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Reducing the Intercontinental Ballistic Missile Alert Rate and the Impact on Maintenance Utilization

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Air Command and Staff College
Wright Flyer Paper No. 26

Air University Press
Maxwell Air Force Base, Alabama

June 2007

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Foreword

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JAY H. LINDELL
Brigadier General, USAF
Commandant

Abstract

We have been at war for four and one-half years. The financial burden of executing Operations Iraqi Freedom and Enduring Freedom caused military services to undergo extensive cost-cutting efforts. The intercontinental ballistic missile (ICBM) community is not exempt. Recently, the Air Force Nuclear General Officer Steering Group (AFNGOSG) requested an additional study of lower missile readiness rates, presumably to identify any potential cost savings from reduced maintenance and security footprints. This research offers an initial study by analyzing the impact of lowered ICBM alert rates caused by not repairing off-alert missiles until a lowered alert-rate threshold is reached and any correlation to a potential decrease in daily ICBM maintenance team utilization.

The intent of this research is to provide an analysis of the ICBM maintenance team utilization at the current ICBM alert rate and at lowered alert rates. Quantitative research methodologies are used to model historical ICBM maintenance data from the 341st Maintenance Group (MG) and simulate future maintenance team utilization at both the current and decreased ICBM alert rates.

The results of this simulation and modeling show negligible savings in overall ICBM maintenance team utilization. One maintenance section under study showed a statistically significant but slight increase in team utilization as the alert rate decreased. Another section under study exhibited a slight decrease in team utilization deemed statistically significant, however, extremely hard to quantify as the increase in team utilization was only .62 percent. The remaining four maintenance sections under study had statistically the same team utilization at all alert-rate levels.

Acknowledgements

Many individuals were vital to the accomplishment of this research paper. I would like to thank CMSgt Leslie S. Ellis, Technical Advisor in the 341st Maintenance Group (MXG/TA), Malmstrom AFB, Montana, and the dedicated personnel in the Plans and Programs branch at the 341st MXG, MSgt Norman T. Vercolen and SSgt Sunshine M. Johnson, who provided all the data for the model along with Capt Tamiko L. Ritschel and SMSgt Michael T. Dawson, Air Force Logistic Management Agency, Maxwell-Gunter Annex AFB, Alabama, who designed and programmed the model for this study. Additionally, I would like to extend a special thanks to Col Randy B. Tymofichuk, Air War College, Class 2006, Maxwell AFB, Alabama, who provided both exceptional knowledge and mentoring throughout the entire process of my research.

Introduction

The intercontinental ballistic missile (ICBM) system has been a key deterrent force of the United States for over 40 years. The maintenance teams within the ICBM system maintains alert rates (total number of missiles alert ready divided by the total number of missiles in the force) at approximately 98 percent annually. The current version of the weapon system, the Minuteman III, is deployed at three wings: Malmstrom AFB, Montana (200 ICBMs); Minot AFB, North Dakota (150 ICBMs); and F. E. Warren AFB, Wyoming (150 ICBMs). Each unit maintains high alert rates, directly attributed to the maintenance effort providing a deterrent posture and combat capability. The ICBM system is the foundation of a rapid global response and maintains the highest alert readiness of America's Cold War–era nuclear triad (ICBMs, submarine-launched ballistic missiles, and bomber forces). The weapon system continues to be alert ready 24/7 fulfilling national security requirements.

Supporting the global war on terrorism (GWOT) and ongoing operations around the world created a budget shortfall, forcing the Air Force to consider measures to save resources. The Air Force expects to be $733 million short in personnel funding, and based on current burn rates, there was a projected $3 billion shortfall in operations and maintenance (O&M) funds by the end of the fiscal year 2005 (FY 05).[1] With fewer funds available, increased security requirements including physical security upgrades, and new methods for countering threats against the ICBM force in the post-9/11 world, coupled with the most intensive ICBM weapon system modernization program in history, ICBM programs, requirements, and policies are under review.[2] Recently, the Air Force Nuclear General Officer Steering Group (AFNGOSG) requested an "additional study of lower requirements for missile readiness (alert rate)."[3] There are many perceived benefits of lowering the ICBM alert rate. One of these benefits that is by lowering the alert rate the ICBM maintenance team utilization will also decrease, thus generating cost and resource savings.

The simulation used is a joint effort using Arena Rockwell Automation software in cooperation with the Air Force Logistics Management Agency (AFLMA) to model maintenance-team utilization at various alert rates (see appendix A for Arena synopsis). Data input for the model consisted of historical data during a six-month period (1 May 2005–31 October 2005) from the 341st Maintenance Group (MG), Malmstrom AFB. Using data inputs and an alert rate of 98.5 percent as the standard, an initial forecast was developed as a baseline. In subsequent simulation runs, the alert rate was reduced to 90 percent and 80 percent, respectively. The output of each modified alert rate was then compared to the current alert rate's output followed by comparisons in maintenance-team utilization.

The expectation is that lowering the ICBM alert rate will not generate any statistically significant savings in the maintenance-team utilization, and any decrease in maintenance-team utilization will only occur in two of the maintenance sections under study. Ongoing maintenance of the launch facilities will negate any savings realized.

Background

A detailed review of maintenance execution and prioritization, ICBM maintenance teams, impact of modifications programs, security resources and environment, and ICBM alert rates was conducted. These areas were critical to formulate data to model and build a simulation. To comprehend ICBM maintenance, a general understanding of the aforementioned items is essential. This section provides a brief explanation of the current ICBM maintenance-operating environment.

Maintenance Execution and Prioritization

Executing ICBM maintenance is unlike any other type of Air Force maintenance. Maj Gen Tom Neary, USAF, retired, former 20th Air Force commander, stated it best, "While operations at most Air Force installations occur on a collocated flight line, ICBM maintenance technicians . . . can travel up to [and in some cases more than]150 miles one way to reach their ICBM launch and alert facilities."[4] In order to perform maintenance, ICBM maintenance technicians dispatch to missile fields ranging in size from 8,600 square miles (Minot AFB) to 23,000 square miles (Malmstrom AFB).

When a maintenance team dispatches to the missile field, they perform maintenance at a launch facility (LF) or a missile alert facility (MAF) (see appendix B for MAF and LF diagrams). A LF is a hardened silo containing one missile. It has operational ground equipment that makes it independent of external support. The facility is hardened to withstand conventional and nuclear attacks. Additionally, an LF has a launcher support building (LSB), a ground-level-buried building adjacent to the launcher, housing a diesel generator, environmental control systems, and other real property installed equipment (RPIE). These sites are unmanned; however, a security system designed to detect unauthorized activity at the LF maintains security.[5] A MAF contains an above ground support facility and a below ground launch control center (LCC). The LCC houses a two-person launch crew who "pull alert duty" and operational ground equipment (OGE) necessary to exercise command and monitor status over the LFs and to communicate with higher command authorities.[6] Like an LF, it too contains a support building with various RPIE items.

Additionally, a structured maintenance priority system serves as a guide in the conduct of both day-to-day maintenance and weapon system modernization. Air Force Space Command Instruction (AFSPCI) 21-114, *Intercontinental Ballistic Missile (ICBM) Maintenance Management*, 1 May 2003, table A2.1, delineates maintenance prioritization on a scale of 1 to 9 (see appendix C for priority designators). Priority 1 (P1) maintenance is the highest priority and requires the repair of critical equipment needed for safe weapon system operations and maintenance actions needed to prevent damage to the weapon system, to avoid personnel injury, and to render the weapon system safe.[7] Priority 2 (P2) maintenance, for the purpose of this study, deals with bringing off-alert missiles (failed missile or ground equipment rendering the missile not launch capable) to alert status, and maintenance required to reposture LFs returned from modification or test programs. These actions make up the majority of the major maintenance activities.

Major maintenance involves maintenance requiring an open launcher closure (LC) door.[8] The LC covers the silo portion of the LF and is only opened during activities that require aerospace vehicle equipment (AVE) replacement consisting of reentry system (RS), missile guidance set (MGS), propulsion system rocket engine (PSRE), and missile booster replacement, or other seldom-performed tasks such as LC repair. Other priorities having varying degrees of importance require scheduling based on the priority system described above.

Maintaining the Minuteman III weapon system can be a daunting task for maintenance supervisors and technicians. For safety reasons, the maximum duty period for dispatching personnel is limited to16 hours in any combination of on- or off-base duty. In addition, technicians earn an uninterrupted 12-hour-rest period upon completion of an off-base dispatch or eight hours rest if they remained overnight at a MAF.[9] With preparatory dispatch maintenance activities taking anywhere from one and one-half to four hours, long-drive times from the missile-support base to the LFs, security requirements to "penetrate" (gain access to the below ground silo) the site, severe weather conditions, and postmaintenance activities, actual maintenance time at a LF may be limited. These factors, coupled with restrictions placed on field maintenance activities due to increased security requirements and an increased maintenance tempo accomplishing weapon-system modification programs, make the scheduling and execution of maintenance difficult.

Maintenance Teams

Several maintenance teams are utilized on a day-to-day basis to maintain the LFs and to keep missiles alert ready. Although not every team included in this study has a direct impact on the alert rate, the effect of lowering the alert rate may or may not affect their utilization. The maintenance tempo is dependent on the number and priority of tasks requiring attention on any given day. The teams listed below perform maintenance on an LF, and at times, compete for critical resources (e.g., security teams to penetrate a site). Consequently, one team's requirements may offset another team's ability to perform maintenance.

1. Electromechanical Team (EMT) technicians perform electronic, electromechanical, security, electrical system repair, troubleshooting, and coding of the ICBM weapon system. An EMT normally consists of two Air Force Specialty

Code (AFSC) 2M0X1 technicians.[10] EMT technicians mainly troubleshoot and repair the OGE on LFs and MAFs.

2. Missile Maintenance Team (MMT) personnel remove and replace (R&R) and transport Minuteman III aerospace vehicle equipment. They also perform maintenance on Minuteman III umbilical cables, the suspension system, and the LC system. The MMTs assist missile-handling technicians (MHT) in the R&R of Minuteman III missiles. An MMT consists of five AFSC 2M0X2 technicians.[11] The MHTs were not included in this study because a MMT will always assist LF task performance and normally have control of the LF during maintenance.

3. Facilities Maintenance Team (FMT) personnel perform on-site repair of LF and MAF power and environmental systems. A FMT normally consists of two AFSC 2M0X3 technicians.[12] FMT technicians predominantly troubleshoot and repair the RPIE on LFs and MAFs.

4. Periodic Maintenance Team (PMT) personnel perform preventative maintenance in accordance with (IAW) a scheduled periodic maintenance cycle. A PMT normally consists of at least five AFSC 2M0X3 technicians.[13]

5. Corrosion Control Team (CCT) personnel perform corrosion maintenance at LFs, MAFs and on-base locations. Like a PMT, a CCT has a periodic preventative maintenance schedule to extend the life of the weapon system. A CCT normally consists of four civil service technicians.

6. Minuteman Integrated Life Extension (Rivet MILE) Teams are a maintenance support program that provides programmed depot maintenance at the space wings. Rivet MILE Team actions include the refurbishment of LFs and MAFs during recurring cycles and are critical to sustain the weapon system beyond 2020.[14]

Although this study does not look at maintenance manning directly, appropriate maintenance manning levels are crucial to accomplishing the maintenance workload. Current manning of AFSCs 2M0X1, 2M0X2, and 2M0X3 personnel at ICBM units seems to be healthy. In fact, at the 341st MG, AFSCs 2M0X1, 2M0X2, and 2M0X3 manning rates (number of personnel assigned as opposed to the number authorized) are 119 percent, 106 percent, and 138 percent, respectively.[15] However, worldwide AFSCs 2M0X1, 2M0X2, and 2M0X3 manning rates are expected to drop to 93 percent, 91 percent, and 88 percent, respectively, between now and FY 09.[16] Reductions may be attributed to estimated reenlistment and retirement rates coupled with accession numbers falling below the norm required to sustain the 2M AFSCs during FY 05–FY 08. The potential ramifications are a reduced number of three- and five-skill-level workers needed to accomplish maintenance in an environment of increasing workloads due to current and future modifications. This may require personnel who are more senior and currently serving at the supervisory level to perform maintenance instead of their current supervisory duties.

Modification Programs and Increased Workloads

In 1999 the ICBM community embarked on a massive $8 billion service-life extension and force modernization program expected to continue through 2012, thus increasing the Minuteman III weapon system's viability until 2020. Today, the propulsion replacement program (PRP), guidance replacement program (GRP), PSRE life extension program, single reentry vehicle program (SRV), safety enhanced reentry vehicle program (SERV), and environmental control system (ECS) replacement program are a few of the 64 modification programs either funded, or proposed, dealing with AVE and OGE.[17]

These programs place huge demands on maintenance technicians and security forces. Aside from the normal accomplishment of scheduled, unscheduled, and periodic maintenance, team utilization increased due to the workload associated with the modification program without an increase to the 2M0X1, 2M0X2, or 2M0X3 AFSC's manning authorizations. At the onset of the modification programs, estimation showed that each ICBM unit would have an increase of 66 maintenance dispatches, six open LC doors, and four RS convoys per month.[18]

Security

Protection of the Minuteman III weapon system is critical to national security. The primary goal of security is the protection of the nuclear weapon, the RS. When a maintenance team dispatches to penetrate a LF, they have a specified number of security escorts, called a security escort team (SET) allotted. SETs are required only when a maintenance team is to penetrate the silo portion of the LF. Additional requirements ensure a much larger security force is available to respond if a hostile event occurs. A larger security force is required when performing major maintenance activities.[19] The post-9/11 environment and revisions of security directives, such as the Department of Defense (DOD) C5210.41-M, Nuclear Weapon Security Manual (U), March 1983, increased security forces (SF) personnel requirements for day-to-day maintenance activities and physical-security modifications on LFs. Maintenance production is often directly tied to the number of SF personnel available to provide site security. With increased demands on SF personnel and no subsequent increase to manning, lower-priority maintenance is sacrificed to accomplish higher-priority maintenance to maximize alert readiness. Maintenance production supervisors must deconflict all requirements to ensure maintenance teams, security escorts, and fielded security forces are available to meet weapon system maintenance demand.

