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SANTA MONICA, Calif., Sept. 25 -- The perfect three-for-three flight record of the NASA-Douglas S-IV stage of the Saturn rocket is the result of one of the most intensive ground qualification testing programs ever attempted.

An all new upper stage rocket with six engines clustered together might be expected to show a high level of failure--especially one that pioneers the use of hard-to-handle cryogenic (super cold) propellants--liquid hydrogen and liquid oxygen.

But the S-IV developed at the Douglas Missile & Space Systems Division here, functioned perfectly in its first three flights.

"It costs too much these days to let any mistakes get into the air before they show up," Douglas engineers say.

Their assignment from NASA's Marshall Space Flight Center was to show, on the ground, that safe and reliable operation of all S-IV systems could be expected with full confidence.

Every unproven component of the S-IV was tested repeatedly. "Breadboard" models of each design were tried first. Then each part was tested in its final design. The components were then tested further, in a subsystem, and again as part of a complete system, to eliminate any "interface" problems.

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The S-IV original test plan, written by Douglas engineers before development was fully under way, listed 270 components for such intensive testing. The list grew as design progressed.

For most parts, tests had to be repeated in several different "environments" of heat, cold, vibration, acceleration or electrical interference--all of which might be encountered in flight.

On the first S-IV flight vehicle, for instance, more than 150 subsystems were qualified. More than 2200 tests were conducted for the single vehicle.

Even after the S-IV's successful maiden flight on January 29, 1964, more than 100 additional multi-environment ground qualification tests were made on the second flight vehicle, which went into orbit on May 28.

More than half the S-IV test activity concentrated on the new hydrogen-oxygen propulsion system. In addition, there were 54 test runs, in less than two months, on a unique helium heater (actually a small rocket engine in itself) used to provide pressurization gas for the S-IV liquid oxygen tank.

Another 23 per cent of the S-IV tests were devoted to the vehicle electrical system. All circuits that generate operational sequence signals for the various systems had to be qualified on the ground.

Balance of the S-IV ground test program involved structural and mechanical tests of the vehicle itself, its instrumentation, hydraulic and range safety systems and the tanks and insulation

for the cryogenic propellants. Tests-to-destruction were conducted on all major structural components to determine actual ultimate strengths.

In all tests the emphasis was on the effects of vibration and acoustical environment because of the extreme vibration and noise created by Saturn's eight powerful first-stage engines.

With their test results recorded on miles of electronic graph paper and in a fast-growing stack of reports to NASA, Douglas officials have delivered each operational S-IV to the launch pad at Cape Kennedy in full confidence that it was as fail-safe as engineering skill and human care could make it. Events in three flights have shown that confidence was justified.

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