geared through a common reduction gear to the single rotation propeller shaft. This engine was rated at 2400 H. P. for take-off, with a normal rating of 2000 H. P. The first engine completed its Navy acceptance test in April of 1941. An engine was installed in the Vultee XP-54 and was operated for many hours, both at Downey Field, California and Wright Field, Dayton, Ohio.



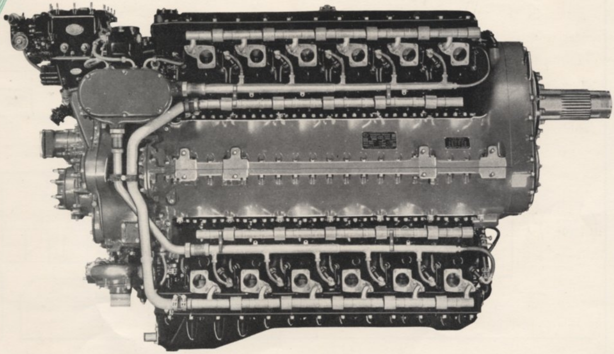
Because the XH-2470 engine was at least twice as large as its predecessor, additional test facilities were required. A large test stand was built at this time so that endurance testing of the complete engine could be carried on, without interrupting the more technical dynamometer work. This stand was so constructed that it was capable of accommodating engines in excess of 5000 H. P. Still another building was constructed for the development of superchargers.

During the summer of 1943 Lycoming engineers and Wright Field Power Plant personnel began discussions of the possibility of developing a still larger engine. Design studies were made and a satisfactory engine type was agreed upon by December of 1943. The new engine was to have a large displacement to horsepower ratio in order to utilize the economic effects of high compression ratio and also require low boost for ground operation. As this work was somewhat different from that previously done, considerable single



cylinder development work was required. The multi-cylinder engine was completed and ready for testing in July of 1946.

The growth of the engine, which had again doubled its size, called for still more improvements in the experimental laboratory. As the existing laboratory had, to a certain extent, just grown up, the need for a new and more modern building was apparent. The plans for the new laboratory were drawn up and construction started in August of 1943. The new laboratory incorporates the latest and most modern scientific equipment now available for the testing of internal combustion reciprocating engines and their components. Facilities are now available for the testing of engines from 65 H. P. up to engines in excess of 7000 H. P. As the Aviation Industry grows, so grows Lycoming.

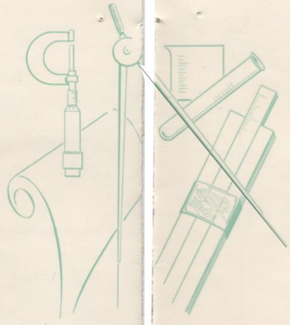


Side View — Lycoming XH-2470

THE NEW LYCOMING EXPERIMENTAL LABORATORY

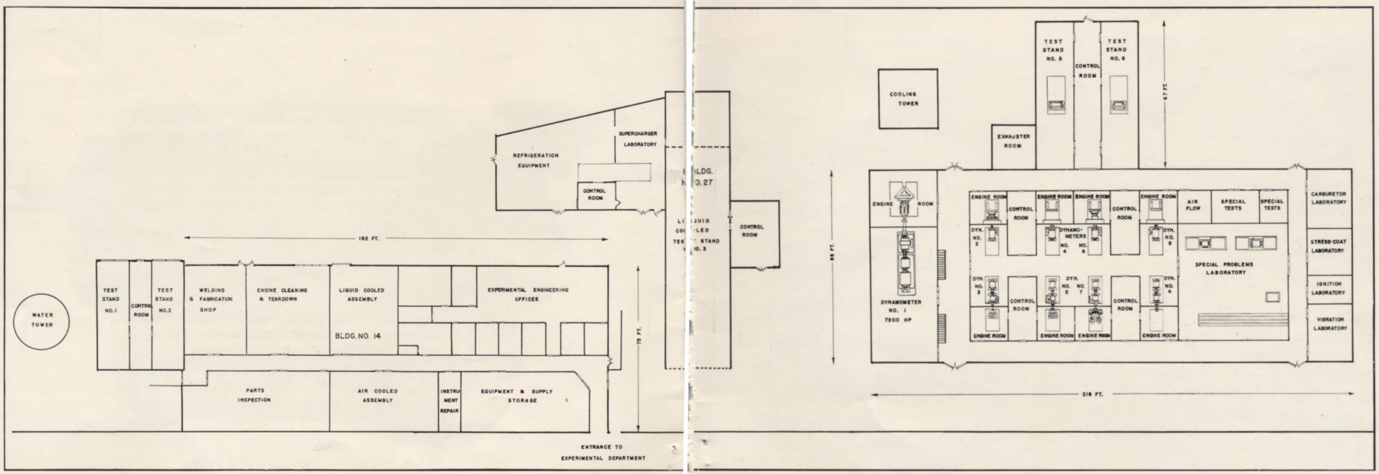
Never before in the history of our nation has the necessity for research and development been so acutely realized as it has been in the past few years. This awareness at Lycoming has resulted in the creation of a laboratory whose scope and facilities would have seemed ridiculously gigantic in the period before the war.