Alert Rates

> *When we had 1,052 [ICBMs], we had room to spare. Now with 500 [ICBMs], I can guarantee you, we've got 500 targets for those 500 missiles, so the value of each one of these ICBMs is extremely important, and we can see that in the words of our President and the words from all our leaders.*
>
> Brig Gen Thomas F. Deppe, USAF

Maintaining high alert rates is a team effort of ICBM operators, security forces, civilians, civil engineers, and several others.[20] However, ICBM maintenance-technicians carry the lion's share of the work on their backs keeping the weapon system operating 24/7 in very demanding environments. Whether mandated by Strategic Air Command Regulation (SACR) 66-12, *Maintenance Management,* vol. 1, *Intercontinental Ballistic Missile Maintenance Management Policy and Supervisory Responsibilities*, 30 October 1989, in the Cold War era, or currently by AFSPCI 21-114, ICBM maintenance directives have changed little when dealing with alert rates as compared below:

> All maintenance actions and all management efforts must support the Single Integrated Operational Plan (SIOP). A high alert rate is required; however it must be the product of effective management without compromising safety, security, or maintenance discipline. It addresses the concept that wings (ICBM) establish a level of alert sorties below which it responds . . . at an intensity to preclude an unacceptable alert rate.[21]

> All maintenance actions and management efforts must be directed towards maximum availability of ICBMs in support of the United States Strategic Command requirements and directives. All maintenance organizations are mandated to use all resources in the most effective and efficient way.[22]

The ICBM maintenance philosophy has always been one of aggressively repairing off-alert missiles and providing the war fighter with the maximum number of alert-ready assets. Any change to this philosophy will require a major paradigm shift. The primary causes of off-alert conditions are scheduled and unscheduled maintenance due to failures with AVE or OGE. Scheduled off-alert conditions include any of the many weapon system modification programs such as the GRP, PRP, SERV, PSRE, limited life component (LLC) recycles of the RS, and Rivet MILE. These programs produce the bulk of the maintenance requirements and are time sensitive in nature. A single unit's inability to execute these programs can affect the entire modernization program's delivery schedules and potentially increase program costs. Additionally, weapon-system failures also cause off-alert conditions. OGE failures make up a small part of unscheduled off-alert conditions. The majority of weapon-system failures driving off-alert conditions are MGS failures. In fact, from 1 April 2004 through 31 March 2005, Minuteman III rejections data showed that 49.6 percent of the fleet's MGSs failed. The 341st MXG was slightly below the average at 49.5 percent.[23]

All units calculate off-alert conditions daily and forward that information to higher headquarters in order to calculate the total ICBM force daily alert rate. The following tells how to calculate a unit's alert rate: if the 341st Space Wing has four scheduled off-alert missiles and three unscheduled off-alert missiles, the alert rate is 96.5 percent (193 on-alert missiles/200 total missiles [based on number of hours off alert]).

The alert rate is a critical aspect of this study. This study's purpose is to highlight maintenance teams *not* performing maintenance on off-alert missiles until the alert rate reaches a lower threshold. Using alert-rate thresholds of 90 percent and 80 percent, respectively, this study compared maintenance team utilization at the current rate of 98.5 percent against the aforementioned rates of 90 percent and 80 percent to determine if maintenance team utilization decreased.

Research Methodology

This research used statistical modeling and simulation to evaluate the potential for decreased maintenance utilization at various alert rates. In quantitative research, the researcher classifies features, counts them, and constructs statistical models in an attempt to explain what is observed, and it tends to allow the researcher to remain objectively separated from the subject matter.[24] Models were created using Rockwell Automation Arena software and successive computer simulations were run. In their book *Simulation with Arena*, the authors explain the value of such simulations this way:

> Computer simulation refers to methods for studying a wide variety of models or real-world systems by numerical evaluation using software designed to imitate the system's operations and characteristics, often over time. From a practical standpoint, simulation is the process of designing and creating a computerized model of a real or proposed system for the purpose of conducting numerical experiments to give us a better understanding of the behavior of that system for a given set of conditions.[25]

This study incorporated data obtained from an existing organization's operation over a six-month period. This allowed us to construct a model that replicates the system's behavior and extend it over a three-year period. The simulations injected stimuli of real-world occurrences; certain entities (maintenance tasks performed) were changed to lower the missile alert rate and to gain an understanding of maintenance team utilization under these new conditions.

System modeling used a discrete-event simulation.[26] Discrete-event simulations concern the modeling of a system as it evolves over time by a representation in which the state variables change instantaneously at separate points in time. These points in time are the ones at which an event occurs, where an event is defined as an instantaneous occurrence which may change the state of the system.[27] Each model was run 30 times and comparisons of model runs were made to ensure validity and reliability between models at a 95 percent confidence level. The results of the baseline simulation closely corresponded to actual system performance of the period used for the study, thus validating the correctness of the models logic.

Team Utilization Model

A model developed in coordination with AFLMA analysts demonstrates the impacts of lowering the missile alert rate on daily maintenance team utilization. Using Rockwell Automation Arena software, a model was constructed using six months of historical maintenance production data from the 341st MG. To make the data collection and analysis manageable, data utilized was from only one organization. The unit selected is the most challenging unit from a maintenance point of view. The 341st has the most expansive missile field and 50 more missiles than the other two ICBM units. Even though the unit has additional personnel to compensate for the increased number of missiles, the sheer size of the missile complex presents a bigger challenge. Although similar maintenance philosophies and practices exist between all three units, any attempt to generalize the model between units must take into account differences in personnel and geography.

To construct a realistic model, several factors were considered beginning with input data. The model used real-world maintenance data for the MMT, EMT, FMT, PMT, Rivet MILE, and CCT over a 180-day period, weekends and holidays excluded, as maintenance performance is drastically reduced on the weekends and security escort availability is skewed. On weekends, security forces normally allocate the standard number of available assets, while maintenance teams are at a minimum. This had the potential to show an increase to the overall average of SFs available, allowing the model to increase maintenance production during the workweek. The MAF and all back-shop maintenance were also omitted from the study, as their impact on the alert rate is more indirect. Additionally, special maintenance activities such as the annual code change (surge maintenance where 50 LFs are penetrated in a three- to four-day period) were also omitted, as it would skew the data. These tasks are higher headquarters directed and time sensitive in nature. A unit normally suspends all maintenance of lower and equal priority and schedules every available asset (maintenance and security) during this period. Again, including this period would show higher available assets and not a true representation of day-to-day operations. However, with the exception of code change and weekends, all teams put in the schedule, whether for LF or MAF maintenance, counted in the daily team availability. Once these items were excluded from the 180-day period, there were 114 days of data for model use.[28]

Another consideration was the current maintenance philosophy and how production-scheduling decisions are made using the priority system in AFSPCI 21-114. The priority system allows managers to allocate resources to each job whether they are maintenance teams or SF personnel. With that, final considerations were how many maintenance teams and SF personnel were available over the six-month period, how were they apportioned to perform maintenance, and what maintenance tasks came up over the six months and their frequency. These considerations aided in the identification of entities and resources for the simulation.

Entities

Most simulations involve *entities* that move around, change status, affect and are affected by other entities in the system, and affect the output performance measures.[29] The entities for this simulation are the jobs to be processed. After analyzing the empirical data and applying the researcher's knowledge of ICBM maintenance management and current guidelines in AFSPCI 21-114, the following entities were developed as the primary drivers for the alert rate and daily maintenance team utilization. These drivers in priority order are: P1, maintenance is the highest priority because clearing these types of discrepancies is critical to weapon system safety. Given the national priority of these assets, it will always trump all other maintenance for resources. P2, other off-alert maintenance. This is an off-alert condition caused by ground equipment, not a MGS failure. An EMT or FMT can clear the condition without performing major maintenance activities. P3, major maintenance (Mx). These activities require an open LC door and other major maintenance such as the modification programs, AVE component removal, and LLC requirements are included here. For purposes of this study, MGS R&R due to failure do not count in this entity. It may seem counterintuitive to perform major maintenance prior to working an unscheduled off-alert MGS failure. However, a joint letter currently in coordination from AFSPC, director of Operations and LC states, "We have directed our wings to maintain their maintenance schedule instead of making changes that free resources to immediately work off-alerts [missiles]."[30] P4, MGS R&R. A failed MGS has a direct impact on the alert rate, and the current maintenance philosophy dictates the immediate replacement of this failed component. However, for this study, MGS R&R is also a variable and will become a higher priority at the 80 percent and 90 percent alert rate. P5, other MMT, FMT, and EMT maintenance activities that are generally lower-priority work orders. P6, Rivet MILE maintenance. This is a depot detachment assigned directly to the wing performing depot level tasks. P7, PMT and CCT periodic maintenance tasks. Table 1 displays the discrete distributions for daily job-type arrivals (i.e., the percentage of time that a specified number of tasks are likely to occur on a given day) based upon the data analyzed.

Table 1. Distribution for entity type and daily occurrence rate

Number of Jobs					
Task Type	0	1	2	3	4
P1	73%	21%	5%	1%	N/A
Other off-alert	85%	14.9%	0.1%	N/A	N/A
Major Mx	22%	68%	10%	N/A	N/A

Table 1. (continued)

Number of Jobs					
MGS R&R	75%	24.5%	0.5%	N/A	N/A
Other MMT	69%	28%	3%	N/A	N/A
Other FMT	3.5%	22.5%	68%	6%	N/A
Other EMT	8%	23%	32%	32%	5%
Rivet MILE	29%	31%	40%	N/A	N/A
PMT	37%	39%	21%	3%	N/A
Corrosion	37%	52%	11%	N/A	N/A

Resources

Entities often compete with each other for service from *resources* that represent things like personnel and equipment.[31] The entities listed above are allocated resources based upon the entities priority and resource availability. The following are resources identified for use in the model: EMT, FMT, MMT, PMT, CCT, Rivet MILE, and CCT as well as security escort teams. Table 2 displays the discrete distributions assigned to EMT, FMT, and MMT based on historical data.

Table 2. Distribution for daily team availability

Number of teams available and corresponding percentage

Available Team	*1*	*2*	*3*	*4*	*5*	*6*
EMT	18%	28%	46%	7.10%	0.90%	N/A
FMT	10%	12%	27%	33%	11%	7%
MMT	25%	53.50%	21.50%	N/A	N/A	N/A

For RM and CCT, the assumption was that two teams will be available on a daily basis and PMT will have three teams available (discussed in the limitations section). Additionally, concerning SF availability, the daily guard count fluctuates due to present-for-duty rates, maintenance requirements, and additional guarding requirements due to LF security system malfunctions. Considering the constant fluctuation in guard counts, AFLMA analysts felt a triangular distribution would be more appropriate and a distribution with a minimum of 9.5 percent, a mode of 22.2 percent, and maximum of 30.5 percent daily available security escorts was established based on the historical data.

Model Operation

Analysts ran the simulation 30 times for 945 days for each run, representing three work years (weekdays only) which included a 180-day "warm-up" period, allowing the system to stabilize before data analyses. It is important to note that the simulation did not take 945 days to get the required output; however, in many simulations, as the time frame becomes longer (like months instead of a day), most results being averaged over the run become less variable.[32]

The base model (98.5 percent alert rate) verification ensured it was representative of current operations. Two additional models were created that allowed the alert rate to drop to 90 percent and 80 percent, respectively, before any action (working MGS R&Rs or other off-alerts) to sustain those rates was permitted. All three models ran with the same parameters for comparison of data outputs. The base model works all tasks possible within the constraints of maintenance team and SET availability. The 90 percent and 80 percent models perform within the same constraints; however, MGS R&Rs and other off-alert tasks are not worked unless the alert rate drops *below* the alert-rate threshold. In the base model, the SETs are allocated in the following priority order: P1; other off-alert maintenance; major maintenance; MGS R&R; other MMT; other FMT; and other EMT, RM, PMT, and CCT. The only changes to SET allocation at the 90 percent and 80 percent models were MGS R&R and major maintenance swap priorities. This only affects the draw of resources when the alert rate drops *below* the established threshold. Additionally, the SETs are normally allocated for quick reaction maintenance (QRM) teams (QRM teams are either the FMT or the EMT or a combination of both scheduled for 24-hour coverage to respond to P1 maintenance) and were deleted from the daily guard count because they were considered a sunk cost.

On a daily basis, the model also generates three scheduled off-alert (F-CAT) missiles to approximate what would normally be encountered at a missile unit. These missiles include the training LF and two LFs undergoing Rivet MILE maintenance and impact the daily alert rate. During the simulation's operation, the following tasks affect the alert rate: approximately 10 percent of all P1 tasks (data for this study showed 10 percent of P1 maintenance results in an off-alert condition), the three scheduled F-CAT missiles per day, MGS R&Rs, other off-alert tasks, and major maintenance tasks. Each occurrence of these tasks counts as 24 hours of off-alert time (this is representative of a realistic off-alert time as some tasks may take more time and some less to restore alert status). If a missile remains off alert due to the aforementioned constraints, it will continue to accumulate 24 hours of off-alert time until repaired. The daily alert rate is based on 200 available missiles, resulting in 4,800 possible alert hours per day (24 x 200). The alert rate is calculated at the end of each day, taking into account the above tasks that were worked that day and any work-in-progress remaining. This forms the basis for decision making for the next day's maintenance in the 90 percent and 80 percent models. For example, if the end-of-day alert rate in the 80 percent model is calculated to be 80 percent, no MGS R&R or other off-alert tasks will be worked that day; when the alert rate drops *below* 80 percent, these are worked and only then. The model also calculates team utilization.

Additionally, team utilization is calculated at the end of each day by dividing the number of a particular team type pulled as a resource by the number of the particular team available on that day. For example, if the simulation generates three EMTs available as a resource and there are only enough SETs available to support two teams, the EMT's utilization rate would be 66.66 percent (three teams available but two teams supportable) for that particular day. The simulation, based on the discrete distributions described earlier, generates the total number of teams available on any given day (see appendices D–H for a graphical representation of submodel processes).

Assumptions

Several assumptions made prior to building the model and simulation to best capture actual execution of maintenance that could not be readily extrapolated from the historical data are listed below:

1. All tasks that occur take one full day to complete, and the maintenance teams assigned to complete a task are dedicated to that task only. The one exception to this rule is that the simulation allows an EMT to perform more than one tape load (a required task after a MGS R&R and some major maintenance tasks) per day.[33] The simulation assigns a value of .5 EMTs for a MGS R&R and the major maintenance tasks that require a tape load. Due to the short duration of the task, the EMTs can perform multiple tape loads in a single shift.

