

BACKGROUND, F-1 ROCKET ENGINE

The F-1 is the most powerful rocket engine to be ordered into production in the United States. It is a single chamber, liquid propellant engine of conventional, proven design developing 1,500,000 pounds of thrust.

The engine has been under development at the Canoga Park plant of Rocketdyne, a division of North American Aviation, Inc. since 1959, under the technical direction of NASA's Marshall Space Flight Center, Huntsville, Ala.

Basic components of the F-1 engine are a tubular wall thrust chamber, direct drive turbopump, a gas generator and its injector and controls for these components.

The thrust chamber assembly consists of a regeneratively cooled, tubular-wall chamber with a gas-cooled extension. The chamber is designed for attachment of the gas-cooled nozzle to facilitate transportation of the engine.

The turbo-pump, which is mounted on the thrust chamber "piggyback" fashion, develops 60,000 horsepower, yet weighs only about 2800 pounds. It moves two tons of liquid oxygen and nearly one ton of narrow-cut kerosene (RP-1) to the engine combustion chamber per second.

To eliminate the need of flexing high-pressure ducting when the engine is gimbaled for thrust vector control, all components are either mounted on the thrust chamber or turbopump assemblies or in the plumbing system between them.

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The engine was designed to the man-rated safety concept, which requires that it be dynamically stable. If any of the engine's systems are disturbed from any source, the system must automatically overcome the disturbance and return to stable operation.

To prove the F-1's ability to stabilize, a method for creating artificial disturbance was introduced by detonating a bomb inside the combustion chamber near the injector face. Different injector designs were evaluated according to their ability to recover quickly from such disturbances. The result is an injector design in the present production configuration of the F-1 engine that has proved to be very quickly self-stabilizing in response to induced disturbances.

The first F-1 production engine was delivered to MSFC on Oct. 30, 1963. To date 16 production and two development engines have been delivered to Huntsville. Subsequently, engines will be delivered to the Boeing Company at NASA's Michoud assembly facility, New Orleans, La.

F-1 completed flight rating tests on Dec. 16, 1964 and was declared by NASA to be ready for cluster firings and actual flight.

Through Aug. 2, 1965, Rocketdyne had conducted 1081 tests of F-1 at the NASA Rocket Engine Test Site, Edwards, Calif. Of these tests, 278 were for 150 seconds or longer, the approximate time the engine will be required to operate in flight. The longest duration that an engine has been operated to date is 186 seconds. The highest thrust achieved by a single F-1 engine was 1,695,000 pounds, recorded during a research and development test conducted on June 22, 1965.

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