In planning the new laboratory, Lycoming engineers, in cooperation with the Air Material Command, had two basic problems before them: To build a laboratory equipped and of sufficient capacity to develop an internal combustion engine of 5000 horsepower and at the same time provide facilities for the development of small aircooled engines for military training and private personal type aircraft. The program for construction was roughly divided into two parts, the first of which consisted of a complete renovation of the former laboratory building to provide space for personnel, engine disassembly, storerooms and general shop space. The second part consisted in the construction of a new building 88 ft. by 216 ft. in plan.



Of primary importance in any internal combustion engine testing laboratory is its dynamometer equipment. Lycoming's new laboratory has nine dynamometer rooms with equipment varying in capacity from 100 to 7200 horsepower. The dynamometer of 7200 H. P. absorbing capacity is provided for dual opposed rotation and is composed of three units in tandem; one 800 horsepower direct current unit and two absorption dynamometers totaling 6400 horsepower with separate Motor Generator sets and amplidyne controls. There are four direct current dynamometers ranging from 150 to 300 horsepower absorption capacity and are self-excited under generating conditions. Also, there are four combination 150 H. P. and 500 H. P. direct current absorption type units with amplidyne controls and self-excitation.

The laboratory has five test stands, four of which are for air cooled engines and the other for large liquid cooled engines. One section of the laboratory is equipped for special test on such things as coolants, oil pumps, bearings, valve gear mechanism, and reduction gears. This room



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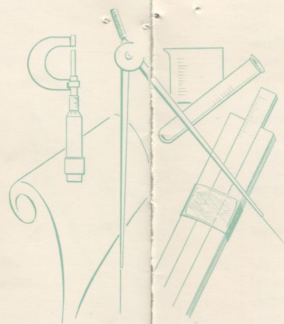
covers an area of 2500 square feet and is equipped with two dynamometers of 50 and 300 H. P. that are suitable for variable speed motoring tests. In addition to this large room, there are three smaller enclosed sound-proof rooms for endurance, fatigue and air flow tests.

Another section of the laboratory is devoted to vibration and electronic tests. Here such instruments as amplifiers, oscillators, oscilloscopes, strain gages, electrical circuits, stroboscopes, and sound analyzing equipment are stored, repaired, and calibrated. In a small room directly adjacent to this, equipment is provided for the testing and checking of generator and ignition systems.

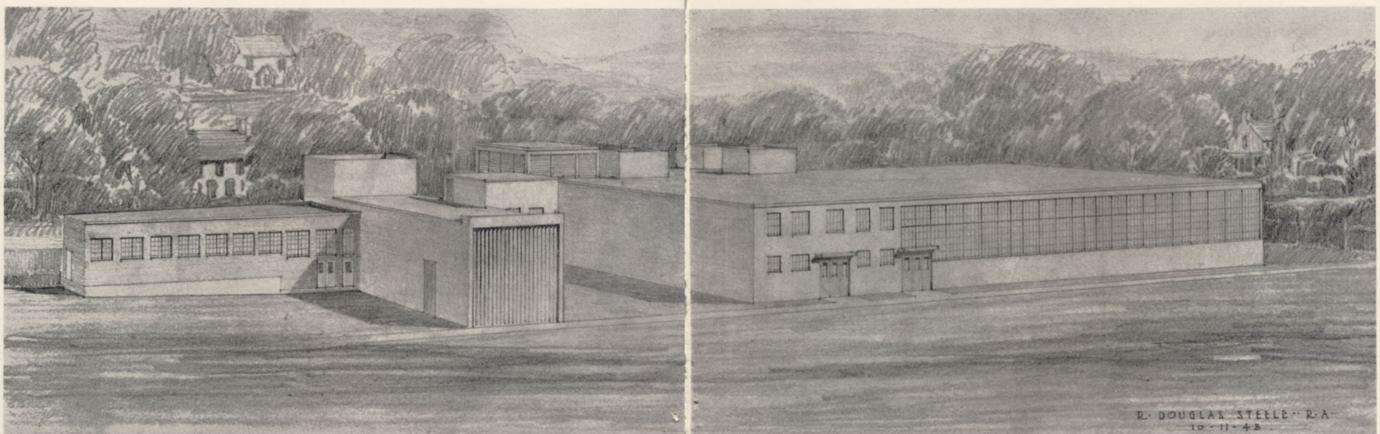
Stress coat and brittle lacquer tests are conducted in an enclosed and insulated room with individual air conditioning system to maintain controlled temperature and humidity conditions. Here investigations are conducted into the strength characteristics of the various engine components.