2. Priority 1 conditions result in an off-alert condition approximately 10 percent of the time. Allocation of these jobs is approximately 78 percent to the FMT and the remainder to the EMT. Other off-alert conditions were distributed equally between the FMT and the EMT.

3. Periodic cancellations occur within the simulation to capture weather or other events that are normally encountered. Based on the time frame in which the historical data was captured, the mild weather caused no cancellations. Additionally, mass maintenance cancellations were not captured in the historical data. Accordingly, an assumption was made to plan for these events in the simulation to capture real-world cancellations and was programmed to occur initially at the 10-day point and every 40 days thereafter.

4. The model also assumed that vehicles and equipment will always be available and does not account for potential fleet-grounding issues for vehicles or equipment.

Limitations

1. Certain teams such as the RM and the CCT are comprised of civilian employees who normally work a four-day workweek. Furthermore, the PMTs normally work on a three-day schedule when performing periodic inspections on a LF. The model does not account for these as it runs on a five-day workweek schedule, causing the model to reflect lower utilization rates of those teams. However, these sections are flexible and often will work on a Friday if the mission requires them to do so.

2. Additionally, the PMT and the CCT do not always penetrate the LF when performing maintenance. For example, when the PMT does a periodic inspection on a LF, they only penetrate the LF on one of the three days of maintenance. The other two days are spent performing maintenance in the LSB. The model only accounts for those tasks that required LF penetration. Therefore, utilization rates for those team types may appear substantially lower than other team types due to the exclusion of this other productive maintenance.

3. Team utilization is based solely on tasks requiring the LF penetration and does not account for MAF and LSB penetration or maintenance at the support base. Again, these tasks do not require security escorts and may have an indirect impact to the alert rate, and the model does not account for these activities.

4. The biggest limitation of the simulation is not being able to account for the human factor. A model of the maintenance-operating environment can never capture risk management and smart maintenance practice decisions made by those with the authority and the experience. Senior maintenance managers have the authority to choose which maintenance task of equal priority to repair when resources are limited or even to work a lower priority job, if the situation dictates. It is that kind of decision making that allows for risk mitigation and alert-rate optimization, and to keep modification programs on schedule. Unfortunately, a computer program cannot simulate making these decisions.

Results and Analyses

After running the three models 30 times, the average team utilization rates listed in table 3 were output from the simulation at the 80 percent, 90 percent, and 98.5 percent alert-rate levels from the 180- day to 945-day period (stabilized model period). For a detailed statistical review of each team's simulation run and the results after 30 iterations at each alert-rate level (see appendices I statistical formulas and J–O for data extracted from the model). For the MMT, FMT, RM, and PMT, the difference in team utilization between the 98.5 percent, 90 percent, and 80 percent models proved statistically insignificant. However for the EMT, the differences between both the 80 percent and 90 percent simulations as compared to the 98.5 percent simulation showed a 2.8 percent and 2.7 percent increase in team utilization, respectively (which is statistically significant) at the lower alert-rate levels. A potential reason for the increase may be attributed to the fact that the bulk of the EMT's jobs are "other maintenance" tasks. With fewer missiles on alert, additional resources may have become available to allow the EMT to work lower priority jobs, which were previously diverted for higher-priority tasks such as tape loads after the MGS R&Rs and other off-alert maintenance required to maintain a 98.5 percent alert rate. Additionally, the CCT showed a decrease of .62 percent between the 98.5 percent and 80 percent simulations, which was statistically significant in the confidence interval between models. Such a slight decrease in team utilization is extremely hard to quantify. As far as all teams are concerned, any difference in team utilization between simulations was minimal. The following may shed some light as to why.

Table 3. Average team utilization rates (180–945 days)

Team	*80%*	*90%*	*98.5%*
MMT	0.779979	0.788052	0.785959
EMT	0.91369	0.917988	0.890874
FMT	0.605873	0.605264	0.604766
RM	0.558268	0.556527	0.558747
PMT	0.299477	0.301713	0.301144
CCT	0.369517	0.3715405	0.375718

Note: 30 simulation runs at various alert rates

Whether a unit has 10 percent or 20 percent of their missiles in off-alert status, the LFs containing the assembled weapon system and critical components must remain operational. The operational ground equipment and real property installed equipment at each LF needs to remain in an operational state to monitor status and provide critical functions (e.g., environmental controls to support the missile). Regardless of alert status, the EMT, FMT, PMT, RM, and CCT (and in some instances MMT) will continue to perform maintenance at all unit LFs. Periodic inspections by the PMT or the CCT do not affect a missile's alert status, so these teams will strive to meet critical inspection interval requirements. The EMT will continue to troubleshoot ground and security systems faults ensuring weapon system safety, security, and command and status monitoring are maintained at all times. The FMT will continue to troubleshoot and repair all power and environmental problems at the 200 LFs. Additionally, the RM will continue to take missiles off alert for programmed maintenance to sustain the weapon system. The bottom line is 200 LFs (150 at the other units) must be maintained regardless of the designated alert rate. Additionally, the aforementioned teams will always be utilized to execute maintenance. Another potential contributing factor to team utilization rates may be the actual value of each missile at the various alert-rate levels.

A single off-alert missile influences the overall alert rate differently between models. In the 98.5 percent model, there is a baseline of 200 missiles with which to work. The impact of one off-alert missile in this model is a decrease of .5 percent to the alert rate (199 divided by 200 equals 99.5 percent). In the 90 percent and 80 percent models, the baseline changed to 180 and 160 missiles, respectively. A single off-alert missile now has an impact of .56 percent in the 90 percent model and .625 percent in the 80 percent model. Maintenance teams, consequently, will have to work harder to maintain the status quo at the new thresholds.

When running the 80 percent and 90 percent simulation models, it took approximately 75 days for the alert rate to drop from 98.5 percent to 90 percent and 179 days for the alert rate to drop from 98.5 percent to 80 percent (see fig. 1 for graphical representation). The simulation expectation was that team utilization would decrease for the MMT while potentially increasing for all others during the periods allowing missiles to fall off alert without repairing them to reach new target alert-rate thresholds. Tables 4 and 5 show the utilization-rate averages over the first 75 days for the 90 percent and 98.5 percent models and averages over the first 179 days for the 80 percent and 98.5 percent models.

Table 4. Average team utilizations rates (1–75 days)

Team	*90%*	*98.5%*
MMT	0.675	0.79
EMT	0.857	0.861
FMT	0.596	0.605
RM	0.559	0.566
PMT	0.304	0.293
CCT	0.362	0.359

Note: 30 simulation runs at various alert rates

Table 5. Average team utilizations rates (1–179 days)

Team	*80%*	*98.5%*
MMT	0.685	0.779
EMT	0.878	0.873
FMT	0.603	0.602
RM	0.56	0.558
PMT	0.301	0.295
CCT	0.36	0.362

Note: 30 simulation runs at various alert rates

Team utilization for the MMT did decrease significantly during the periods of decreasing alert rates. Their utilization rates decreased by approximately 11.5 percent during the 75-day period (98.5 percent alert rate to 90 percent alert rate) and approximately 9.4 percent during the 179-day period (98.5 percent alert rate to 80 percent alert rate) it took to achieve the new thresholds. However, once the new target alert rates (80 percent and 90 percent) were reached, the MMT utilization immediately increased back to previous utilization rates to maintain the new target thresholds of an 80 percent or 90 percent alert rate. As far as the EMT, FMT, PMT, RM, and CCT are concerned, during the 75- and 179-day period it took for the alert rates to reach the new lowered alert-rate thresholds, team utilization rates varied between models and slightly increased or decreased during those periods. However, any increase or decrease during those periods was statistically the same (see appendices P–U for data extracted from the model).

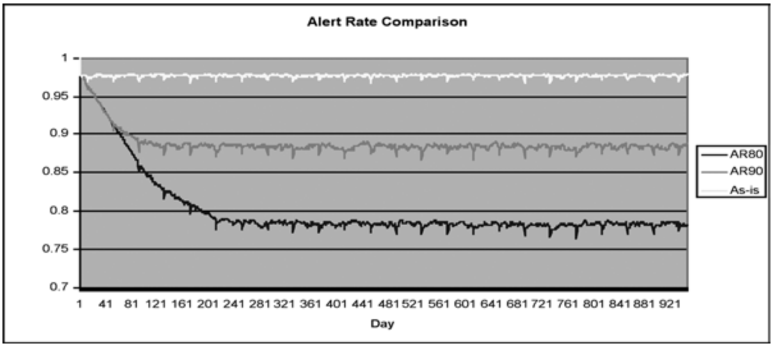


Figure 1. Alert-rate decrease over time for various models

Recommendations

The intent of this research was to determine if ICBM maintenance team utilization would decrease if higher headquarters permitted ICBM units to drop to alert rates of 90 percent or 80 percent. In short, units would not repair off-alert missiles until they reached the new target-alert rate threshold, and then only perform off-alert maintenance essential to maintain that threshold. The thought process behind the study was that if team utilization decreased at these new levels, Air Staff and AFSPC leadership would have the ability to make manpower decisions to generate cost savings by reducing the ICBM maintenance-manpower footprint. However, as this paper shows, there is no corresponding decrease in ICBM maintenance team utilization with a decrease in the alert rate. With that, the following recommendations may inform any final decisions made by senior leaders concerning lowering the alert rate or reducing ICBM maintenance manning.

First continue to repair off-alert missiles and allow ICBM units the flexibility to continue to repair unscheduled off-alert missiles in a timely manner while maintaining their maintenance schedule. This will provide United States Strategic Command (USSTRATCOM) personnel with sufficient assets for their planning purposes. In most cases, it will not result in a missile's off-alert time exceeding 96 hours.[34] One of the biggest problems of allowing the off-alert missiles to stack up, to as many as 20 to 40 missiles in the unit under study or up to 100 missiles fleetwide, is the time it would take to generate the missiles to alert status during higher states of readiness. Generation under current operating parameters occurs in days but may take months if the alert rate were allowed to fall to decreased levels. The immediate replacement of up to 100 MGSs in order to generate poses several problems. In a related study conducted by Col Randy B. Tymofichuk, the simulation was exercised in reverse to demonstrate the timing required to generate from an 80 percent alert rate back to 98.5 percent using the same parameters (team distributions, weekday maintenance only, etc.) as models used in this paper. A lack of personnel manpower and security extended recovery time. This makes such practices unacceptable from a war-fighting readiness perspective. His assessment showed a full recovery time of 62 workdays (based on the unit under study) and did not account for the delivery of assets from the depot required to generate three ICBM wings, thus making even this timing extremely optimistic.[35]

Receiving assets from the depot is another key reason to continue to repair off-alert missiles in a timely manner. There is not an infinite supply of missile guidance sets. Every time a missile guidance set fails, it is shipped to the Boeing Guidance Repair Center (BGRC) for repair or modification IAW the GRP and immediately returned to the serviceable inventory. Leaving failed MGSs in the field until a lowered alert rate is achieved jeopardizes both the GRP modification schedule and PRP. A PRP booster requires a GRP-modified MGS installed on it. At some point, leaving so many failed MGSs in the field will affect both programs, which can come at a cost. The Air Staff estimates any delays to the PRP modification scheduling that breach contract requirements could cost up to $100 million annually.[36]

Second then focus on scheduled maintenance. The ICBM prime contractor, Northrop-Grumman in coordination with the ICBM Systems Program Office, has been working to develop an integration plan that coordinates the execution of all modification programs and LLC exchanges (LLC schedules are very rigid, as time-change compliance is mandated by the Department of Energy). The goal is to provide ICBM units with a roadmap for use in building unit-level monthly and long-range maintenance schedules as well as to help deconflict resource utilization and prioritization to keep delivery schedules intact. Any reduction to the alert rate caused by not repairing off-alert missiles in a timely manner will throw the plan into disarray and jeopardize the modification programs.

ICBM maintenance managers at the unit level have effectively balanced resources, modification schedules, and surge maintenance while providing the war fighter high alert rates. This in large part may explain why the simulation showed no real savings in maintenance team utilization. Unit-level leadership needs to continue to make decisions on when to pursue the cost benefit of performing scheduled maintenance in lieu of unscheduled off-alert maintenance. Although this simulation showed negligible changes in team utilization at lower alert rates for teams that perform periodic maintenance activities such as the PMT or the CCT, the loss of only one or two days of periodic maintenance can take months to recover.[37] Unit-level decision makers are in the best position to maximize scheduling and maintenance effectiveness.

Third, ICBM maintenance manning requires a formal study. Air Force leaders are trying to find ways to save money by cutting resources to meet the costs of Operation Iraqi Freedom, Operation Enduring Freedom, and the GWOT. Their desire to reduce manning while maintaining acceptable operational rates relates directly to this paper as an example of possible savings that does not appear plausible. The lack of a current manning standard for the 2M0X1, 2M0X2, or 2M0X3 career fields place any study at risk. The Strategic Air Command accomplished the last formal manpower study of the ICBM community. According to Headquarters AFSPC Manpower and Personnel and Manpower Requirements, "In the past 20 plus years, the AFSCs have drastically changed which makes it difficult to determine exactly which standard would be [used] for the 2M0s."[38] Additionally, CMSgt Joesph Lafferty, Headquarters Air Force Information and Logistics, AFSC 2M0 functional manager, confirmed, "No manning standard exists for the 2M0 community."[39]

Before resorting to extreme measures (e.g., lowered alert rates), a manning study of all 2M0 AFSCs at ICBM units is recommended to establish levels based on the actual workload requirements of the current environment. Additionally, at the completion of all ICBM modernization programs (tentatively scheduled to take place sometime in 2012), 2M0 AFSC requirements need restudied to meet new maintenance demands. A modernized weapon system may result in increased time between component failures and decreased maintenance requirements.

