

50th IAA HISTORY OF ASTRONAUTICS SYMPOSIUM (E4)  
Scientific & technical histories (2)

Author: Dr. Benjamin Davis  
Dulles University, United States, ben.davis35@verizon.net

FROM DEALER OF DEATH TO GUARDIAN OF LIFE: MAN-RATING THE GEMINI TITAN II  
LAUNCH VEHICLE**Abstract**

There is a significant difference between a launcher designed to kill and a launcher designed to protect lives. Performance requirements are different, design parameters are more stringent, and reliability standards are higher. The Air Force Titan II ICBM had to make this transition when it was selected as the launcher for the Gemini program. The Air Force was charged with the defense of the nation, and the Titan II was a proven, acceptably reliable launcher. Changes, it was feared, would add weight and could compromise reliability, hence the Air Force was reluctant to make any revisions.

In man-rating the Titan II, NASA faced technical and managerial problems. The technical issue that caused the greatest difficulty was “pogo,” longitudinal shaking in the first stage. Unmanned launchers can accept more “pogo” than can manned launchers, and the Air Force had finally achieved a level acceptable for a nuclear missile. This, however, was significantly greater than what NASA felt it could subject astronauts to in flight. NASA’s limit was  $\pm 0.25$  g while the Air Force was willing to accept  $\pm 0.60$  g. It took intervention by Air Force General Schriever to prod the Air Force and the contractor, the Martin Company, to resolve the problem. Fuel accumulators and oxidizer standpipes were added, and the goal was finally accomplished.

The elimination of “pogo” was not the only technical issue addressed. A malfunction detection system was installed to provide information to the pilots so corrective action could be taken. Redundant systems were added to assure there would be no launch failures. Tracking, hydraulic, and electrical systems were modified to improve reliability, and the inertial guidance system was replaced by a radio-controlled system. In the second stage, combustion instability had to be corrected (it was statistically stable but not sufficiently stable enough for man-rating) and propellant tanks were lengthened to provide a longer burn time.

The managerial issues included addressing the competing goals and requirements of NASA and the Air Force as well as issues with quality control on the part of the contractor. Costs for the modifications soared and had to be more tightly controlled, and NASA had to force stronger operational controls on the part of the manufacturer.

The changes worked – there were no failures of the Titan II booster during the complete program, and Gemini met program objectives. How this came to be is the focus of the paper.