Carburetor and fuel injection tests are carried out in a room that is both fireproof and individually ventilated. It is fitted with a carburetor flow bench and an injector test bench for testing fuel injector pumps and injector nozzle characteristics. The supercharger test room is equipped with a 1200 H. P. motor with a geared drive which is capable of handling complete accessory and supercharger sections. Additional space and facilities are provided for various phases of experimental work, such as office space for approximately 140 engineers and mechanical personnel. Equipment and tool store rooms, instrument repair room, teardown and parts cleaning rooms, inspection room, assembly room, fabrication and welding shop, in addition to refrigeration equipment having a capacity of 20,000 lbs. per hour at -70° F. The gasoline supply system consists of nine separate systems having a total capacity of 64,000 gallons. Each system consists of a tank, turbine type deep well pump and distribution lines. A cooling water tower with a re-circulating system to provide cooling water to heat exchangers and absorption type dynamometers is located on a plot adjacent to the main laboratory building.



All the engine and dynamometer base blocks are integral reinforced concrete and completely isolated from the rest of the building. Slotted cast iron bases, grouted on the base blocks are used for direct mounting of the equipment.

All shafting connecting the dynamometers and engines are designed to give minimum torsional vibration and whipping. Air-flex couplings are used on the small dynamometer set-ups while Bartlett Hayward couplings are used on the large dynamometer. The dynamometer engine rooms are provided with low head, large capacity, exhauster fans which are located on the exterior of the building. These fans are designed to



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maintain from two to three inches of water at negative pressure in the engine rooms, thereby eliminating the hazard of carbon monoxide gas. In addition, two of the small dynamometer rooms have connections to high vacuum exhausters permitting engine performance investigation under low exhaust back pressure conditions.

Each engine test activity is provided with an automatic fuel weight system actuated by a toggle switch which is connected with pressure regulators, coolers, filters, weigh scales and flow meters. Also, a fuel selector center is provided outside of each engine room. A recirculating type oil supply system, with automatic temperature control, is provided along with a recording device for measuring temperature. Oil flow consumption and blow-by are also measured.

"Ram" fans are provided with all multi-cylinder dynamometers to control carburetor air pressure. Either refrigerated air or atmosphere air is available for the operator's selection. Single cylinder development dynamometers receive their combustion air from the factory compressed air line after passing through suitable pressure regulators which are remotely controlled from the operator's panel. This is necessary in order to obtain high induction pressures simulating supercharged conditions. Conventional type sharp edge measuring orifices, filters, heaters and coolers are also provided.

All the air cooled dynamometers are equipped with cooling fans which receive their air from the roof through masonry stacks. The inlet stacks to the fans are fitted with an orfice plate for measuring the air flow. A pressure type cooling system with automatic temperature control which is similar to the oil system is provided for liquid cooled engine stands.

Each small dynamometer is supplied with 250 volt direct current from a bank of three motor generator sets for starting and motoring, while for generating they are self-excited in order to reduce line surges to a minimum. The generated power is dissipated in resistor grids that are located on the top of the building. Four of the small dynamometers which are composed of both direct current and absorption machines have amplidyne control which permits either single, direct current, absorption operation or combined operation with proportional loading. The 7200 H. P. dynamometer has a similar control arrangement, excepting only that it has separate motor generator sets and the generated power is fed back into the line. A central control room is located directly adjacent to the supervisor's office. Every effort has been directed to keep all individual engine test controls closely grouped and within easy reach of the operator. These controls consist of such utilities as the main fuel pump, water circulating pumps, and motor generator sets. Safety controls are also provided to prevent damage from over-speeding or loss of oil pressure.

Certain features in the overall design have been incorporated that are distinct improvements of heretofore existing systems. For example, all equipment and piping is in the open and so arranged as to facilitate maintenance. Nothing excepting drains is hidden underground nor in trenches. All electrical starting equipment for the motors required on each test activity is installed in a centrally located starting center for each activity with remote push button stations located in each control room.