Finally, previous concepts could be revived and modified to decrease ICBM maintenance manning. One issue brought up during the 2003, 2M0/2W2 Worldwide Conference was a merger of the 2M0X1 (EMT) and 2M0X3 (FMT) AFSCs. However, "due to current issues going on in these AFSCs, this is not something Air Force Information and Logistics (ILMW) will [wants to] pursue at this time."[40] ILMW, in coordination with Headquarters AFSPC/LCM and Air Training Command (AETC), needs to look at the possibility of combining these two AFSCs again. Additionally, within the 2M0X2 AFSC, the same organizations may want to look at combining the Missile Maintenance and Missile Handling Team sections. All 2M0X2 technicians attend the same technical school training and within a MMT or MHT technician's career, the chances are good that they will serve in both sections. The commonality between the sections supports a merger. Combining both the EMT with the FMT and the MMT with the MHT could yield manpower savings. This alone warrants a serious study. Merging sections is not new to ICBM maintenance. The current the EMT section is the result of merging the EMT, security system-maintenance teams, and the combat targeting teams, which took place in the late 1970s and early 1980s after weapon-system modifications.

A final recommendation would be for Headquarters AFSPC/LCM to submit a formal request to AFLMA to conduct a more detailed study of optimizing ICBM maintenance team and security force utilization using data from all three ICBM units. This study may yield potential manpower savings by finding a better way to conduct field operations between maintenance and security forces.

Conclusion

The argument that lowering ICBM alert rates would cause a reduction in ICBM maintenance team utilization, and potentially allow for savings in manpower resources, lacks empirical basis. As the research, modeling, and analyses cited in this paper show, allowing the missile alert rate to drop to 90 percent or 80 percent did little to change team utilization. In fact, four of the teams under study (MMT, FMT, PMT, and Rivet MILE) had utilization rates that were the same from a statistical point of view whether the alert rate was 98.5 percent, 90 percent, or 80 percent. For the EMT section, the utilization rate actually increased at lower alert rates. Again, the bulk of EMT tasks are "other maintenance" tasks. With fewer missiles on alert, additional resources may have become available to allow the EMT to work lower priority tasks. Finally, the CCT did show one statistically significant decrease of .62 percent in team utilization at the 80 percent alert rate level. Thus, no evidence suggests that reduced alert rates will generate manpower savings. However, deleterious effects are likely.

Senior leaders in the ICBM and war-fighting community must take into account and discuss several items prior to reducing the alert rate. While operating under extremely tight budget constraints, senior leaders must consider the potential costs associated with lowering the alert rate. The cost of potential modification program contract breaches in actual dollars and the cost of not sending the MGSs to BGRC to keep inventories at required levels may impact the number of required war-fighting assets needed to generate during real-world contingencies. Additionally, the time and resources necessary to generate all missiles to alert status during potential contingencies should be of great concern. Finally, ICBM maintenance manning levels need attention.

As previously indicated, the 2M0 AFSCs will suffer a manning decrease between now and the FY 07–FY 08 time frame bringing all three 2M0 AFSCs below authorized manning levels. However, the modernization program will continue through FY 12 along with required maintenance. Additionally, whether the alert rate is lowered or not, maintenance technicians must still perform maintenance on either 200 or 150 LFs, depending on the unit. Team utilization rates stayed consistent regardless of alert rate levels because of this. With that, before any further reduction in ICBM maintenance manning is discussed to save future costs, a manpower study must be accomplished to determine a manpower standard. A valid standard could help affect manpower adjustments that yield savings.

For more than 40 years maintenance professionals have kept ICBMs on alert at the levels mandated by the war planners; they will continue to do so. As lowering the alert rate causes no reduction in maintenance team utilization or manpower savings, we must continue to provide high alert rates while balancing current and future maintenance requirements. Maintaining current alert rates maintains weapon system health, continues to feed the modernization program, and provides maximum flexibility to the war fighter with no significant increase in costs.

Notes

(All notes appear in shortened form. For full details, see the appropriate entry in the bibliography.)

1. Byron, "Air Force Officials Project Budget Shortfall."
2. Dawson, "Maximizing Security Forces Response Time."
3. Minutes, Air Force Nuclear General Steering Group.
4. Neary, "Twentieth Air Force From B-29s to ICBBs," 4.
5. Gilbert, "ICBM Handbook (Draft)."
6. Ibid.
7. Air Force Space Command Instruction (AFSPCI) 21-114, 6–9.
8. Ibid., 20.
9. Ibid., 70.
10. Ibid., 53.
11. Ibid.
12. Ibid., 52.
13. Ibid., 53.
14. Gilbert, "ICBM Handbook (Draft)."
15. Hughes, "341st Maintenance Group Summary Supplemental."
16. Punnett, briefing.
17. Briefing, ICBM Long-range Requirements Planning, 5.
18. Briefing, Directorate of Logistics and Communications, Maintenance.
19. Dawson, "Maximizing Security Forces Response Time," 3.
20. Ogden, "Missiles on Target."
21. Strategic Air Command Regulation 66-12, vol. 1, 1-1.
22. AFSPCI 21-114, 6.
23. Briefing, ICBM Program Team, W. R. Faris, subject: Minuteman Field Performance, Minuteman Guidance Technical Review No.18, author has copy, 20 April 2005, 9.
24. Neill, "Qualitative versus Quantitative Research."
25. Kelton et al., *Simulation with Arena*, 7.
26. Discrete-event simulation is used to simulate components that normally operate at a higher level of abstraction than components simulated

by continuous simulators. Within the context of discrete-event simulation, an event is defined as an incident, which causes the system to change its state in some way. For example, a new event is created whenever a simulation component generates output. Successions of these events provide an effective dynamic model of the system being simulated. What separates discrete-events simulation from continuous simulation is the fact that the events in a discrete-event simulator can only occur during a distinct unit of time during the simulation events are not permitted to occur in between time units. (Source: Craig, "Extensible Hierarchical Object-Oriented Logic Simulation.")

27. Law and Kelton, *Simulation Modeling and Analysis*, 6.

28. By removing weekend and specialty maintenance activities, only 114 available data days were available for the model's use. The author, along with AFLMA analysts, felt that the 114 days provided ample data for a realistic representation of the actual maintenance environment, a goal while constructing the model. Adding the specialty and weekend maintenance to the models would have skewed the distributions for maintenance team and security forces personnel availability. It would provide the simulation with more teams and security forces personnel than available in the normal maintenance environment, potentially invalidating the entire model.

29. Law and Kelton, *Simulation Modeling and Analysis*, 24.

30. Fraser, draft memorandum.

31. Kelton et al., *Simulation with Arena*, 26.

32. Ibid., 8.

33. A tape load is a task performed any time a replacement MGS is installed on a missile or the existing data in the MGS is overwritten. An EMT loads critical data into the MGS's computer allowing it to process, issue, and execute certain commands. This task is very short.

34. Fraser, draft memorandum.

35. Tymofichuk, "The Importance of Maintaining Maximum Combat Effectiveness," 30.

36. Directorate of Nuclear Operations, Deputy Chief of Staff, Air and Space Operations, Maintenance, Headquarters USAF/Air and Space Operations-Nuclear Operations (XOS-NO) Point Paper, Subject: "Propulsion Replacement Program Contract," 10 November 2005.

37. Dawson, "Maximizing Security Forces Response Time," 16.

38. Deborah Grace, Headquarters Air Force Space Command/Manpower and Personnel and Manpower Requirements, interview by author, 17 November 2005.

39. CMSgt Joseph Lafferty, Headquarters United States Air Force/Installations and Logistics Maintenance, interview by author, 4 January 2006.

40. Lafferty, briefing.

Appendix A

Arena Simulation Synopsis

Arena version 10.0 is a product of Rockwell Automation, Inc. Arena is a Microsoft based computer simulation program. Arena allows users to perform discrete event and batch and continuous simulation. Several users including manufacturing firms, supply chain managers, the Department of Defense, health care professionals, contact centers, and business processors have used Arena to analyze and predict system performance. Additionally, 350,000 users worldwide have used Arena to improve business processes, provide better service, lower costs, and avoid unnecessary costs.

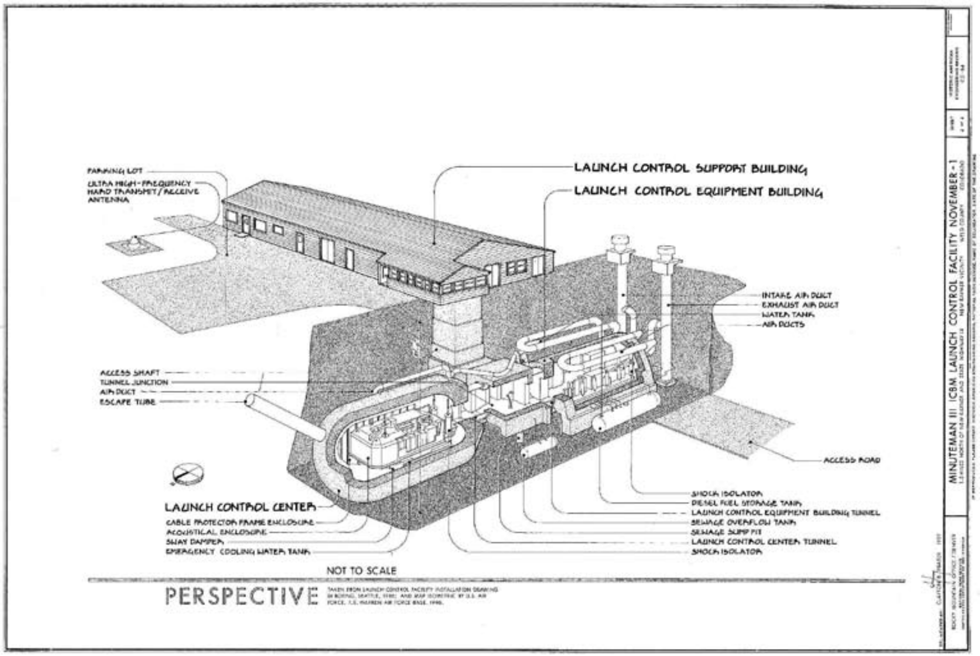
Arena allows users to build flexible, animated models or processes, operations or systems, and then analyze the performance of those models.

Sources:

1. "Arena® Forward Visibility for Your Business,™" available at http://www.avidcom.com/portfolio/arena_DOD/Arena _Demo_on_Demand.html.
2. "Your Path to Success with Simulation, Systems Modeling," available at http://www.sm.com.

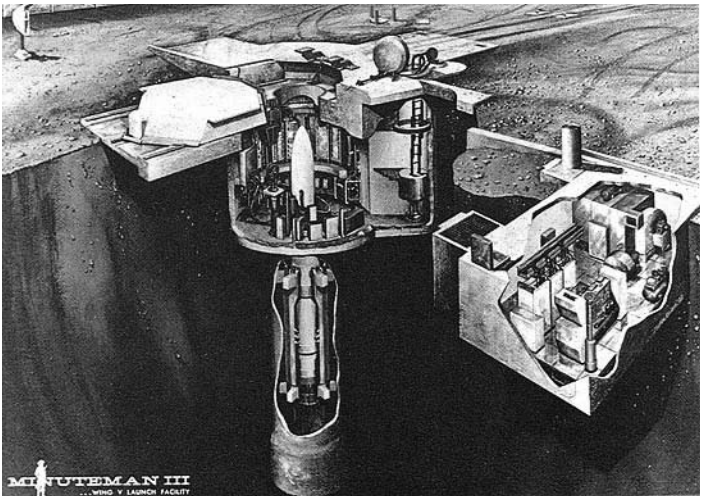
Appendix B

Launch Control Support and Control Equipment Building



Appendix B-1

Minuteman III launch facility



Appendix C

AFSPCI 21-114 (1 May 2003)
Maintenance Priority Designators

Missile Maintenance Priority Designators

Table A2.1. Priority Designators.

Maintenance Priority	*Application*
1	Repair of critical equipment needed for safe operation of the weapon system Maintenance actions needed to prevent damage or further damage to the weapon system, avoid injury to personnel or render the weapon system safe
2	Priority 2 maintenance is listed by order of relative priority Return of an LCC to operational status when three or more are non-operational in the same squadron Maintenance required to retain/return "A Category (CAT)" sorties to EWO alert status Actual EWO generation of "F CAT" and "L CAT" sorties Time change requirements for re-entry systems when the due date is within 30 days Maintenance required to reposture LFs and LCCs being returned from modification/test programs When a known environmental compliance discrepancy exists which could result in a violation of federal, state or local regulations or Air Force/base instructions Repair of severed, damaged or seriously degraded Hardened Intersite Cable System (HICS) Multiple outages of command and control systems (Strategic Automated Command and Control System (SACCS), Milstar, Air Force Satellite Communications (AFSATCOM), Survivable Low Frequency Communications System (SLFCS), ICBM SHF Satellite Terminal (ISST) and UHF Radio System) which will seriously jeopardize alert notification to two or more LCCs in a squadron Restoration of squadron IPD collection capability to the Missile Support Base Maintenance required to deposture LFs and LCCs committed to modification/command approved or directed test programs

Table A2.1. (Continued)

Maintenance Priority	*Application*
3	Discrepancies expected to affect alert posture or degrade impact accuracy Discrepancies which are time sensitive as directed by technical data or which, because of the nature of the discrepancy, require periodic monitoring Maintenance required to return an LCC to operational status when two are non-operational in the same squadron Return of a single command and control communications system at an LCC involving SACCS, Milstar, AFSATCOM, SLFCS, EWO-2, Hardened Voice Channel (HVC), ISST or UHF Radio System All PMC conditions not specifically identified as Priority 4 A hardness/survivability PMC discrepancy within the launch tube or which affects the missile Maintenance to clear discrepancies which require camper alert teams Support of Dash 6 periodic maintenance schedules even though the package may be composed of discrepancies of lower priority Support equipment requiring emergency repair or calibration, the lack of which will delay or prevent mission accomplishment Critical end items and repairable spares designated "Priority Repair" Actions to accomplish immediate MCLs Maintenance required to bring serviceable quantities to established critical levels Time change requirements for RS when due date is within six months Discrepancies expected to affect systems or subsystems which will not directly impact alert posture but may result in a guarded site or a PMC condition or a safety deficiency if not corrected in optimum time
4	Hardness/survivability discrepancies in the LERs, but not in the launch tube Outages on non-command and control communications systems Impairments to any command and control communications systems Scheduled training dispatches/tasks Training devices requiring repair which prevent or delay training Return of an LCC to operational status when four are operational in the same squadron
5	Hardness/survivability discrepancies in the LCC TCTOs and MCLs, which if not promptly completed, could exceed recession date; also MCLs designated as "Urgent" Overdue periodic inspections and overdue time change items Site or support equipment discrepancies not expected to result in a PMC condition, but if corrected will enhance safety, weapon system operation or reliability Impairments to non-command and control communication systems

Table A2.1. (Continued)

Maintenance Priority	*Application*
6	Periodic Inspections, TCTOs, MCLs and time change items Communications preventative maintenance inspections (PMI) Routine maintenance of training devices Scheduled calibration of support equipment not listed under a higher priority
7	Minor repair of missiles and support equipment not listed under a higher priority Fabrication and repair of weapon system items not carrying a higher priority of non-weapon system items Communication discrepancies which don't affect equipment status
8	Informational entries
9	Deferred discrepancies

Note:

1. The Maintenance Group Commander has the authority to work lower priorities over higher priorities to meet mission requirements consistent with safety and security.

