MINUTEMAN III GUIDANCE AND PROPULSION REPLACEMENT PROGRAMS (GRP)

Air Force ACAT IC Program

Total Number of Systems:	500 missiles deployed
Guidance Replacement Program (GRP):	652 guidance units replaced
GRP Program Costs (TY$):	$1.889B
GRP Unit Costs (TY$):	$2.9M
GRP Production:	December 1999
Propulsion Replacement Program (PRP):	607 boosters remanufactured
PRP Program Costs (TY$):	$2.589B
PRP Unit Costs (TY$):	$4.3M
PRP Production:	2QFY01

Prime Contractor

ICBM Prime Integrating Contractor (TRW)

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2020

Minuteman III is an Intercontinental Ballistic missile (ICBM) deployed in hardened silos. Five hundred Minuteman III ICBMs and 50 Peacekeeper ICBMs together form one leg of the Strategic Triad of bombers, submarine-launched ballistic missiles, and ICBMs that provide strategic nuclear deterrence for the United States. Operational basing support for Minuteman III includes missile alert facilities,

hardened launch facilities, and underground launch control centers. Minuteman III bases are currently located at Francis E. Warren AFB, WY; Minot AFB, ND; and Malmstrom AFB, MT.

The ***Guidance Replacement Program (GRP)*** is a set of hardware and software modifications designed to extend the service life of the Minuteman III while preserving its current capabilities. This program is needed to prevent a projected decline in reliability due to aging electronic components and unavailable replacement parts. GRP replaces the guidance computer, signal converters, and power distribution components while retaining the current Minuteman III Inertial Measurement Unit (IMU). Affordability considerations precluded IMU replacement, which would have permitted improvements in accuracy and more significant improvements in reliability and availability. GRP is required to preserve current accuracy and reliability while enhancing supportability. Since the threshold requirement for the GRP was to maintain current Minuteman III capabilities, the Operational Requirements Document (ORD) and evaluation criteria for the GRP were derived from the performance and specification of the presently fielded Minuteman III guidance system (designated the NS-20). GRP reached Milestone III in December 1999, and is currently in full-rate production. The program achieved Initial Operational Capability, defined as having ten GRP-modified guidance systems (designated the NS-50) with an excess of 720 hours of operation plus four spares on July 20, 2000.

The ***Propulsion Replacement Program (PRP)*** will extend the life of the MM III operational force by replacing the solid propellant propulsion sub-systems. The solid propulsion systems now in the force are projected to begin aging out in 2002 and must be replaced in order to support current force planning. PRP is being executed in two phases, Technology Insertion (TI) and Remanufacture. During the TI phase, new materials and manufacturing processes were qualified to replace unavailable or environmentally prohibited materials (e.g., ozone depleting chemicals). During remanufacture, the solid rocket motors and inter-stage hardware and ordnance are being recycled from the force and remanufactured at a rate of up to eight motors per month during the FY00-FY08 period. PRP is currently in LRIP. PRP is required to preserve current Minuteman III effectiveness and suitability characteristics.

As ***Joint Vision 2020*** looks to the future of America's armed forces, it also provides a vision for America's continuing strategic requirement. As an important component of the Strategic Triad, Minuteman III directly contributes to ***precision engagement*** with its flexibility to re-target its weapons when required.

BACKGROUND INFORMATION

The DOT&E approved TEMP and Test Plan for GRP incorporated a test concept that combined a series of developmental and operational tests and culminated in two operational test flights in 1998. The TEMP acknowledged that a data base of two flights was insufficient for confident estimates of accuracy and reliability. The test methodology relied upon extensive Hardware-In-The-Loop simulations and engineering estimates to help mitigate the risks that attend this small sample size. It was understood that observations taken from follow-on operational test flights with the modified guidance system and the two Propulsion Replacement Program flights, which require the modified guidance system, would expand these data bases. GRP test and evaluation ran from 1994-1999, and comprised 17 discreet test and evaluation events. DOT&E staff and support personnel observed ground and flight tests throughout the test program.

DOT&E prepared a B-LRIP report for the Guidance Replacement Program in December 1999. Based on the information collected and analyzed during IOT&E, and the combined developmental and

operational test activities preceding it, DOT&E determined the GRP upgrades to be operationally effective and suitable. However, in the B-LRIP report, DOT&E indicated that there had been insufficient numbers of flights to confirm accuracy and reliability assessments. Specifically, the GRP program's two flight tests and the PRP program's two subsequent flight tests, all four using the NS-50 guidance system, had not decisively demonstrated that the GRP-equipped MM III met the accuracy threshold listed in the ORD. GRP proceeded to full-rate production in December 1999. Although GRP testing was adequate to support the Milestone III decision in December 1999, DOT&E requested that additional test data from the PRP flight tests and the Air Force Space Command-conducted Force Development Evaluation flight test program continue to be collected and analyzed to strengthen evaluations of accuracy, availability, mean time between maintenance, and service life.

