

*Command and Service Module development*

Command and Service Module development difficulties have been encountered during 1966, principally in the service propulsion tanks and in the Environmental Control System.

*Stress corrosion of titanium propellant tanks*

Last year I reported the problem of stress corrosion with the titanium propellant tanks and the nitrogen tetroxide oxidizer. We resolved that problem by adding an inhibiting agent to nitrogen tetroxide, allowing us to use the tanks safely without a hardware change. An extensive test program has verified that a small amount of nitric oxide (less than 1 percent) effectively stops the stress corrosion.

More recently, another fluid incompatibility with titanium has been encountered: methyl alcohol (methanol). In late October 1966, one of the titanium tanks in the Service Module of Spacecraft 017, planned for use on the first Apollo/Saturn V flight, failed during pressure test at the North American Aviation plant (fig. 43, MA66-9169). One of the two main fuel tanks exploded, causing extensive damage to the Service Module. Methyl alcohol was used for this test to avoid using the actual propellant, a hydrazine blend which is toxic. The tank that failed had successfully passed several acceptance "proof" pressure tests previously at significantly higher levels of stress than that at which it failed. From analysis of the failed tank and from laboratory specimen tests at the Manned Spacecraft Center, Langley Research Center, North American Aviation, and Boeing Co., we have determined that the titanium alloy from which these tanks are made is very susceptible to stress corrosion cracking under methyl alcohol exposure. This phenomenon has been observed and verified at stress levels of approximately 100,000 psi, which corresponds to our tank operating pressure.

We immediately alerted the technical community to this incompatibility and are documenting and making available all test data. Although the use of methyl alcohol as a test fluid has been stopped, this difficulty highlights the importance.



FIGURE 43