2. Shop maintenance required to repair items needed to clear site discrepancies will carry the priority of the site discrepancy if repair is not adequately covered elsewhere in this attachment.

3. For minor hardware hardness discrepancies not expected to be a degraded condition, classify as a Priority 5. Additional hardness/survivability discrepancy guidance is available on a case-by-case basis through 20 AF/LG/LGMO.

4. Be consistent when prioritizing like discrepancies.

5. The following are guidelines to assist MMOC and Materiel Control determine UJCs:

5.1. For initial requests of items from base supply, use UJC "AA."

5.2. For backordered items, use the following UJCs:

5.3. Supplies required to correct a red X condition, use UJC "1A." The lack of the item(s) prevents mission accomplishment because the end item is not operationally ready, out of commission or inoperative. These are MICAP conditions.

5.4. Supplies required to correct red W conditions, use UJC "JA." Lack of the requested item(s) impair primary mission accomplishment because the end item is not fully equipped or is operating in a limited or restricted capacity. These are MICAP conditions.

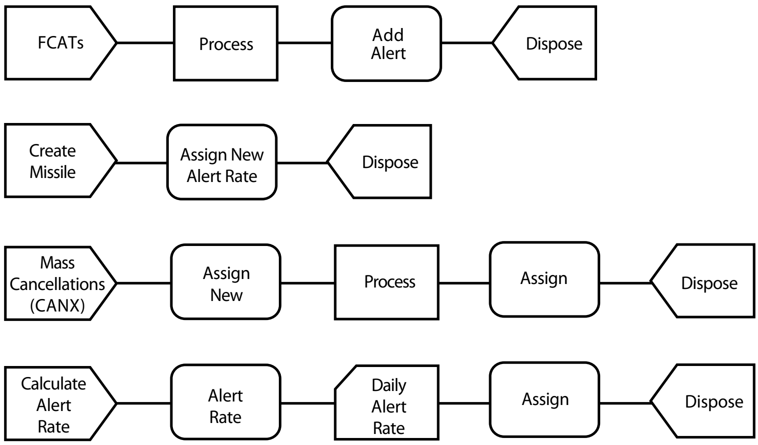
5.5. Supplies required to correct red diagonal conditions, use UJC "BQ." The item required is one that impairs assigned combat/support mission or tasks of the force/activity involved. Also use when the training for such missions and tasks can be accomplished but with decreased effectiveness and efficiency. These are delayed discrepancies.

6. The maintenance priority designator for an outage affecting the command and control communications at multiple sites should be elevated to reflect the higher maintenance priority of the communications outage. Contact Communications Job Control for determination.

Reprinted from AFSPCI 21-114, *Maintenance Priority Designators*, 1 May 2003.

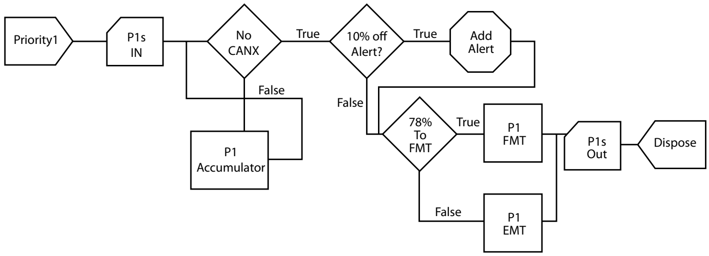
Appendix D

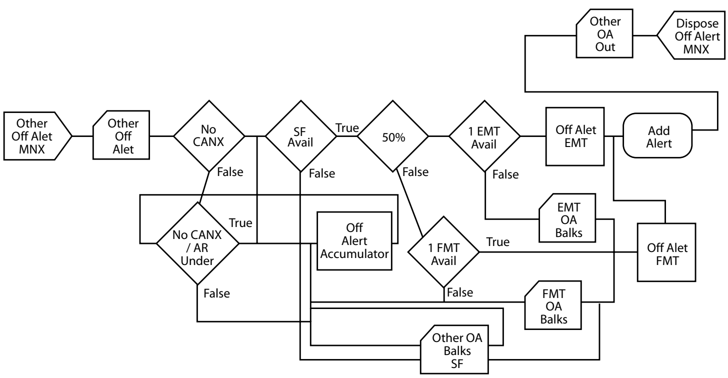
Alert Rate and Miscellaneous Model Flow Diagrams



Appendix E

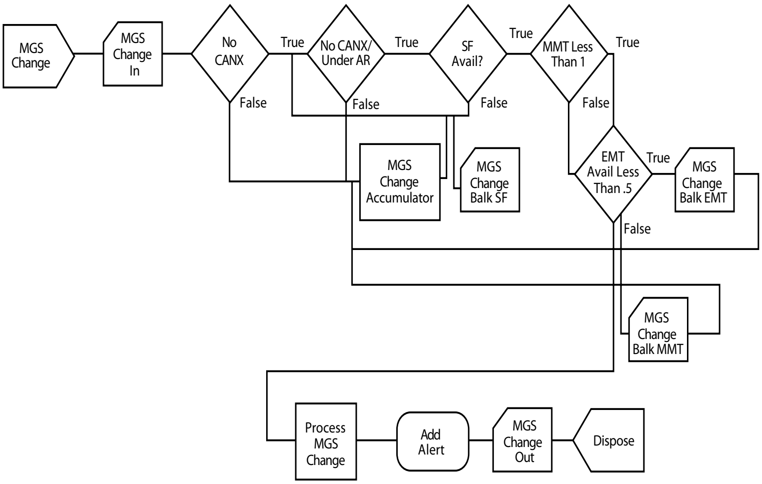
Priority 1 and Other Off-Alert Model Flow Diagrams

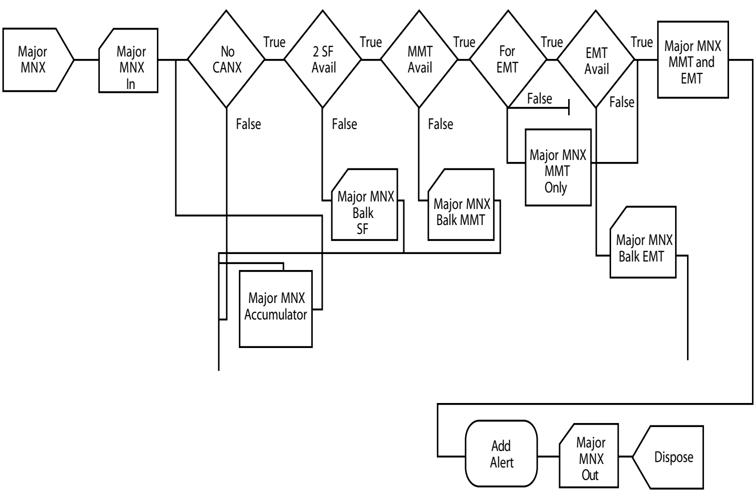




Appendix F

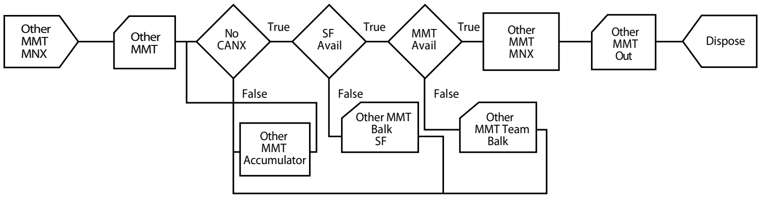
MGS R&R and Major Maintenance Model Flow Diagrams

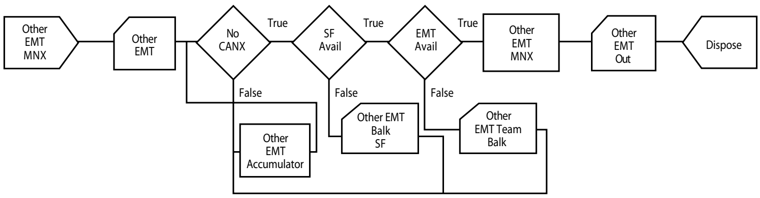


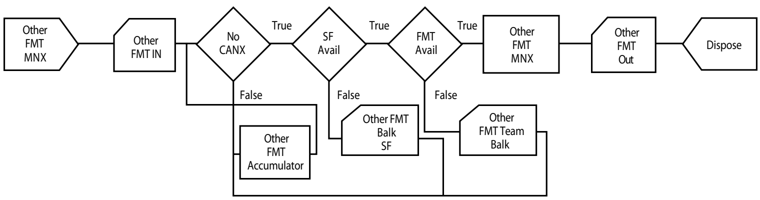


Appendix G

Other MMT, EMT, and FMT Maintenance Flow Diagrams

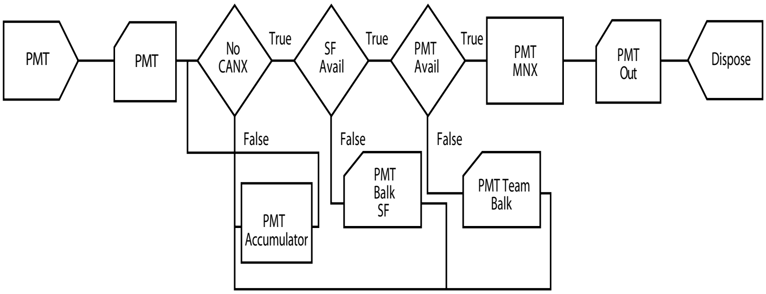


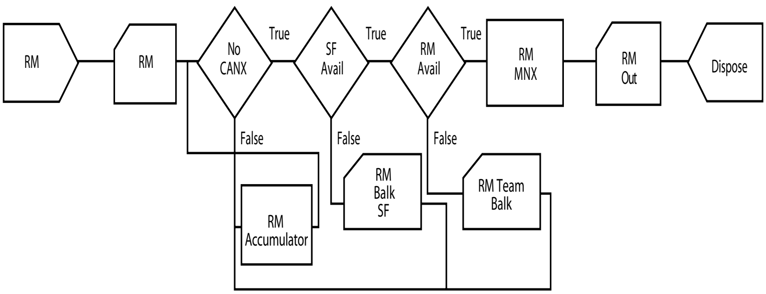


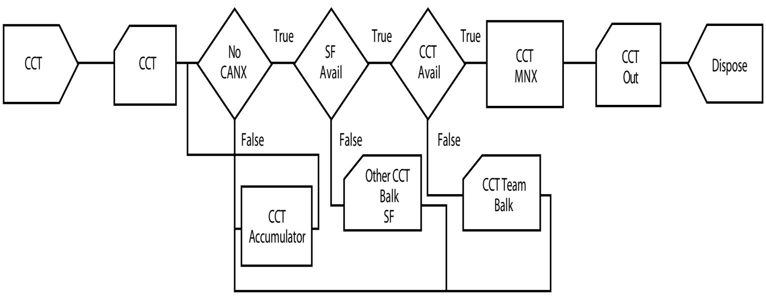


Appendix H

PMT, RM, and CCT Maintenance Model Flow Diagrams







Appendix I

Statistical Formulas for Model Confidence Intervals

1. Average team utilization rate from 30 simulation iterations at each alert rate (Avg)

$$\overline{X}(n) = \sum_{j=1}^{n} x_j \Big/ n$$

$\overline{X}$ = average per iteration

j = number of the specific iteration (could be 1–30)

n = total number of iterations

2. Variance calculations (Var)

$$S^2 = \frac{1}{n-1}\sum_{i=1}^{n}\left(Xi - \overline{X}\right)^2$$

S^2 = variance

n = number of iterations

X_i = utilization rate average of specific iteration (1–30)

$\overline{X}$ = overall utilization rate average

3. Degrees of freedom (D)

$$\hat{f} = \frac{\left[S_1^2(n_1)/n_1 + S_2^2(n_2)/n_2\right]^2}{\dfrac{\left[S_1^2(n_1)/n_1\right]^2}{(n_1-1)} + \dfrac{\left[S_2^2(n_2)/n2\right]}{(n_2-1)}}$$

$\hat{f}$ = degrees of freedom

$\mathbf{S}_1^2$ = variance of 80% or 90% simulation run

S_2^2 = variance of 98.5% simulation run

n = total number of simulation runs (30) per model

4. T distribution (T-Stat)

The T-Stat is a standard numerical value assigned based on the confidence level and degrees of freedom. No calculations were performed to gain the value of the T-Stat.