TEST & EVALUATION ACTIVITY

All programmed Operational Test events have been completed for the Guidance and Propulsion Replacement Programs. AFOTEC conducted Early Operational Assessments and IOT&E on both replacement programs, and also collected extensive information during Hardware-In-The-Loop developmental testing. The results of both Early Operational Assessments were satisfactory. AFOTEC determined in its April 1999 final IOT&E report that GRP was operationally effective and suitable. AFOTEC began dedicated IOT&E in January 2000 for the Propulsion Replacement Program. The second demonstration flight test of May 24, 2000 was the last dedicated IOT&E event, but AFOTEC continued to monitor static firings into September 2000. AFOTEC is currently preparing its final IOT&E report for PRP.

Considerable Propulsion Replacement Program test activity continued throughout FY00, culminating in two capability demonstration launches on November 13, 1999 and May 24, 2000. Although the propulsion objectives of the capability demonstration launches were achieved, both launches experienced anomalies. The final evaluation report for the first Flight Test (FTM-1) revealed a higher than predicted use of injectant by the Stage 3 Liquid Injectant Thrust Vector Control system during the flight. While FTM-1 completed the test mission, the program determined that the high injectant usage rate was caused by the misalignment of the Stage 3 nozzle due to a flaw in the alignment process. The necessary corrections to the alignment process delayed the second flight test from February-May 2000. The re-entry vehicle miss distances were considerably larger than the requirement specified in the ORD. FTM-2 was launched on May 24, 2000, but it terminated pre-maturely when stage separation did not occur. An Air Force investigation found that the anomaly occurred in the Stage 3/Propulsion System Rocket Engine (PSRE) separation event. The arm/disarm switch for the ordnance that separates Stage 3 from the PSRE was at fault. The Air Force report concluded that the anomaly was an isolated problem that was not related to the PRP, GRP, or PSRE programs. Unfortunately, this fourth flight test using the GRP-modified NS-50 guidance system did not provide any accuracy data.

On September 28, 2000, Air Force Space Command launched two Minuteman III ICBMs configured with the GRP-modified NS-50 guidance system, each carrying two instrumented test re-entry vehicles from Vandenberg AFB to the Kwajalein Missile Range. The short-time interval launches occurred within two hours of each other. The four instrumented test re-entry vehicles were scored, but the quick-look impact data again did not decisively demonstrate that the accuracy key performance parameter had been achieved. Two more flight tests are scheduled in February and June 2001.

TEST & EVALUATION ASSESSMENT

DOT&E's conclusions concerning the accuracy of the Minuteman III guidance replacement package have not changed since issuing the GRP BLRIP report. When the report was written, the Air Force had conducted three flight tests with the new guidance system. As noted previously, a fourth accuracy data point did not subsequently materialize due to the premature termination of the FTM-2 flight test. Flight test data available to date are insufficient for a determination as to whether Minuteman III accuracy requirements are being met. Accuracy is a key performance parameter in both the GRP and PRP ORDs.

Early test planning recognized the limitation of conducting only two flight tests for GRP and two more flight tests for PRP. Since flight test assets are taken from a finite number of available spares that must sustain the operational force through 2020, the Air Force made a strong case that the "Engineering Estimates" accuracy model, validated with years of accumulated data from flight testing using the pre-GRP NS-20 guidance system, was the most cost-effective means to evaluate the GRP-modified NS-50 guidance system. This approach balanced the sustainment and test needs of the operational force against the need to test the GRP and PRP modifications. Since the NS-50 was designed as an electronic component replacement program and not a totally new design guidance system, the Engineering Estimates model was adjusted for the parameters affected by the GRP modifications, and the test community accepted the model as a valid way to evaluate the accuracy of the modified NS-50 guidance system. AFOTEC used the Engineering Estimates model and analyzed actual flight test data relative to the model's prediction to evaluate the issue of operational effectiveness. The Air Force maintains that NS-50 performance falls within the family of NS-20 demonstrated results over the history of the Minuteman III program. Based on the NS-50 flight tests to date, DOT&E is not convinced that the NS-50 results belong to the NS-20 family of results. Additional flight testing is required.

Due to inconclusive accuracy results of the first four NS-50 flights, DOT&E now requires four additional NS-50 flight tests to support the PRP B-LRIP report. The PRP TEMP is being modified to reflect the additional flights, which will use already scheduled Force Development Evaluation (i.e., follow-on operational) flight tests of Minuteman III ICBMs configured with the NS-50 guidance system. As noted earlier, two of the four additional flight tests were conducted on September 28, 2000, but accuracy data has not yet been available for DOT&E analysis. DOT&E will prepare a PRP B-LRIP report after results of additional flight testing are available. In the interim, the PRP has entered a second year of LRIP.

CONCLUSIONS, RECOMMENDATIONS AND LESSONS LEARNED

The Guidance and Propulsion Replacement Programs came under OSD oversight well after the initial TEMPs had been developed. DOT&E accepted the test methodology and approach after-the-fact, including reliance on the Engineering Estimates accuracy model and only four capability demonstration flight tests. However, the four capability demonstration flight tests were not enough to decisively demonstrate that the accuracy key performance parameter in the GRP and PRP ORDs had been achieved. The Engineering Estimates accuracy model predicts a slight improvement in accuracy compared with the Operational Requirements Document threshold, and both programs assumed success. DOT&E would be reluctant to approve such limited flight test planning in the future.