5. Confidence interval (CI)

$$\overline{X}_1 - \overline{X}_2 \pm T - Stat\sqrt{S_1^2/n_1 + S_2^2/n_2}$$

$\overline{X}_1$ = overall average of team utilization rates at 80% or 90% models (whichever is being compared)

$\overline{X}_2$ = overall average of team utilization at 98.5% model

S_1 = variance calculated at 80% or 90% model (whichever is being compared)

S_2 =variance calculated at 98.5% model

n_1 or n_2 = number of iterations per model (30 in both cases)

Appendix J

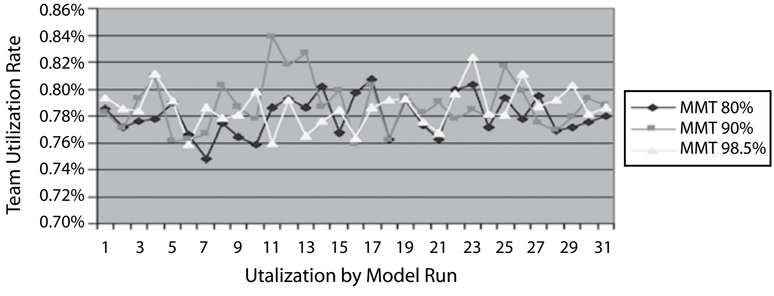
MMT Team Utilization Rates*

Model Run	*MMT 90%*	*MMT 98.5%*	*MMT 80%*	*MMT 98.5%*
1	0.782419	0.793082	0.785457	0.793082
2	0.770672	0.785685	0.771539	0.785685
3	0.792645	0.78394	0.776107	0.78394
4	0.809178	0.811354	0.77785	0.811354
5	0.76109	0.791343	0.790458	0.791343
6	0.763048	0.759141	0.766097	0.759141
7	0.766967	0.786551	0.747821	0.786551
8	0.802876	0.778723	0.7748	0.778723
9	0.785902	0.781116	0.763924	0.781116
10	0.777416	0.797654	0.758926	0.797654
11	0.838773	0.759576	0.786117	0.759576
12	0.817454	0.791773	0.792214	0.791773
13	0.826799	0.765012	0.786552	0.765012
14	0.78611	0.776326	0.802213	0.776326
15	0.798517	0.784819	0.767401	0.784819
16	0.758692	0.763705	0.797432	0.763705
17	0.802872	0.786119	0.807444	0.786119
18	0.761736	0.792003	0.762614	0.792003
19	0.794162	0.792864	0.791552	0.792864
20	0.781988	0.775022	0.772633	0.775022
21	0.790035	0.767187	0.763048	0.767187
22	0.777413	0.796563	0.799599	0.796563
23	0.784373	0.823542	0.803743	0.823542

Model Run	*MMT 90%*	*MMT 98.5%*	*MMT 80%*	*MMT 98.5%*
24	0.779146	0.781325	0.771535	0.781325
25	0.817012	0.780678	0.793295	0.780678
26	0.798305	0.81114	0.777845	0.81114
27	0.774795	0.786775	0.794807	0.786775
28	0.769137	0.791561	0.768928	0.791561
29	0.779585	0.802869	0.771745	0.802869
30	0.79243	0.781332	0.775674	0.781332
Avg	**0.788052**	**0.785959**	**0.779979**	**0.785959**
Var	**0.0004**	**0.000225**	**0.000225**	**0.000225**
df	**53.76433**		**57.99995**	
T-Stat	**1.674116**		**1.672029**	
CI	***-0.00555***	***0.009736***	***-0.01246***	***0.000497***

***Note: Overall confidence level = .95 percent**

The overall confidence level of 95 percent indicates that if we ran the simulation 100 times, 95 of the simulation runs would contain the true mean. In this case, the true mean difference between the two models under comparison whether it is the 98.5 percent model as compared to either the 90 percent or the 80 percent model. If the models are statistically the same, the confidence intervals between the two models will contain zero. Therefore, when the confidence interval contains zero when comparing the difference in means, we are 95 percent confident that the difference between these two models is statistically insignificant. This applies to all charts in appendices J–U. Tabulations were done by Capt Tamiko L. Ritschel, Air Force Logistics Management Agency (AFLMA), Maxwell AFB, Gunter Annex, Alabama.



Appendix K

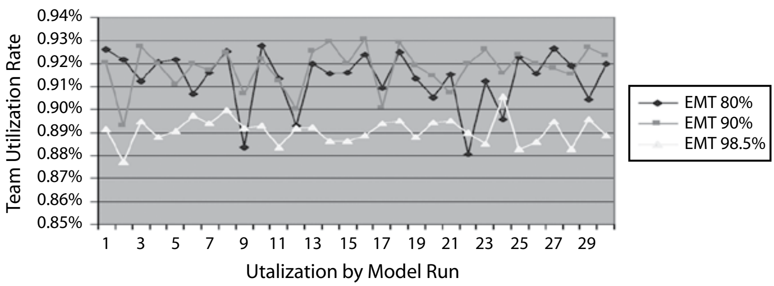
EMT Team Utilization Rates*

Model Run	*EMT 90%*	EMT 98.5%	*EMT 80%*	*EMT 98.5%*
1	0.920336	0.89127	0.926016	0.89127
2	0.893106	0.877439	0.921787	0.877439
3	0.927242	0.894809	0.912209	0.894809
4	0.91973	0.888188	0.920394	0.888188
5	0.91085	0.890623	0.921615	0.890623
6	0.919892	0.897611	0.906817	0.897611
7	0.917097	0.893889	0.916265	0.893889
8	0.924781	0.899488	0.925269	0.899488
9	0.906809	0.891958	0.88345	0.891958
10	0.922119	0.893013	0.927833	0.893013
11	0.912371	0.883491	0.913578	0.883491
12	0.900033	0.891661	0.89285	0.891661
13	0.92558	0.892281	0.919986	0.892281
14	0.929388	0.886308	0.915778	0.886308
15	0.919954	0.886242	0.916227	0.886242
16	0.93076	0.888922	0.923811	0.888922
17	0.900766	0.894005	0.909336	0.894005
18	0.929112	0.89521	0.925157	0.89521
19	0.918975	0.888178	0.913577	0.888178
20	0.914632	0.89426	0.905375	0.89426
21	0.907106	0.895337	0.915452	0.895337
22	0.919866	0.889877	0.880452	0.889877
23	0.926014	0.885155	0.912544	0.885155
24	0.915867	0.90577	0.895987	0.90577
25	0.92376	0.882745	0.922805	0.882745
26	0.919799	0.885719	0.915834	0.885719
27	0.917996	0.894833	0.926568	0.894833
28	0.91529	0.883004	0.919204	0.883004
29	0.927017	0.895924	0.904641	0.895924
30	0.923388	0.88902	0.919898	0.88902

Model Run	EMT 90%	EMT 98.5%	EMT 80%	EMT 98.5%
Avg	**0.917988**	**0.890874**	**0.91369**	**0.890874**
Var	**8.43E-05**	**3.32E-05**	**0.000147**	**3.32E-05**
df	**48.78819**		**41.4661**	
T-Stat	**1.677224**		**1.682878**	
CI	***0.033795***	***0.030432***	***0.018691***	***0.026941***

***Note: Overall confidence level = .95 percent**

The overall confidence level of 95 percent indicates that if we ran the simulation 100 times, 95 of the simulation runs would contain the true mean. In this case, the true mean difference between the two models under comparison whether it is the 98.5 percent model as compared to either the 90 percent or the 80 percent model. If the models are statistically the same, the confidence intervals between the two models will contain zero. Therefore, when the confidence interval contains zero when comparing the difference in means, we are 95 percent confident that the difference between these two models is statistically insignificant. This applies to all charts in appendices J–U. Tabulations were done by Capt Tamiko L. Ritschel, Air Force Logistics Management Agency (AFLMA), Maxwell AFB, Gunter Annex, Alabama.



Appendix L

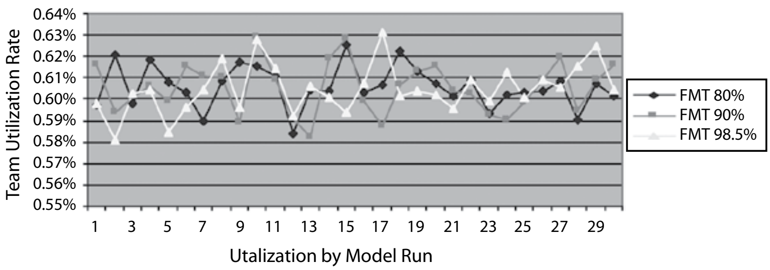
FMT Team Utilization Rates*

Model Run	*FMT 90%*	*FMT 98.5%*	*FMT 80%*	*FMT 98.5%*
1	0.615901	0.597757	0.597214	0.597757
2	0.594059	0.581253	0.620813	0.581253
3	0.600654	0.602584	0.597868	0.602584
4	0.606084	0.604243	0.618131	0.604243
5	0.599052	0.58447	0.60794	0.58447
6	0.615191	0.596171	0.603265	0.596171
7	0.610664	0.604505	0.58967	0.604505
8	0.610232	0.618819	0.608607	0.618819
9	0.589311	0.596059	0.617159	0.596059
10	0.629158	0.62747	0.61526	0.62747
11	0.609317	0.614568	0.610855	0.614568
12	0.590867	0.591965	0.583836	0.591965
13	0.58194	0.606339	0.60462	0.606339
14	0.618896	0.601068	0.603513	0.601068
15	0.628027	0.593586	0.625383	0.593586
16	0.599281	0.607443	0.602986	0.607443
17	0.58749	0.631089	0.606706	0.631089
18	0.606568	0.601565	0.622279	0.601565
19	0.613321	0.603674	0.613317	0.603674
20	0.615645	0.601999	0.607539	0.601999
21	0.603877	0.595722	0.601443	0.595722
22	0.602879	0.609268	0.60888	0.609268
23	0.592852	0.598888	0.593185	0.598888
24	0.590166	0.612467	0.60214	0.612467
25	0.598538	0.600743	0.603007	0.600743
26	0.60879	0.609104	0.603547	0.609104
27	0.619552	0.605745	0.608287	0.605745
28	0.594317	0.615477	0.590303	0.615477

Model Run	*FMT 90%*	*FMT 98.5%*	*FMT 80%*	*FMT 98.5%*
29	0.609163	0.624855	0.607183	0.624855
30	0.616116	0.604099	0.601247	0.604099
Avg	**0.605264**	**0.604766**	**0.605873**	**0.604766**
Var	**0.000144**	**0.000129**	**9.42E-05**	**0.000129**
df	**57.83271**		**56.5992**	
T-Stat	**1.672029**		**1.672522**	
CI	***0.00455***	***0.005546***	***0.00346***	***0.005673***

***Note: Overall confidence level = .95 percent**

The overall confidence level of 95 percent indicates that if we ran the simulation 100 times, 95 of the simulation runs would contain the true mean. In this case, the true mean difference between the two models under comparison whether it is the 98.5 percent model as compared to either the 90 percent or the 80 percent model. If the models are statistically the same, the confidence intervals between the two models will contain zero. Therefore, when the confidence interval contains zero when comparing the difference in means, we are 95 percent confident that the difference between these two models is statistically insignificant. This applies to all charts in appendices J–U. Tabulations were done by Capt Tamiko L. Ritschel, Air Force Logistics Management Agency (AFLMA), Maxwell AFB, Gunter Annex, Alabama.



Appendix M

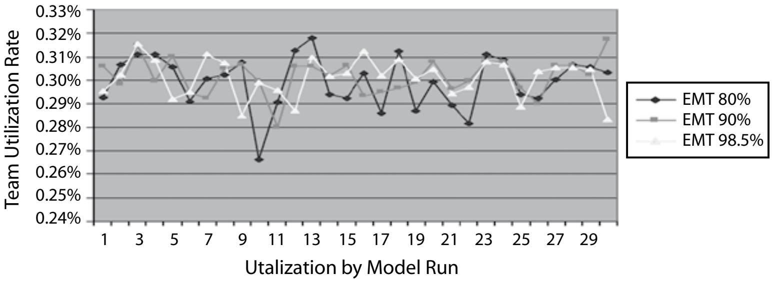
PMT Team Utilization Rates*

Model Run	*PMT 90%*	*PMT 98.5%*	*PMT 80%*	*PMT 98.5%*
1	0.305867	0.295431	0.292808	0.295431
2	0.298467	0.302402	0.306748	0.302402
3	0.315	0.315462	0.31109	0.315462
4	0.299785	0.308503	0.311094	0.308503
5	0.310234	0.291935	0.305446	0.291935
6	0.294564	0.295005	0.29108	0.295005
7	0.292389	0.311101	0.300655	0.311101
8	0.305014	0.307167	0.302394	0.307167
9	0.306728	0.284965	0.307608	0.284965
10	0.29979	0.298907	0.266277	0.298907
11	0.279758	0.295852	0.290645	0.295852
12	0.305871	0.287162	0.312821	0.287162
13	0.305862	0.309798	0.318057	0.309798
14	0.301975	0.301517	0.294133	0.301517
15	0.306305	0.302849	0.292356	0.302849
16	0.293258	0.312393	0.302834	0.312393
17	0.294996	0.301953	0.286286	0.301953
18	0.296743	0.308909	0.312399	0.308909
19	0.298924	0.300654	0.28717	0.300654
20	0.308068	0.304569	0.299354	0.304569
21	0.296298	0.294557	0.289342	0.294557
22	0.299787	0.297159	0.281495	0.297159
23	0.308061	0.308047	0.311099	0.308047
24	0.308063	0.306734	0.308928	0.306734
25	0.296726	0.288892	0.294133	0.288892
26	0.290209	0.303704	0.292383	0.303704
27	0.306315	0.305432	0.3002	0.305432

Model Run	*PMT 90%*	*PMT 98.5%*	*PMT 80%*	*PMT 98.5%*
28	0.306309	0.305437	0.306757	0.305437
29	0.302398	0.304578	0.305457	0.304578
30	0.317625	0.283249	0.303272	0.283249
Avg	**0.301713**	**0.301144**	**0.299477**	**0.301144**
Var	**6.04E-05**	**6.84E-05**	**0.000127**	**6.84E-05**
df	**57.78053**		**53.25821**	
T-Stat	**1.672029**		**1.674116**	
CI	***-0.0029***	***0.004033***	***-0.00593***	***0.0026***

***Note: Overall confidence level = .95 percent**

The overall confidence level of 95 percent indicates that if we ran the simulation 100 times, 95 of the simulation runs would contain the true mean. In this case, the true mean difference between the two models under comparison whether it is the 98.5 percent model as compared to either the 90 percent or the 80 percent model. If the models are statistically the same, the confidence intervals between the two models will contain zero. Therefore, when the confidence interval contains zero when comparing the difference in means, we are 95 percent confident that the difference between these two models is statistically insignificant. This applies to all charts in appendices J–U. Tabulations were done by Capt Tamiko L. Ritschel, Air Force Logistics Management Agency (AFLMA), Maxwell AFB, Gunter Annex, Alabama.



Appendix N

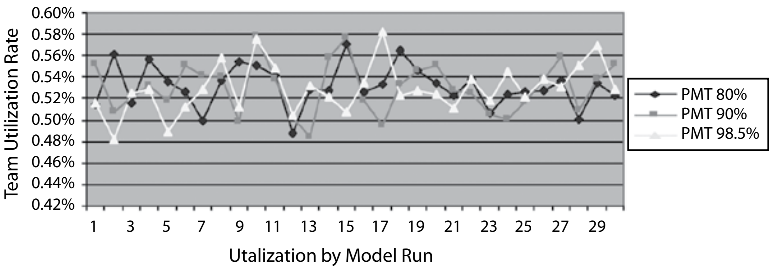
Rivet MILE Team Utilization Rates*

Model Run	*RM 90%*	*RM 98.5%*	*RM 80%*	*RM 98.5%*
1	0.563969	0.550914	0.550914	0.550914
2	0.561358	0.553525	0.569843	0.553525
3	0.53329	0.556136	0.536554	0.556136
4	0.565927	0.578982	0.55483	0.578982
5	0.54765	0.54047	0.548956	0.54047
6	0.548303	0.562663	0.555483	0.562663
7	0.575718	0.555483	0.574413	0.555483
8	0.563969	0.578982	0.567885	0.578982
9	0.565274	0.55483	0.546345	0.55483
10	0.548956	0.575065	0.545692	0.575065
11	0.561358	0.567885	0.577676	0.567885
12	0.568538	0.578982	0.548303	0.578982
13	0.548303	0.577023	0.577676	0.577023
14	0.570496	0.52154	0.573107	0.52154
15	0.524804	0.537859	0.534595	0.537859
16	0.545039	0.545039	0.550914	0.545039
17	0.580287	0.565274	0.55483	0.565274
18	0.532637	0.55483	0.560705	0.55483
19	0.541123	0.541123	0.549608	0.541123
20	0.550914	0.563316	0.568538	0.563316
21	0.561358	0.52154	0.56201	0.52154
22	0.559399	0.563969	0.565927	0.563969
23	0.575065	0.571802	0.556789	0.571802
24	0.587467	0.593342	0.580287	0.593342
25	0.564621	0.558094	0.557441	0.558094
26	0.555483	0.531332	0.552219	0.531332
27	0.542428	0.543081	0.563969	0.543081

Model Run	RM 90%	RM 98.5%	RM 80%	RM 98.5%
28	0.562663	0.565274	0.551567	0.565274
29	0.544386	0.573107	0.553525	0.573107
30	0.545039	0.58094	0.557441	0.58094
Avg	**0.556527**	**0.558747**	**0.558268**	**0.558747**
Var	**0.000217**	**0.000321**	**0.000138**	**0.000321**
df	**55.93099**		**50.06291**	
T- Stat	**1.673034**		**1.675905**	
CI	***-0.0093***	***0.004865***	***-0.00703***	***0.006074***

***Note: Overall confidence level = .95 percent**

The overall confidence level of 95 percent indicates that if we ran the simulation 100 times, 95 of the simulation runs would contain the true mean. In this case, the true mean difference between the two models under comparison whether it is the 98.5 percent model as compared to either the 90 percent or the 80 percent model. If the models are statistically the same, the confidence intervals between the two models will contain zero. Therefore, when the confidence interval contains zero when comparing the difference in means, we are 95 percent confident that the difference between these two models is statistically insignificant. This applies to all charts in appendices J–U. Tabulations were done by Capt Tamiko L. Ritschel, Air Force Logistics Management Agency (AFLMA), Maxwell AFB, Gunter Annex, Alabama.



Appendix O

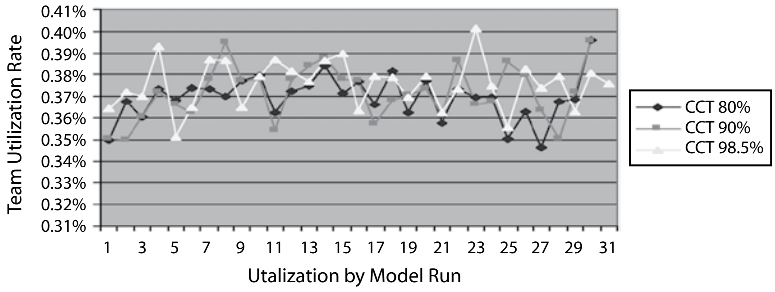
CCT Team Utilization Rates*

Model Run	*CCT 90%*	*CCT 98.5%*	*CCT 80%*	*CCT 98.5%*
1	0.3505222	0.36423	0.3498695	0.3642298
2	0.3498695	0.372063	0.3674935	0.3720627
3	0.3603133	0.370104	0.3603133	0.3701044
4	0.3720627	0.39295	0.3733681	0.3929504
5	0.366188	0.351175	0.3681462	0.3511749
6	0.3622715	0.364883	0.3740209	0.3648825
7	0.3779373	0.387076	0.3733681	0.3870757
8	0.3949086	0.386423	0.3701044	0.386423
9	0.3772846	0.364883	0.3772846	0.3648825
10	0.3779373	0.379243	0.3798956	0.3792428
11	0.3544386	0.387076	0.3622715	0.3870757
12	0.3779373	0.381854	0.3727154	0.3818538
13	0.383812	0.376632	0.3746736	0.3766319
14	0.3877285	0.386423	0.383812	0.386423
15	0.3779373	0.389687	0.3714099	0.3896867
16	0.3772846	0.363577	0.3766319	0.363577
17	0.3570496	0.379243	0.366188	0.3792428
18	0.3681462	0.37859	0.3818538	0.3785901
19	0.3707572	0.369452	0.3622715	0.3694517
20	0.3733681	0.379243	0.3772846	0.3792428
21	0.3609661	0.362272	0.3577023	0.3622715
22	0.386423	0.373368	0.3733681	0.3733681
23	0.366188	0.401436	0.3694517	0.401436
24	0.3674935	0.374674	0.3694517	0.3746736
25	0.3857702	0.355744	0.3505222	0.3557441
26	0.3798956	0.382507	0.3629243	0.3825065
27	0.363577	0.374021	0.3466057	0.3740209

Model Run	CCT 90%	CCT 98.5%	CCT 80%	CCT 98.5%
28	0.3505222	0.379243	0.3674935	0.3792428
29	0.3720627	0.362924	0.368799	0.3629243
30	0.3955614	0.380548	0.3962141	0.3805483
AVG	**0.3715405**	**0.375718**	**0.369517**	**0.375718**
VAR	**0.0001583**	**0.00013**	**0.0001076**	**0.0001297**
DF	**57.430721**		**57.50217**	
T-Stat	**2.1808829**		**2.1808829**	
CI	***-0.010935***	***0.00258***	***-0.012334***	***-6.81E-05***

***Note: Overall confidence level = .95 percent**

The overall confidence level of 95 percent indicates that if we ran the simulation 100 times, 95 of the simulation runs would contain the true mean. In this case, the true mean difference between the two models under comparison whether it is the 98.5 percent model as compared to either the 90 percent or the 80 percent model. If the models are statistically the same, the confidence intervals between the two models will contain zero. Therefore, when the confidence interval contains zero when comparing the difference in means, we are 95 percent confident that the difference between these two models is statistically insignificant. This applies to all charts in appendices J–U. Tabulations were done by Capt Tamiko L. Ritschel, Air Force Logistics Management Agency (AFLMA), Maxwell AFB, Gunter Annex, Alabama.



Appendix P

MMT Team Utilization during Alert-Rate Decrease Period*

Model Run	*MMT 80% (179)*	*MMT 98.5% (179)*	*MMT 90% (75)*	*MMT 98.5% (75)*
1	0.709497207	0.812849162	0.691093333	0.817773333
2	0.706709497	0.781195531	0.686666667	0.78668
3	0.679692737	0.777469274	0.69556	0.720013333
4	0.729044693	0.691798883	0.695533333	0.68668
5	0.667597765	0.74022905	0.644426667	0.688906667
6	0.654558659	0.732759777	0.64	0.653306667
7	0.671312849	0.811916201	0.677773333	0.842226667
8	0.707620112	0.744877095	0.66	0.768893333
9	0.703910615	0.730916201	0.626666667	0.700013333
10	0.741150838	0.768162011	0.5844	0.726693333
11	0.659201117	0.783072626	0.653306667	0.78224
12	0.741156425	0.813782123	0.76888	0.826666667
13	0.664782123	0.770005587	0.651093333	0.79776
14	0.659212291	0.80447486	0.668866667	0.788893333
15	0.710396648	0.824022346	0.67996	0.848893333
16	0.637810056	0.739296089	0.606653333	0.773333333
17	0.661072626	0.756055866	0.757786667	0.78224
18	0.664793296	0.75326257	0.686653333	0.764453333
19	0.68527933	0.828675978	0.68	0.842213333
20	0.683407821	0.776536313	0.702213333	0.84
21	0.700173184	0.798888268	0.73556	0.946666667
22	0.701106145	0.814715084	0.695546667	0.864453333
23	0.689944134	0.78398324	0.697786667	0.79776
24	0.632217877	0.82122905	0.63332	0.860013333
25	0.742089385	0.796100559	0.719986667	0.848893333

Model Run	*MMT 80% (179)*	*MMT 98.5% (179)*	*MMT 90% (75)*	*MMT 98.5% (75)*
26	0.64803352	0.837055866	0.553306667	0.837773333
27	0.656418994	0.746731844	0.7	0.715546667
28	0.74301676	0.811	0.72	0.748893333
29	0.618251397	0.72998324	0.644453333	0.808906667
30	0.674100559	0.791435754	0.68888	0.83332
Avg	**0.684785289**	**0.779082682**	**0.674879111**	**0.790003556**
Var	**0.001169246**	**0.001312497**	**0.00218879**	**0.004205448**
df	**57.80739604**		**52.75274805**	
T-Stat	**1.672028889**		**1.674689154**	
CI	***0.109505025***	***0.07908976***	***0.139573832***	***0.090675057***

***Note: Overall confidence level = .95 percent**

The overall confidence level of 95 percent indicates that if we ran the simulation 100 times, 95 of the simulation runs would contain the true mean. In this case, the true mean difference between the two models under comparison whether it is the 98.5 percent model as compared to either the 90 percent or the 80 percent model. If the models are statistically the same, the confidence intervals between the two models will contain zero. Therefore, when the confidence interval contains zero when comparing the difference in means, we are 95 percent confident that the difference between these two models is statistically insignificant. This applies to all charts in appendices J–U. Tabulations were done by Capt Tamiko L. Ritschel, Air Force Logistics Management Agency (AFLMA), Maxwell AFB, Gunter Annex, Alabama.

Appendix Q

EMT Team Utilization during Alert-Rate Decrease Period*

Model Run	*EMT 80% (179)*	*EMT 98.5% (179)*	*EMT 90% (75)*	*EMT 98.5% (75)*
1	0.882206704	0.909469274	0.89444	0.906186667
2	0.894441341	0.879396648	0.801106667	0.865546667
3	0.860569832	0.874329609	0.825013333	0.863973333
4	0.890821229	0.847307263	0.872773333	0.860506667
5	0.86852514	0.85098324	0.830546667	0.816626667
6	0.935743017	0.868407821	0.900533333	0.887653333
7	0.857810056	0.843446927	0.915546667	0.800306667
8	0.861815642	0.844608939	0.841666667	0.849973333
9	0.892452514	0.86877095	0.87276	0.854413333
10	0.887312849	0.867664804	0.821653333	0.836093333
11	0.865212291	0.887547486	0.841666667	0.898333333
12	0.87149162	0.863424581	0.81552	0.839746667
13	0.90572067	0.868446927	0.89	0.864413333
14	0.91027933	0.873564246	0.871106667	0.8622
15	0.876150838	0.891402235	0.84	0.861426667
16	0.87327933	0.895452514	0.844466667	0.896106667
17	0.902793296	0.858435754	0.89556	0.828853333
18	0.882860335	0.887212291	0.885773333	0.876413333
19	0.886256983	0.867519553	0.812426667	0.85108
20	0.855888268	0.89101676	0.885546667	0.896613333
21	0.907357542	0.873100559	0.902893333	0.846613333
22	0.89522905	0.88403352	0.920533333	0.893866667
23	0.825553073	0.919888268	0.846906667	0.932746667
24	0.823743017	0.879050279	0.84	0.868626667
25	0.823536313	0.85796648	0.708426667	0.811613333

Model Run	*EMT 80% (179)*	*EMT 98.5% (179)*	*EMT 90% (75)*	*EMT 98.5% (75)*
26	0.865463687	0.892195531	0.883346667	0.885533333
27	0.927597765	0.87450838	0.88244	0.859413333
28	0.860340782	0.855765363	0.852213333	0.813826667
29	0.860787709	0.850050279	0.832213333	0.84828
30	0.880106145	0.871944134	0.87112	0.84276
Avg	**0.877711546**	**0.873230354**	**0.856606667**	**0.860658222**
Var	**0.000738947**	**0.00034404**	**0.001832431**	**0.000937987**
df	**51.19300812**		**52.52502133**	
T-Stat	**1.675284951**		**1.674689154**	
CI	***-0.005584409***	***0.014546792***	***-0.0201449***	***0.012041784***

***Note: Overall confidence level = .95 percent**

The overall confidence level of 95 percent indicates that if we ran the simulation 100 times, 95 of the simulation runs would contain the true mean. In this case, the true mean difference between the two models under comparison whether it is the 98.5 percent model as compared to either the 90 percent or the 80 percent model. If the models are statistically the same, the confidence intervals between the two models will contain zero. Therefore, when the confidence interval contains zero when comparing the difference in means, we are 95 percent confident that the difference between these two models is statistically insignificant. This applies to all charts in appendices J–U. Tabulations were done by Capt Tamiko L. Ritschel, Air Force Logistics Management Agency (AFLMA), Maxwell AFB, Gunter Annex, Alabama.

Appendix R

FMT Team Utilization during Alert-Rate Decrease Period*

Model Run	*FMT 80% (179)*	*FMT 98.5% (179)*	*FMT 90% (75)*	*FMT 98.5% (75)*
1	0.565022346	0.596111732	0.57648	0.618013333
2	0.631128492	0.604117318	0.625813333	0.59492
3	0.602899441	0.619502793	0.62312	0.633586667
4	0.593620112	0.618452514	0.589386667	0.635813333
5	0.620418994	0.633357542	0.57516	0.610906667
6	0.583441341	0.592497207	0.598226667	0.615586667
7	0.59227933	0.621452514	0.584226667	0.675146667
8	0.632329609	0.599173184	0.655373333	0.625586667
9	0.617162011	0.569675978	0.636946667	0.60492
10	0.601329609	0.622670391	0.605826667	0.664933333
11	0.587731844	0.616614525	0.61092	0.617626667
12	0.61326257	0.593502793	0.620706667	0.599373333
13	0.548335196	0.606351955	0.504226667	0.574893333
14	0.633441341	0.612318436	0.66604	0.669346667
15	0.591005587	0.618	0.626253333	0.620706667
16	0.61075419	0.589882682	0.636706667	0.577586667
17	0.625251397	0.578240223	0.63692	0.565306667
18	0.587653631	0.615759777	0.6018	0.605586667
19	0.617061453	0.58	0.618693333	0.57292
20	0.605446927	0.598368715	0.59292	0.584933333
21	0.614094972	0.548804469	0.492253333	0.486706667
22	0.558675978	0.603659218	0.546693333	0.631146667
23	0.592743017	0.625463687	0.56556	0.615813333
24	0.573575419	0.603094972	0.588	0.613813333
25	0.626553073	0.592318436	0.582693333	0.531626667

Model Run	*FMT 80% (179)*	*FMT 98.5% (179)*	*FMT 90% (75)*	*FMT 98.5% (75)*
26	0.606083799	0.571134078	0.557573333	0.589813333
27	0.616871508	0.591826816	0.569133333	0.58424
28	0.621173184	0.605055866	0.554706667	0.5956
29	0.630206704	0.630301676	0.61896	0.656053333
30	0.596201117	0.594430168	0.617786667	0.57468
Avg	**0.603191806**	**0.601737989**	**0.595970222**	**0.604906222**
Var	**0.000500299**	**0.000379763**	**0.00159168**	**0.001548121**
df	**56.93201056**		**57.98883909**	
T-Stat	**1.672522304**		**1.672028889**	
CI	***-007604923***	***0.010512558***	***-0.026041439***	***0.008169439***

***Note: Overall confidence level = .95 percent**

The overall confidence level of 95 percent indicates that if we ran the simulation 100 times, 95 of the simulation runs would contain the true mean. In this case, the true mean difference between the two models under comparison whether it is the 98.5 percent model as compared to either the 90 percent or the 80 percent model. If the models are statistically the same, the confidence intervals between the two models will contain zero. Therefore, when the confidence interval contains zero when comparing the difference in means, we are 95 percent confident that the difference between these two models is statistically insignificant. This applies to all charts in appendices J–U. Tabulations were done by Capt Tamiko L. Ritschel, Air Force Logistics Management Agency (AFLMA), Maxwell AFB, Gunter Annex, Alabama.

Appendix S

PMT Team Utilization during Alert-Rate Decrease Period*

Model Run	*PMT 80% (179)*	*PMT 98.5% (179)*	*PMT 90% (75)*	*PMT 98.5% (75)*
1	0.279284916	0.297888268	0.337773333	0.337746667
2	0.357513966	0.273670391	0.333306667	0.239893333
3	0.305374302	0.305368715	0.284426667	0.311093333
4	0.260648045	0.296039106	0.226613333	0.26216
5	0.281134078	0.292324022	0.27544	0.302186667
6	0.273698324	0.314642458	0.297733333	0.31548
7	0.322111732	0.335173184	0.306626667	0.315546667
8	0.309083799	0.288564246	0.302186667	0.2932
9	0.303463687	0.301648045	0.275453333	0.324453333
10	0.292357542	0.292335196	0.288906667	0.32
11	0.309050279	0.296022346	0.3466	0.279946667
12	0.283027933	0.322145251	0.302186667	0.302186667
13	0.31096648	0.296055866	0.337733333	0.275533333
14	0.303497207	0.318385475	0.328866667	0.35548
15	0.312793296	0.284893855	0.3466	0.262186667
16	0.318413408	0.307201117	0.324386667	0.311066667
17	0.337	0.323994413	0.328826667	0.302146667
18	0.297905028	0.322100559	0.306626667	0.31992
19	0.303497207	0.303519553	0.319946667	0.28
20	0.296011173	0.279273743	0.297693333	0.311053333
21	0.28672067	0.271849162	0.213266667	0.26664
22	0.264363128	0.297927374	0.279946667	0.337746667
23	0.36122905	0.273675978	0.342173333	0.266613333
24	0.335128492	0.312787709	0.395506667	0.253266667
25	0.253212291	0.288575419	0.262146667	0.30212

Model Run	*PMT 80% (179)*	*PMT 98.5% (179)*	*PMT 90% (75)*	*PMT 98.5% (75)*
26	0.314648045	0.283027933	0.306586667	0.279986667
27	0.320256983	0.269955307	0.319946667	0.30216
28	0.290435754	0.256927374	0.275533333	0.23548
29	0.290413408	0.284860335	0.288826667	0.275453333
30	0.268111732	0.260659218	0.275493333	0.253253333
Avg	**0.301378399**	**0.295049721**	**0.304245333**	**0.293133333**
Var	**0.000682664**	**0.000378015**	**0.001362314**	**0.000912569**
df	**53.57988565**		**55.81831917**	
T-Stat	**1.674116237**		**1.673033966**	
CI	***-0.003625766***	***0.016283122***	***-0.003456795***	***0.025680795***

***Note: Overall confidence level = .95 percent**

The overall confidence level of 95 percent indicates that if we ran the simulation 100 times, 95 of the simulation runs would contain the true mean. In this case, the true mean difference between the two models under comparison whether it is the 98.5 percent model as compared to either the 90 percent or the 80 percent model. If the models are statistically the same, the confidence intervals between the two models will contain zero. Therefore, when the confidence interval contains zero when comparing the difference in means, we are 95 percent confident that the difference between these two models is statistically insignificant. This applies to all charts in appendices J–U. Tabulations were done by Capt Tamiko L. Ritschel, Air Force Logistics Management Agency (AFLMA), Maxwell AFB, Gunter Annex, Alabama.

Appendix T

Rivet MILE Team Utilization during Alert-Rate Decrease Period*

Model Run	*RM 80% (179)*	*RM 98.5% (179)*	*RM 90% (75)*	*RM 98.5% (75)*
1	0.527932961	0.553072626	0.513333333	0.546666667
2	0.567039106	0.586592179	0.54	0.593333333
3	0.606145251	0.55027933	0.64	0.58
4	0.561452514	0.55027933	0.553333333	0.6
5	0.502793296	0.527932961	0.566666667	0.6
6	0.511173184	0.581005587	0.553333333	0.533333333
7	0.578212291	0.583798883	0.593333333	0.56
8	0.583798883	0.547486034	0.593333333	0.526666667
9	0.575418994	0.516759777	0.513333333	0.446666667
10	0.594972067	0.51396648	0.54	0.513333333
11	0.575418994	0.533519553	0.586666667	0.553333333
12	0.594972067	0.539106145	0.6	0.5
13	0.567039106	0.575418994	0.56	0.593333333
14	0.578212291	0.558659218	0.56	0.626666667
15	0.592178771	0.5	0.54	0.553333333
16	0.600558659	0.589385475	0.58	0.606666667
17	0.497206704	0.569832402	0.52	0.56
18	0.519553073	0.553072626	0.493333333	0.6
19	0.592178771	0.558659218	0.626666667	0.56
20	0.569832402	0.558659218	0.56	0.593333333
21	0.553072626	0.586592179	0.546666667	0.653333333
22	0.575418994	0.555865922	0.573333333	0.593333333
23	0.61452514	0.567039106	0.633333333	0.5
24	0.586592179	0.62849162	0.546666667	0.646666667
25	0.530726257	0.527932961	0.466666667	0.546666667
26	0.592178771	0.592178771	0.62	0.586666667
27	0.527932961	0.581005587	0.513333333	0.586666667

Model Run	*RM 80% (179)*	*RM 98.5% (179)*	*RM 90% (75)*	*RM 98.5% (75)*
28	0.494413408	0.600558659	0.533333333	0.553333333
29	0.505586592	0.491620112	0.586666667	0.533333333
30	0.530726257	0.555865922	0.52	0.54
Avg	**0.560242086**	**0.557821229**	**0.559111111**	**0.566222222**
Var	**0.001291816**	**0.000940686**	**0.001755504**	**0.002013589**
df	**56.59986843**		**57.72932642**	
T-Stat	**1.672522304**		**1.672028889**	
CI	***-0.012007181***	***0.016848894***	***-0.025852492***	***0.01163027***

***Note: Overall confidence level = .95 percent**

The overall confidence level of 95 percent indicates that if we ran the simulation 100 times, 95 of the simulation runs would contain the true mean. In this case, the true mean difference between the two models under comparison whether it is the 98.5 percent model as compared to either the 90 percent or the 80 percent model. If the models are statistically the same, the confidence intervals between the two models will contain zero. Therefore, when the confidence interval contains zero when comparing the difference in means, we are 95 percent confident that the difference between these two models is statistically insignificant. This applies to all charts in appendices J–U. Tabulations were done by Capt Tamiko L. Ritschel, Air Force Logistics Management Agency (AFLMA), Maxwell AFB, Gunter Annex, Alabama.

Appendix U

CCT Team Utilization during Alert-Rate Decrease Period*

Model Run	*CCT 80% (179)*	*CCT 98.5% (179)*	*CCT 90% (75)*	*CCT 98.5% (75)*
1	0.351955307	0.337988827	0.337988827	0.346666667
2	0.37150838	0.363128492	0.363128492	0.34
3	0.363128492	0.351955307	0.351955307	0.34
4	0.346368715	0.363128492	0.363128492	0.38
5	0.343575419	0.368715084	0.368715084	0.36
6	0.324022346	0.340782123	0.340782123	0.333333333
7	0.365921788	0.37150838	0.37150838	0.353333333
8	0.365921788	0.396648045	0.396648045	0.466666667
9	0.346368715	0.354748603	0.354748603	0.36
10	0.365921788	0.402234637	0.402234637	0.346666667
11	0.396648045	0.37150838	0.37150838	0.393333333
12	0.351955307	0.343575419	0.343575419	0.38
13	0.382681564	0.326815642	0.326815642	0.306666667
14	0.368715084	0.374301676	0.374301676	0.32
15	0.337988827	0.337988827	0.337988827	0.4
16	0.379888268	0.363128492	0.363128492	0.34
17	0.377094972	0.357541899	0.357541899	0.373333333
18	0.335195531	0.346368715	0.346368715	0.373333333
19	0.368715084	0.354748603	0.354748603	0.346666667
20	0.32122905	0.391061453	0.391061453	0.44
21	0.351955307	0.374301676	0.374301676	0.353333333
22	0.354748603	0.329608939	0.329608939	0.346666667
23	0.374301676	0.377094972	0.377094972	0.38
24	0.377094972	0.374301676	0.374301676	0.32
25	0.377094972	0.357541899	0.357541899	0.36
26	0.363128492	0.346368715	0.346368715	0.366666667
27	0.335195531	0.38547486	0.38547486	0.34

Model Run	*CCT 80% (179)*	*CCT 98.5% (179)*	*CCT 90% (75)*	*CCT 98.5% (75)*
28	0.363128492	0.363128492	0.363128492	0.333333333
29	0.349162011	0.351955307	0.351955307	0.32
30	0.396648045	0.37150838	0.37150838	0.346666667
AVG	**0.360242086**	**0.361638734**	**0.361638734**	**0.358888889**
VAR	**0.000365094**	**0.000354467**	**0.000354467**	**0.001161941**
DF	**57.98735078**		**45.18727415**	
T-Stat	**1.672028889**		**1.679427393**	
CI	***-0.009585387***	***0.006792091***	***-0.009190274***	***0.014689964***

***Note: Overall confidence level = .95 percent**

The overall confidence level of 95 percent indicates that if we ran the simulation 100 times, 95 of the simulation runs would contain the true mean. In this case, the true mean difference between the two models under comparison whether it is the 98.5 percent model as compared to either the 90 percent or the 80 percent model. If the models are statistically the same, the confidence intervals between the two models will contain zero. Therefore, when the confidence interval contains zero when comparing the difference in means, we are 95 percent confident that the difference between these two models is statistically insignificant. This applies to all charts in appendices J–U. Tabulations were done by Capt Tamiko L. Ritschel, Air Force Logistics Management Agency (AFLMA), Maxwell AFB, Gunter Annex, Alabama.

Abbreviations

AETC	Air Education and Training Command
AFNGOSG	Air Force Nuclear General Officer Steering Group
AR	alert rate
AVE	aerospace vehicle equipment
BGRC	Boeing Guidance Repair Center
CANX	Cancel
CCT	Corrosion Control Team
DOD	Department of Defense
ECS	environmental control system
EMT	Electromechanical Team
FCAT	off-alert for scheduled maintenance
FMT	Facilities Maintenance Team
GRP	guidance replacement program
GWOT	global war on terrorism
ICBM	intercontinental ballistic missile
In	in
LC	launcher closure
LCC	launch control center
LF	launch facility
LLC	limited life component
LSB	launch support building
MG	Maintenance Group
MGS	missile guidance set
MHT	Missile-Handling Technicians
MMT	Missile Maintenance Team
MNX	Maintenance
Mx	major maintenance
O&M	operations and maintenance
OA	off-alert
OGE	operational ground equipment
P1	Priority 1
P2	Priority 2
P3	Priority 3

P4	Priority 4
PHT	Periodic Maintenance Team
PRP	propulsion replacement program
PSRE	propulsion system rocket engine life extension program
QRM	quick reaction maintenance
R&R	remove and replace
Rivet MILE	Minuteman Integrated Life Extension Teams
RM	Rivet MILE
RPIE	real property installed equipment
RS	reentry system
SERV	safety enhanced reentry vehicle program
SET	security escort team
SF	security forces
SRV	single reentry vehicle program

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